



Bridge-Seton Water Use Plan

Monitoring Program Terms of Reference

BRGMON-15 Seton Erosion Management Projects: Phases 1 and 3

**Revision 1
November 9, 2020**

Bridge-Seton Water Use Plan
BRGMON-15: Seton Erosion Management Projects: Phases 1 and 3 - Erosion Site Identification, Prioritization, and Monitoring
Revision 1

REVISION RATIONALE

- The original Terms of Reference (TOR) was submitted in response to Schedule A Clause 13 a to d (i.e., non-heritage resources). This Revision incorporates requirements under Schedule A clause 12 (heritage resources) and develops associated management questions.
- This Revision clarifies the scope of this project (e.g., Seton River and Reservoir) and the linkages with other erosion-related projects.
- This Revision also reflects modifications to the methods and project tasks developed in consultation with St’át’imc since the project was initiated.

Table 1: Key changes to the BRGMON-15 TOR and rationale for their inclusion

Section	Change	Rationale
1.0 Context	<ul style="list-style-type: none"> • New section 	<ul style="list-style-type: none"> • References the WUP Order clauses for which this TOR is intended to address
2.0 Monitoring and Related Physical Works Program Rationale	<ul style="list-style-type: none"> • Added information • Described how the monitoring and physical works projects work together • Added sections on links to other projects 	<ul style="list-style-type: none"> • Edited and information added for clarity • Clarifies the links to related projects often collectively referred to as SLEMP
3.0 Monitoring Project Outcomes	<ul style="list-style-type: none"> • Rewritten with added explanation • Changed the order of this section and management questions 	<ul style="list-style-type: none"> • For improved clarity and to reflect the nature of a monitoring project used to support a subsequent physical works project
4.0 Management Questions	<ul style="list-style-type: none"> • Added new management questions • Edited some questions for clarity 	<ul style="list-style-type: none"> • Questions added to meet requirements for Schedule A, Clause 12 • Questions revised to reflect the requirements for subsequent physical works phases
Hypothesis Testing by the Monitoring	<ul style="list-style-type: none"> • Deleted 	<ul style="list-style-type: none"> • Unlike most monitoring studies, this project is intended to inform and develop physical works, so the questions are intended to provide information to subsequent phases of the project rather than test hypotheses
Key Water Use Decision Affected	<ul style="list-style-type: none"> • Deleted 	<ul style="list-style-type: none"> • As above, this project is intended to inform and develop physical works projects
5.0 Approach: Monitoring and Physical Works	<ul style="list-style-type: none"> • New section 	<ul style="list-style-type: none"> • Clarifies the stages of the projects using terminology common to other physical works projects • Makes clear the linkages between this and BRGWORKS-2

Section	Change	Rationale
6.0 Methods – Identification and Prioritization (Phase 1)	<ul style="list-style-type: none"> • Revised tasks • Added new tasks • Provided additional detail 	<ul style="list-style-type: none"> • Additional tasks added and clarified • Reflects the approach agreed to between BC Hydro and St’át’imc as the project has evolved
7.0 Methods – Monitor (Phase 3)	<ul style="list-style-type: none"> • Revised tasks • Added new tasks • Provided additional detail 	<ul style="list-style-type: none"> • Additional tasks added and clarified the intent of the monitoring
Interpretation of Results	<ul style="list-style-type: none"> • Deleted 	<ul style="list-style-type: none"> • Not required as input to physical works project
8.0 Schedule	<ul style="list-style-type: none"> • Revised and added years 	<ul style="list-style-type: none"> • Updated to reflect added tasks and effort
9.0 Budget	<ul style="list-style-type: none"> • Updated 	<ul style="list-style-type: none"> • Updated to reflect actual expenditures to date, and assumptions for the completion of the project.

1.0 Context

This Terms of Reference (TOR) is for the identification and monitoring stages of the Seton Erosion Management Projects around Seton Lake and on the Seton River.

It is submitted in response to the *Water Act Order* issued by the Comptroller of Water Rights (CWR) on March 30, 2011. The Bridge River Water Use Plan (WUP) Order contains two sections that relate to the Seton erosion projects as follows:

- Schedule A, Clause 12 titled Seton Lake Erosion Management Program (SLEMP) is as follows:
 - (a) *Implement a program to develop and deliver an effective long term program for addressing moderate and high risk shoreline erosion issues for Seton Lake and along Seton River with particular reference to heritage, cultural and aesthetic resources that may be affected;*
- Schedule A, Clause