2023

POTENTIAL REMOVAL OF THE COLDSTREAM DAM IN COLDSTREAM, ONTARIO

PROJECT SUMMARY

ST. CLAIR REGION CONSERVATION AUTHORITY | 205 Mill pond Crescent, Strathroy, ON N7G 3P9

Background

The Coldstream Dam is located approximately 12 km northeast of Strathroy in Coldstream, Ontario in the headwaters of the east Sydenham River. Originally constructed in 1968, the structure is approximately 3.35m high and consists of a 45m long retaining wall of vertical sheet piles made of heavy gauge ARCH-Type individual sheets locked together at joint during installation. Large armor stone was placed on the downstream side of the dam ranging in size from 16-24 inches in diameter and placed on a slope of 3:1 horizontal to vertical. An earthen berm approximately 40m long is located at the southern end of the sheet pile dam. The dam does not contain any spillways or stop logs so there is no way to adjust the water levels in the reservoir. The dam is equipped with a low flow bypass valve however, the condition of the valve is believed to be non-operatable. The original purpose of the dam and reservoir was to support recreational opportunities like swimming, boating, and fishing.

Figure 1 Right: Coldstream dam 1986, Left: Coldstream reservoir used for swimming and boating in the 1970's

Since the installation of the dam and creation of the reservoir sedimentation has occurred increasing the depth of sediment in the reservoir. Additionally, the water quality has declined. This has resulted in a negative impact on recreational activities and wildlife habitat.

Dams in general can negatively impact river ecosystems by creating barriers to fish passage, impeding mussel distribution, altering thermal regimes, altering sediment transport, and degrading water quality (temperature, oxygen levels, algal growth, and bacteria levels). Local concerns have been raised about the water quality in the reservoir, specifically the algal blooms that occur.

Figure 2 2022 Algal bloom in reservoir at Coldstream

With this change in function of the reservoir, and new information regarding the impacts of dams on freshwater systems, the St. Clair Region Conservation Authority (SCRCA) is interested in the feasibility of removing the dam and restoring the reservoir to a more natural river system. The SCRCA has hired GSS Engineering Consultants Ltd. to review the current conditions of the dam and reservoir and investigate the potential removal of the dam. This report summarizes the information obtained from the report titled Potential Removal of the Coldstream Dam in Coldstream, Ontario.

Ecological impacts

The International Union for Conservation of Nature has designated the Sydenham River as one of thirteen freshwater Key Biodiversity Areas in Canada. This is due to the diversity of freshwater species supported by the Sydenham River. The Sydenham River is home to 34 mussel species and 80 fish species as well as many other semi-aquatic species such as turtles, snakes, amphibians, and dragonflies. Some of these species are designated as Species at Risk and are found nowhere else in Canada or remain in only a few locations globally.

As noted in the 2018 Sydenham River Recovery Strategy (Strategy) there are several threats to aquatic Species at Risk that inhabit the Sydenham River. Specifically, dams are identified in the Strategy as negatively impacting aquatic habitat by:

- Causing thermal warming – based on surveys conducted by SCRCA staff over three years, temperature loggers recorded water temperature at the upstream and downstream end of the reservoir and noted on average the water temperature downstream of the reservoir was 2.8°C warmer in the summer months than upstream of the reservoir.

- Decreasing water quality – due to the low flows and shallow water within the reservoir algal blooms have increased. Algal blooms impact water quality by depleting oxygen levels and can create an unpleasant odor and safety concerns on top of being aesthetically unappealing.
- Altering sediment transport processes and sediment deposition - the Coldstream dam prevents sediments such as sand and gravel from moving downstream, this sediment is necessary for some wildlife and their various life stages.
- barrier to fish migration and mussel distribution – the Coldstream dam limits the ability of fish to move freely through the Sydenham River and access a wide variety of habitat types. Additionally, by limiting the ability of fish to move the distribution of mussels are also impacted as many mussels rely on fish hosts to move their young upstream.

Removal of the Coldstream dam would eliminate an identified threat to aquatic species at risk and their habitat and life stages. However, removal of the dam can also negatively impact aquatic species and their habitats if the sediment, specifically the silt, in the reservoir is not managed effectively. Silt, unlike sand and gravel, can negatively impact species downstream by increasing turbidity and making it difficult for species to fulfill their life cycle requirements. Silt can also smother and suffocate sedentary species like mussels or fish eggs. With the amount of silt that has accumulated behind the Coldstream Dam, additional study is recommended to determine silt transport rates and the affected downstream area if the decision is made to remove the dam and allow sediment to naturally migrate downstream.

Overall, removal of the dam should have a net benefit to river ecology. Dam removal should improve habitat for aquatic species at risk by restoring natural sediment transport and supply downstream of the dam, by reducing the thermal impact to the river caused by the dam reservoir and by restoring fish passage. The dam removal options that include allowing the sediment to naturally wash down the river, if considered, should be carefully discussed in advance with regulatory authorities including the Department of Fisheries and Oceans, and the provincial MNRF and MECP. It is critical that these agencies, and perhaps others, come to agreement early in the planning process as to the preferred means to deal with the large volume of sediment stored in the reservoir.

Existing Conditions and Sediment Analysis

Based on the GSS report and subsequent dam condition report prepared by True Engineering in June 2022, the Coldstream dam appears to be in good condition overall. The total life expectancy is estimated at 75-100 years, with the remaining life expectancy estimated at 20-45 years. The reservoir is approximately 4.5 ha in size. The overall depth is relatively shallow with a maximum depth of approximately 1.37m. Historically the reservoir would have been deeper but large volumes of sediment have accumulated and are still accumulating since the time of construction. Sediment depths will continue to increase over time closer to the dam.

Surveys completed by GSS Engineering Consultants summarized the various water depths over the sediment ranged from 0.76m to 1.37m with a typical depth of water over sediment being 1.1m. Reservoir depths were greater toward the Coldstream dam confirming that this area is still slowly accumulating sediment. The sediment depth ranged from less than 0.5m around the edges of the reservoir to over 2m depth in certain areas, more typically, sediment depths of 0.5m to 1.5m cover much of the reservoir.

The volume of sediment in the reservoir currently is estimated to be over 22,500 cubic meters. Based on the watershed area upstream of Coldstream dam it is estimated 444 m^3/year is the total sediment infill rate to the Coldstream dam reservoir. Using the estimated sediment infill rate the reservoir is filling at approximately 10mm (1cm) per year. If this accumulation rate continues, it is projected that over the next 50 years the remaining water depth, above the sediment, would reduce by approximately 0.5m to a depth of approximately 0.6m.

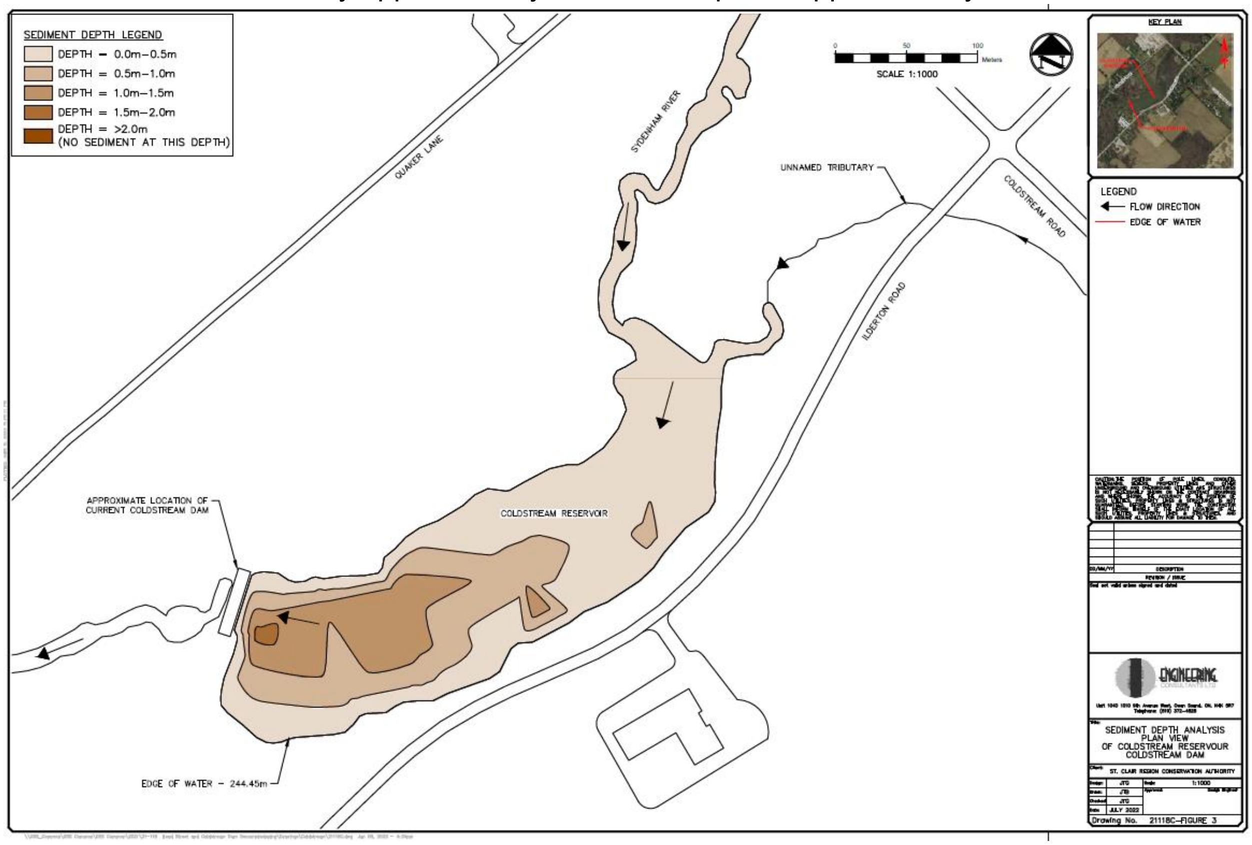

Figure 3 Sediment Depth Analysis for the Coldstream Reservoir

Sediment samples were also collected for analysis to determine if any contaminants are present in the system. Results of the analysis indicate that the sediment quality in the Coldstream reservoir is free of contaminants other than a few locations where elevated levels of phosphorus and manganese were detected. Although these levels were elevated, they were still below the sediment quality standard for phosphorus and manganese set by the Ministry of Environment Conservation and Parks.

A study prepared by GEO Morphix in January 2023 reviewed the potential effects of sediment release and channel formation following the removal of the dam. This study concludes that the new channel that forms in the reservoir (after dam removal) could form significant meander belts with widths ranging from 55m to 80m. These widths approach the widest part of the reservoir. The channel width and depth that could form through the sediment deposition area is estimated to have a width of 7.4 m and a depth of 0.74 m. However, this depth is from final water level to final channel bottom and does not include the height of riverbanks (i.e. remaining sediment) above the final water level at normal river flow rates.

Based on the current sediment conditions in the reservoir it is estimated that an approximate volume of 7,000 cubic meters of sediment would be released from the reservoir if the entirety of the dam were removed. This is 31% of the total estimated volume of sediment currently in the reservoir. It is not known the rate of transport of the released sediment and further evaluation of sediment management options would be required.
It is noted that new regulations in Ontario govern the movement of excess fill and earth material (*Excess Soil Regulation O. Reg. 406/19*). Therefore, if excavation or dredging sediment from the reservoir is proposed additional samples of sediment may be required for analysis of a wider range of parameters to meet the requirements of the regulation.

Based on current conditions, and without further studies, the following conclusions have been presented by GSS Engineers Consultants for sediment management:

1. As per the GSS Engineering and Geo Morphix reports it does not appear practical to dredge or excavate the sediment from the reservoir before the dam is removed.
2. Slow release of the sediment in the reservoir by a stepped removal of the dam over three years would pose less risks to the downstream channel condition than if the dam was completely removed in one season.

Flood and Erosion Analysis

The GSS report looked at what impacts the dam removal would have on flooding and sediment transport.

The flood flows of the East Sydenham River at Coldstream have been estimated by prorating B.M. Ross and Associates' flood flow estimates of the East Sydenham River at Strathroy by the difference in upstream drainage area for the Coldstream dam location. The drainage area upstream of Strathroy is 2.8 times that of Coldstream. Based on this, the flood flows range from 19 m^3/s for the 2-year flood flow to 45 m^3/s for the 100-year flood flow for the Coldstream dam location.

Methods of Dam Removal and Sediment Management Strategies

If a decision is made to remove the Coldstream dam, there are several methods for removing a dam to consider, they are as follows:

1. Full removal of the dam for one summer work period.
2. Gradual removal of the dam over two or more seasons where stop logs are removed in the first year followed by full removal of the dam in the second year or full removal of the dam over several subsequent years.
3. Partial removal of the dam where enough of a dam is removed to achieve environmental goals (i.e. restore fish passage and reduce summertime heating of stream water temperatures) but retain some of the dam to retain sediment storage capacity or to provide some other social or economic benefit by retaining some level of ponding behind the remaining portion of the dam.

4. Construct a permanent bypass channel around the head pond, leaving the dam and head pond sediment as is.

To manage the sediment within the reservoir the following options have been presented by GSS Engineering Consultants:

1. Prior to dam removal, remove the sediment from the reservoir by use of a hydraulic dredge. This requires a floating dredge system that pumps a large volume of sediment mixed with water to a receiving basin that would allow the sediment fraction to settle and the clear "decant" water to return to the river.
2. As part of the dam removal process, construct a large bypass channel or pipeline around the reservoir and dam and discharge the river flow below the dam site. Once the stream bypass is established, mechanically remove reservoir sediment "in the dry" using large excavation equipment and dump trucks etc.
3. Remove dam in stages and allow vegetation to establish and stabilize soils. River flow will transport some sediment in the reservoir downstream naturally.
4. Remove dam in one season and allow flow to transport the sediment in the reservoir downstream naturally.

Table 6 provides a summary of seven general dam removal options including sediment management strategies for each option. This includes the option to "do nothing" (leave dam in place).

For all options proposing dam removal (Options 1, 2, 3, 4, and 5), the dam removal component of the overall project is of moderate complexity as the dam height (3.35 m) is of moderate height and the volume of fill and rock armor stone beside the sheet pile dam is relatively high. Capital costs to remove the dam only (i.e. without sediment management costs) are estimated to range from $500,000 to $1,600,000.

Table 7 provides an overall preliminary cost estimate for the seven different dam removal options. Option 5, partial removal of the sheet pile dam, is estimated to be the lowest cost of dam removal with the highest cost being Option 3 where the dam is removed in steps over several years with water remaining in the reservoir while the dam is removed.

Much higher costs are assigned to active sediment management for Options 1 and 2 where the sediment is removed first by dredging or mechanical excavation before the dam is removed. Such active sediment management costs are estimated to cost at least $1,800,000 in addition to dam removal costs. As discussed in the next sections these active sediment management costs are also seen to have extreme technical challenges and potentially high social impacts.

TABLE 6
Sediment Management and Dam Removal Options
Potential Removal of the Coldstream Dam

December 12, 2023 | 21-118

Sediment Management and Dam Removal Options	Economic Considerations	Technical Obstacles	Social Impacts	Environmental Impacts	Regulatory Concerns
Option 1: **Dredging of sediment with water in head pond followed by complete dam removal.**	• Very expensive sediment management option as very large volume of sediment/ water mixture will be produced. • Dam removal will be relatively inexpensive.	• Onsite sediment dewatering required. Very large settling pond likely required. • Ultimate sediment disposal requirements could be difficult. • Equipment mobilization, operation and demobilization required.	• Large area required for sediment dewatering in current park area. Major impact to park users.	• Aquatic species (fish, turtles, etc.) in the head pond may be entrained in the dredged sediment. • Fish migration provided. • Thermal impacts to water temperature from head pond are eliminated.	• Regulations regarding sediment disposal on off-site lands are now quite stringent.
Option 2: **Temporary bypass of river around dam. Excavate sediment "in the dry" and complete dam removal.**	• Expensive sediment management option. • Temporary bypass pipe or channel around head pond will be expensive to construct. • Least expensive dam removal option.	• Construction of bypass pipe or new channel around the reservoir could be very difficult to design and locate. • Ultimate sediment disposal requirements could be difficult. • Excavating wet sediment with equipment within pond footprint likely difficult.	• Bypass pipe or channel could be a safety hazard until dam and sediments are removed. • Large area of deep, soft sediment could be a danger to pedestrians.	• As head pond level lowers, aquatic species may become trapped in the drying up reservoir. • Fish migration provided. • Thermal impacts to water temperature from head pond are eliminated.	• Regulations regarding sediment disposal on off-site lands are now quite stringent.
Option 3: **Remove dam in phases over ± 3 years. Allows slow release of sediment over 3 years.**	• More expensive dam removal option than Option 4. • No significant cost for sediment management.	• Maintaining structural integrity of dam is required over ± 3 year process. • The long timeline to remove dam may be difficult contractually.	• Current reservoir area could be a safety hazard for multiple years due to large areas of deep, soft sediment.	• Sediment is released downstream at a relatively high rate. • Sydenham River downstream of dam will become turbid following each step of dam removal due to entrained sediment. • Fish migration provided. • Thermal impacts to water temperature from head pond are eliminated.	• LIRA (MNRF) permitting may be complicated due to partial removal of dam in steps. • Regulators may not allow the periodic release of large volumes of sediment.
Option 4: **One time removal of complete dam. Allow one time release of sediment.**	• Relatively inexpensive dam removal option. • No significant cost for sediment management.	• Water velocity management required to allow head pond to drain slowly.	• Current reservoir area could be a safety hazard for one or two years due to large areas of deep, soft sediment.	• Very large amount of sediment will be transported downstream in a relatively short timeframe. • Sydenham River downstream of dam will become turbid due to entrained sediment. • Fish migration provided. • Thermal impacts to water temperature from head pond are eliminated.	• Regulators may not allow the sudden release of large volumes of sediment.

Sediment Management and Dam Removal Options	Economic Considerations	Technical Obstacles	Social Impacts	Environmental Impacts	Regulatory Concerns
<u>Option 5:</u> **Partial dam removal. Construct "rocky ramp" step pool system to provide fish passage.**	• Least expensive dam removal option. • No significant cost for sediment management.	• Water velocity management required to allow head pond to drain slowly.	• Current reservoir area could be a safety hazard for one or two years due to large areas of deep, soft sediment.	• Fish migration provided. • Thermal impacts to water temperature from head pond are largely eliminated. • Sediment is partially released downstream at a relatively high rate. • Sydenham River downstream of dam will become turbid following partial dam removal due to entrained sediment.	• Regulators may not allow the sudden release of sediment.
<u>Option 6:</u> **Construct permanent new, natural stream channel around dam headpond. Leave dam, head pond and sediment in place as is.**	• Cost to build permanent bypass stream channel quite high. • Avoids cost of dam removal and cost of removing sediment.	• Geotechnical investigations required to confirm remaining land between water in head pond and new channel will be structurally stable and hydraulically stable. • Bridges (pedestrian and/or vehicle bridges) to cross over new stream channel may be required to access north end of dam.	• This Option maintains a lake environment at the site and provides a new, natural stream channel area for viewing, nature enjoyment and passive recreational use. • As the dam deteriorates it will eventually become safety hazard.	• Fish migration provided. • Thermal impacts to water temperature from head pond are largely eliminated as flow through head pond is significantly reduced. • Sediment release from the head pond is avoided.	• This option requires a large volume of earth fill to be removed to construct new, natural stream channel. Need to follow Excess Fill regulations for disposal of fill elsewhere. • As the dam's structural integrity degrades over time, regulators may be concerned with public safety and dam failure.
<u>Option 7:</u> **Do nothing.**	• No immediate cost. • Potential for increased maintenance costs as the dam deteriorates.	• Dam may need to be structurally reinforced in the future.	• As the dam deteriorates it will eventually become safety hazard.	• The dam obstructs fish migration. • The dam deprives aquatic species (including SAR) downstream of dam of required sediment. • The head pond continues to warm up water temperatures during the summer.	• As the dam's structural integrity degrades over time, regulators may be concerned with public safety and dam failure.

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TABLE 7
Sediment Management and Dam Removal Options - Preliminary Cost Estimate
Potential Removal of the Coldstream Dam

December 12, 2023 21-118

Sediment Management and Dam Removal Options	Capital Cost Estimate for Dam Removal	Capital Cost Estimate for Sediment Removal	Total Capital Cost Estimate	Comments
<u>Option 1:</u> **Dredging of sediment with water in head pond followed by complete dam removal.**	$1,100,000 to $1,300,000	>$2,000,000 Need to construct very large sediment/dewatering lagoon on north side of head pond.	>$3,100,000 to $3,300,000	Cost to design, approve and construct large sediment/dewatering pond difficult to estimate. Would also be final restoration costs of dewatering pond once sediment dries. Major impact on conservation authority site project.
<u>Option 2:</u> **Temporary bypass of river around dam. Excavate sediment "in the dry" and complete dam removal.**	$700,000 to $900,000	>$1,800,000 Cost to build large bypass channel or large bypass pipe around north side of head pond would be extremely high.	>$2,500,00 to $2,700,000	Technically difficult. The bypass channel/pipeline likely would need to be quite large to accommodate a reasonably large flow, i.e. ± 5 m^3/s. Deep excavation likely required through higher lands on northern side of pond. Removal of excavated sediment from "dry pad" likely difficult due to wet, soft soil conditions.
<u>Option 3:</u> **Remove dam in phases over ± 3 years. Allows slow release of sediment over 3 years.**	$1,600,000	Essentially zero cost for active sediment management as sediment would slowly wash downstream. Assume $300,000 for bioengineering stabilization of emerging stream banks.	$1,900,000	Second lowest overall cost. Agreement from all review agencies (DFO, MECP, MNRF and SCRCA) required <u>in advance</u> to allow downstream sediment release from head pond.
<u>Option 4:</u> **One time removal of complete dam. Allow one time release of sediment.**	$1,100,000 to $1,300,000	Essentially zero cost for active sediment management as sediment would wash downstream. Assume $300,000 for bioengineering stabilization of emerging stream banks.	$1,400,000 to $1,600,000	Lowest overall cost. Agreement from all review agencies (DFO, MECP, MNRF and SCRCA) required <u>in advance</u> to allow downstream sediment release from head pond.
<u>Option 5:</u> **Partial dam removal. Construct "rocky ramp" step pool system to provide fish passage.**	$500,000 for partial dam removal in one year.	Essentially zero cost for active sediment management as sediment would wash downstream. Assume $300,000 for bioengineering stabilization of emerging stream banks.	$800,000	Lowest overall cost. Provides fish passage and minimizes downstream sediment migration.
<u>Option 6:</u> **Construct permanent new, natural stream channel around dam headpond. Leave dam and sediment in place as is.**	New channel would be approximately 350 m long and designed for major flood flows of approximately 100 cubic meters per second. The cost of the new channel is estimated to be $1,800,000 to $2,100,000.	No cost. Sediment remains in place.	Cost for new permanent, stream channel estimated to be $1,800,000 to $2,100,000.	Cost similar to Options 3 and 4 but more than Option 5. Long term, dam removal and sediment management may still be required.
<u>Option 7:</u> **Do nothing.**	Theoretically zero cost. However, ultimately, dam will reach end of service life and will need to be repaired, rebuilt or removed.	No cost.	Theoretically zero.	Volume of sediment in head pond will continue to increase over time. With inflation and extra sediment, future costs for dam removal will increase compared to current costs.

Note: Capital costs do not include consultation, engineering or permitting costs.

Summary of Options and Costs

As per the options and estimated costs presented in Table 6 and Table 7, there appears to be very significant costs and technical challenges to complete Option 1 or Option 2 with preliminary cost estimates ranging from $2.5 M to $3.3 M. Both options would deal proactively with the sediments to prevent sediment in the reservoir from being naturally transported downstream. However, the technical and environmental challenges, and the capital and engineering costs of Option 1 and 2, would appear beyond the reach of the project. As such, the recommendation of GSS Engineering Consultants Ltd is that Option 1 and Option 2 are not considered feasible at this time and that Option 3, 4, 5, and 6 be considered further for removal of the Coldstream dam.

It is likely unrealistic for a dam removal strategy to be implemented that proactively removes the accumulated sediment in the Coldstream reservoir. Therefore, it is assumed that if the dam is removed the accumulated sediment will be left to be naturally transported downstream over time. As the river meanders through the empty reservoir in search of its final channel path, much of the sediment will be transported and this will alter the topography of the former reservoir area. As such it is recommended that any major rehabilitation efforts in the reservoir take place only after the river has found it’s final path and the topography is relatively constant. This may take 5-10 years.

Alternatively, one option includes a permanent, natural bypass channel around the dam and reservoir. This option would avoid release of sediment from the head pond and therefore the following rehabilitation options would not apply for this option as the reservoir would remain “as is”.

Until the river has created a final path, the large plain of drying sediment and meandering river may be dangerous for human use. It is recommended that human use of the former reservoir be discouraged until rehabilitation is fully completed.

Potential Removal of Coldstream Dam Next-Steps

Figure 3 provides a general outline of the next steps for the potential removal of the Coldstream Dam in the form of a flow chart. The flow chart follows the steps including selection of preferred removal and sediment management method, consultation with review agencies, recommended additional studies, engineering of dam removal, tendering the project, removal of the dam, and finishing with the rehabilitation of the former reservoir. Emphasis is placed on communication with review agencies. If the dam is to be removed, it is very important that all appropriate review agencies (MNRF, MECP, DFO, Indigenous groups) are consulted to determine the preferred dam removal and sediment management option. If passive sediment management is the preferred option, it is important that all review agencies are aware of the effects this will have on the East Sydenham River (increased turbidity and siltation downstream of the dam).

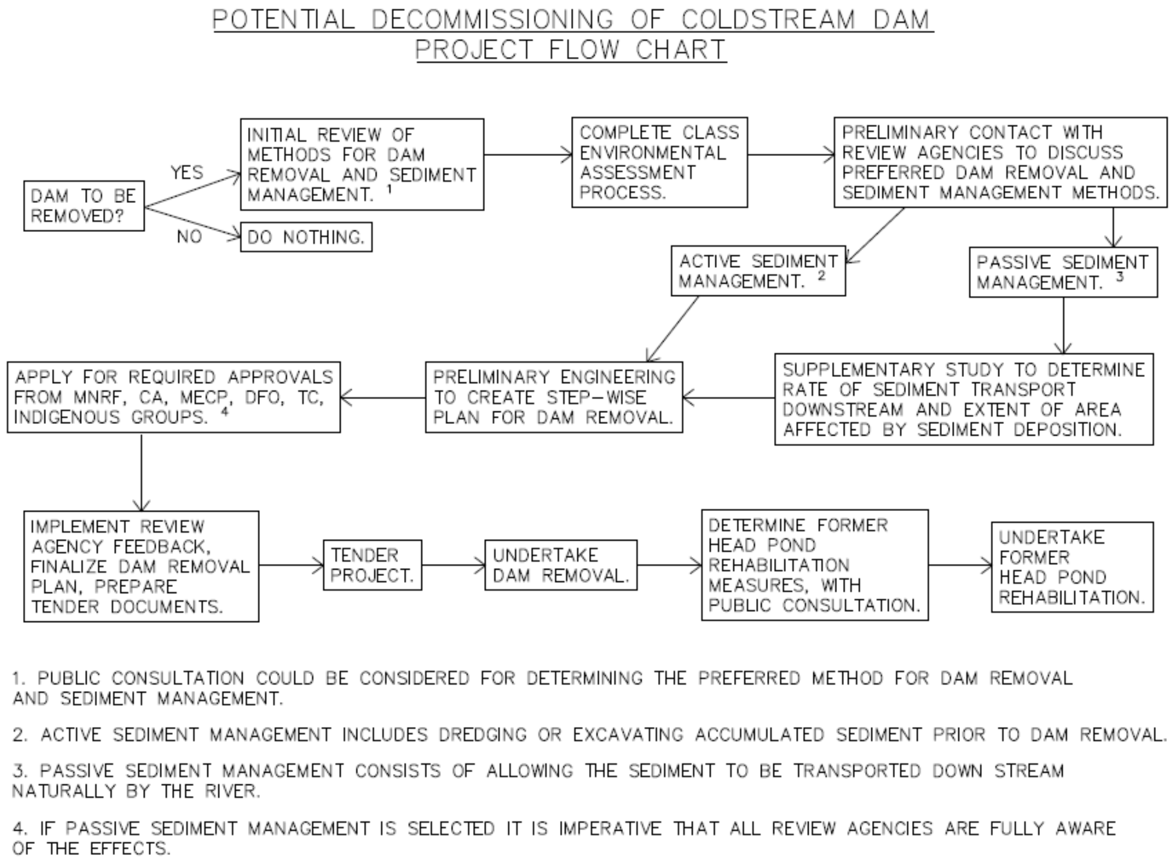
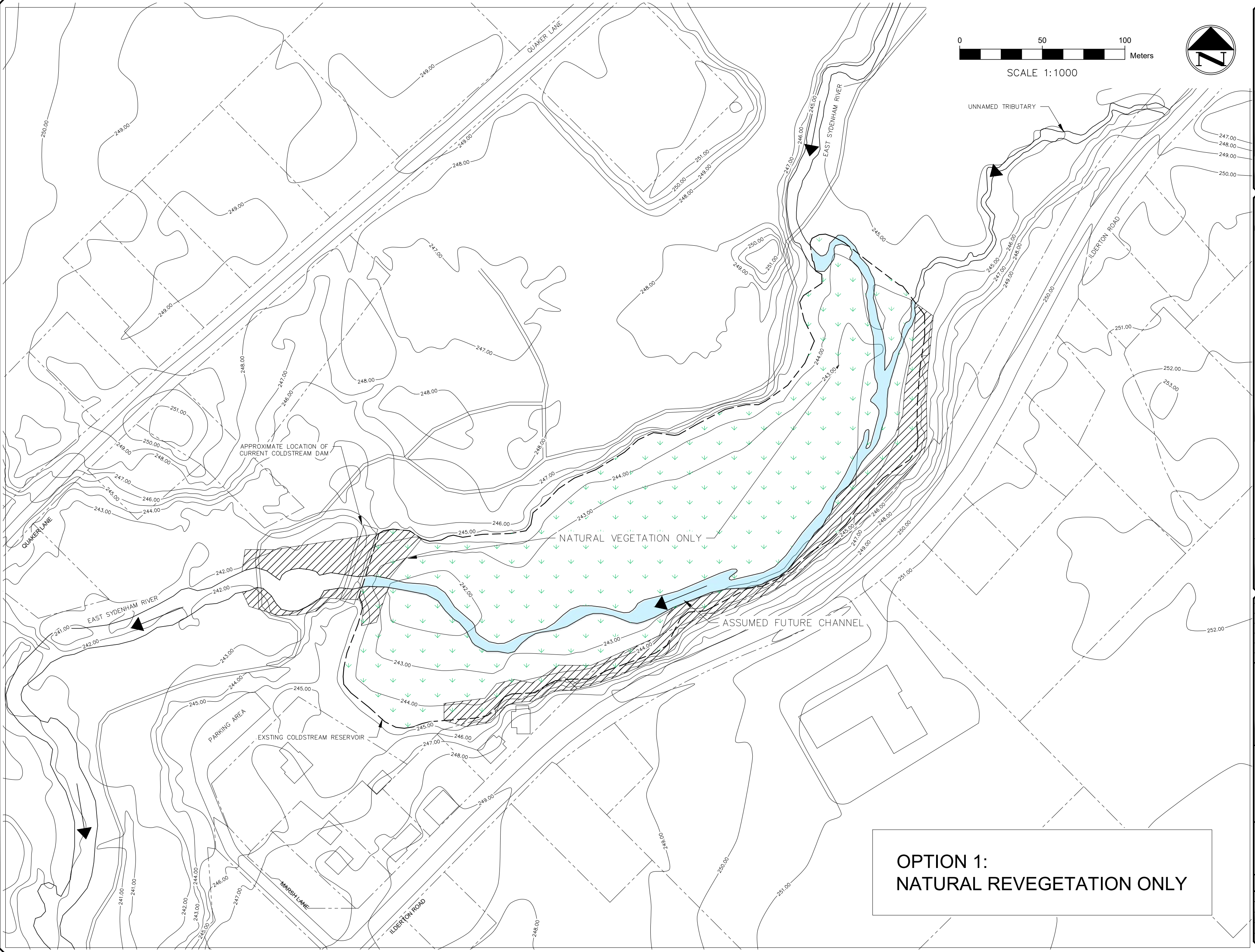


Figure 3 Next Steps for Potential Decommissioning of Coldstream Dam Project

Restoration of the Reservoir

The Coldstream dam reservoir has an area of approximately 4.5ha. This large area provides an opportunity for a range of rehabilitation options if ever the dam is considered for removal. Options have been presented by GSS Engineering Consultants, based on feedback from the SCRCA and relatively low costs for construction and maintenance. The following figures provide a visual concept for restoration of this area following dam removal and include options for creating passive recreation and improving natural wildlife habitats.

All the rehabilitation options highlight areas in which erosion control may be required. These areas include the shores of the dam and along the south shoreline as this is the estimated path of the river through the reservoir. If the final river path is different then that identified on the restoration drawings, the areas requiring erosion control should be altered accordingly.



KEY PLAN

LEGEND

- EDGE OF EXISTING HEAD POND
- PROPERTY LINE
- EXISTING TRAIL
- ASSUMED FUTURE CHANNEL IN THE EXISTING HEAD POND
- PROPOSED NATURALLY RE-VEGETATED AREA
- PROPOSED PLANTED TREES AT HIGHER ELEVATIONS
- PROPOSED PLANTED WET TOLERANT SHRUBS AT LOWER ELEVATIONS
- PROPOSED TRAIL
- PROPOSED WATER FEATURE (POND/WETLAND)
- OVERFLOW CULVERT FROM WATER FEATURE TO RIVER
- *AREA FOR POTENTIAL EROSION CONTROL
- 253.00 **CONTOURS (1.00m)

*AREAS FOR POTENTIAL EROSION CONTROL ARE BASED ON THE ASSUMED FINAL CHANNEL PATH. THE ACTUAL AREAS REQUIRING EROSION CONTROL SHOULD BE SELECTED BASED ON THE ACTUAL FINAL CHANNEL PATH.

**ELEVATION CONTOURS IN THE RESERVOIR REPRESENT THE HARD BOTTOM AND ASSUME THE ACCUMULATED SEDIMENT IS REMOVED.

CAUTION: THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWERS, PROPERTY LINES AND OTHER UNDERGROUND AND OVERGROUND UTILITIES ARE STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES, PROPERTY LINES & STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES, PROPERTY LINES & STRUCTURES, AND SHOULD ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

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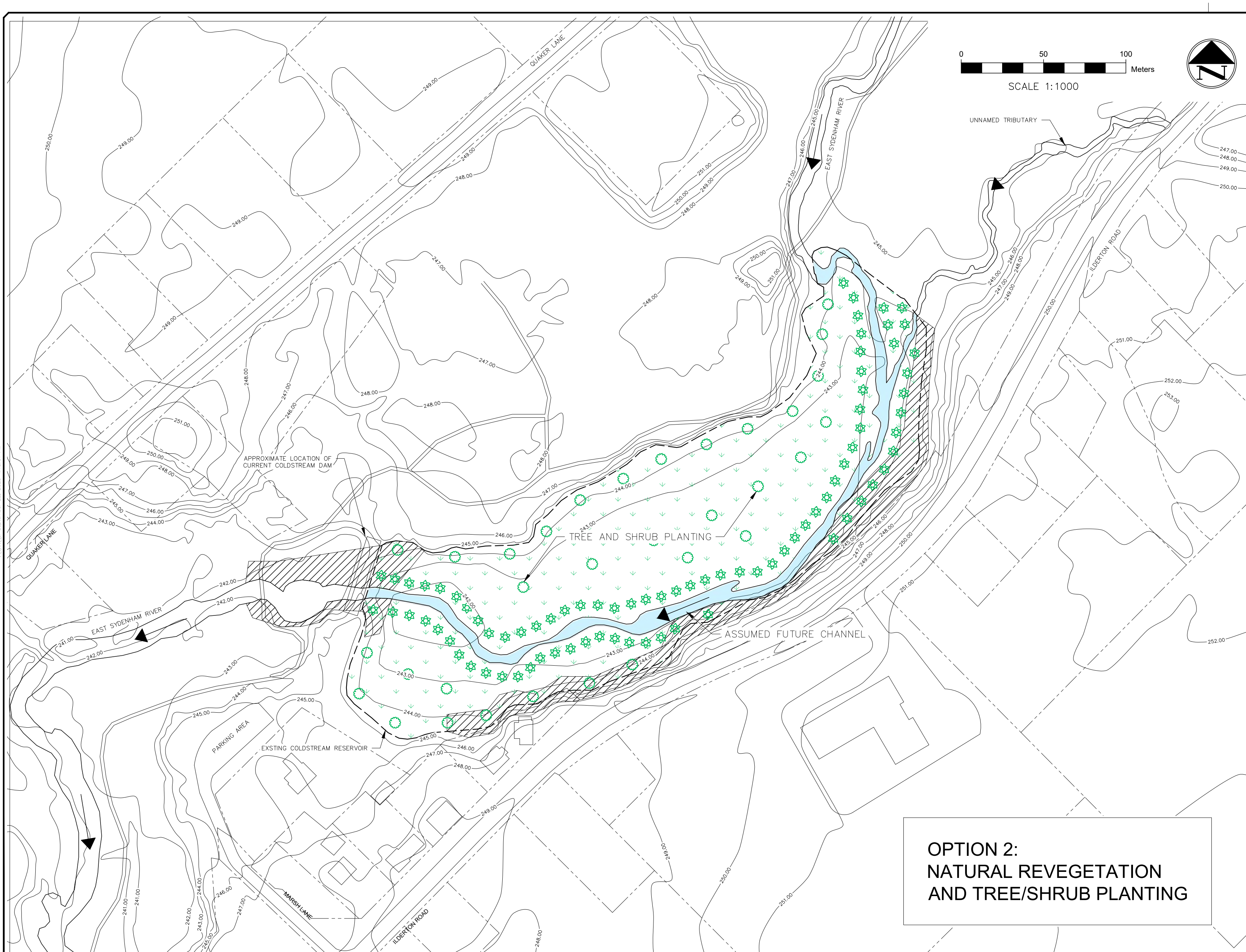
GSS ENGINEERING CONSULTANTS LTD
Unit 104D 1010 9th Avenue West, Owen Sound, ON, N4K 5R7
Telephone: (519) 372-4828

Title:
OPTION 1
HEAD POND RESTORATION
COLDSTREAM DAM

Client: ST. CLAIR REGION CONSERVATION AUTHORITY

Design:	JTG	Scale:	1:1000
Drawn:	JTB	Approved:	Design Engineer
Checked:	JTG		
Date:	JUNE 2023		

Drawing No. 21118C-FIGURE 7



OPTION 2: NATURAL REVEGETATION AND TREE/SHRUB PLANTING

KEY PLAN

LEGEND

- EDGE OF EXISTING HEAD POND
- PROPERTY LINE
- EXISTING TRAIL
- ASSUMED FUTURE CHANNEL IN THE EXISTING HEAD POND
- PROPOSED NATURALLY RE-VEGETATED AREA
- PROPOSED PLANTED TREES AT HIGHER ELEVATIONS
- PROPOSED PLANTED WET TOLERANT SHRUBS AT LOWER ELEVATIONS
- PROPOSED TRAIL
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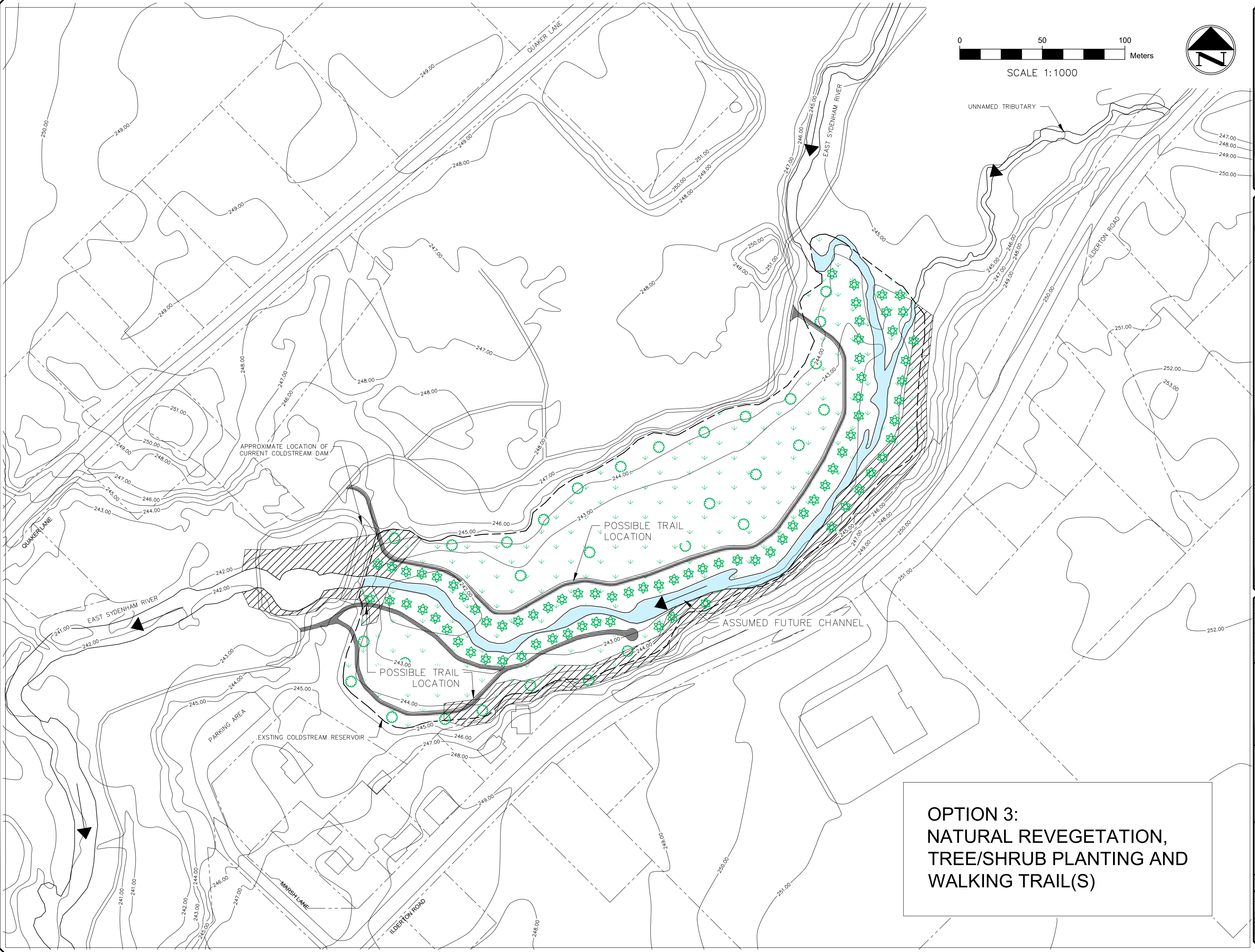
GSS ENGINEERING CONSULTANTS LTD
Unit 104D 1010 9th Avenue West, Owen Sound, ON, N4K 5R7
Telephone: (519) 372-4828

Title: OPTION 2 HEAD POND RESTORATION COLDSTREAM DAM

Client: ST. CLAIR REGION CONSERVATION AUTHORITY

Design:	JTG	Scale:	1:1000
Drawn:	JTB	Approved:	Design Engineer
Checked:	JTG		
Date:	JUNE 2023		

Drawing No. 21118C-FIGURE 8



OPTION 3:
NATURAL REVEGETATION, TREE/SHRUB PLANTING AND WALKING TRAIL(S)

KEY PLAN

LEGEND

- EDGE OF EXISTING HEAD POND
- PROPERTY LINE
- EXISTING TRAIL
- ASSUMED FUTURE CHANNEL IN THE EXISTING HEAD POND
- PROPOSED NATURALLY RE-VEGETATED AREA
- PROPOSED PLANTED TREES AT HIGHER ELEVATIONS
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**ELEVATION CONTOURS IN THE RESERVOIR REPRESENT THE HARD BOTTOM AND ASSUME THE ACCUMULATED SEDIMENT IS REMOVED.

CAUTION: THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWERS, PROPERTY LINES AND OTHER UNDERGROUND AND OVERGROUND UTILITIES ARE STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES, PROPERTY LINES & STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES, PROPERTY LINES & STRUCTURES, AND SHOULD ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

DD/MM/YY	DESCRIPTION
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Seal not valid unless signed and dated

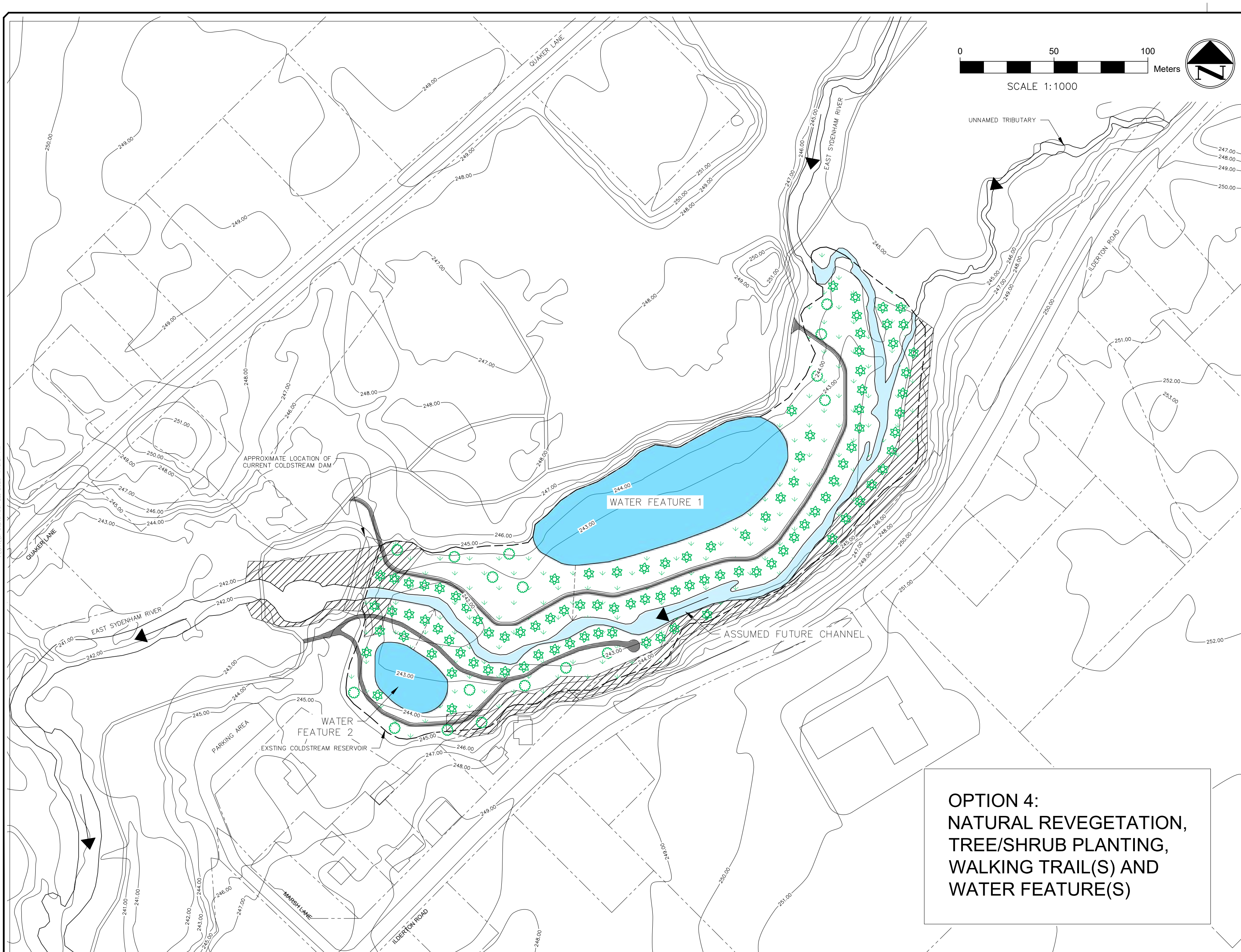
GSS ENGINEERING CONSULTANTS LTD
Unit 104D 1010 9th Avenue West, Owen Sound, ON, N4K 5R7
Telephone: (519) 372-4828

Title:
OPTION 3
HEAD POND RESTORATION
COLDSTREAM DAM

Client: ST. CLAIR REGION CONSERVATION AUTHORITY

Design:	JTG	Scale:	1:1000
Drawn:	JTB	Approved:	Design Engineer
Checked:	JTG		
Date:	JUNE 2023		

Drawing No. 21118C–FIGURE 9



OPTION 4:
NATURAL REVEGETATION, TREE/SHRUB PLANTING, WALKING TRAIL(S) AND WATER FEATURE(S)

KEY PLAN

LEGEND

- EDGE OF EXISTING HEAD POND
- PROPERTY LINE
- EXISTING TRAIL
- ASSUMED FUTURE CHANNEL IN THE EXISTING HEAD POND
- PROPOSED NATURALLY RE-VEGETATED AREA
- PROPOSED PLANTED TREES AT HIGHER ELEVATIONS
- PROPOSED PLANTED WET TOLERANT SHRUBS AT LOWER ELEVATIONS
- PROPOSED TRAIL
- PROPOSED WATER FEATURE (POND/WETLAND)
- OVERFLOW CULVERT FROM WATER FEATURE TO RIVER
- *AREA FOR POTENTIAL EROSION CONTROL
- 253.00 **CONTOURS (1.00m)

*AREAS FOR POTENTIAL EROSION CONTROL ARE BASED ON THE ASSUMED FINAL CHANNEL PATH. THE ACTUAL AREAS REQUIRING EROSION CONTROL SHOULD BE SELECTED BASED ON THE ACTUAL FINAL CHANNEL PATH.

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OPTION 4
HEAD POND RESTORATION
COLDSTREAM DAM

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Design:	JTG	Scale:	1:1000
Drawn:	JTB	Approved:	Design Engineer
Checked:	JTG		
Date:	JUNE 2023		

Drawing No. 21118C–FIGURE 10

Additional potential restoration features include:

Wildlife habitat in the form of grasslands or pollinator meadows can be created to promote diversity.

Reforestation of the area with native plantings of trees and shrubs can be an effective way to restore the property.

Water features such as shallow wetland areas or ephemeral pools for amphibians and deeper ponds to support fish communities can be located adjacent to the new channel location and enhance habitat in this area; these types of features would be constructed offline and would not be directly linked to the new channel.

Viewing platforms or towers can be installed at various location for wildlife observations.

Trails complete with sitting areas may be created or enhancements made to the existing trail system to promote physical activity and highlight the restoration features of the property.

Additional recreational amenities such as picnic areas and water access points for canoes/kayaks that are linked to the new trail system may be integrated into the property.

To improve fish habitat conditions, a variety of in channel features may be considered to enhance the restoration including step pools, spawning/gravel beds, vortex weirs and woody overhead cover.

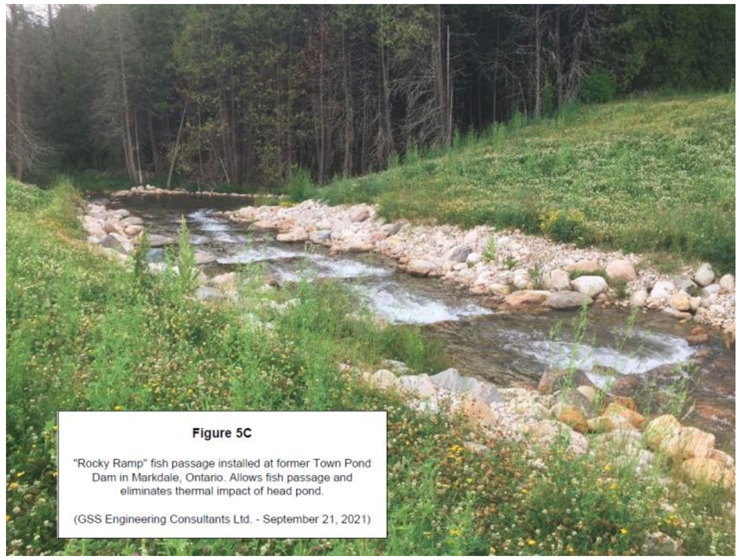

Figure 5C

"Rocky Ramp" fish passage installed at former Town Pond Dam in Markdale, Ontario. Allows fish passage and eliminates thermal impact of head pond.

(GSS Engineering Consultants Ltd. - September 21, 2021)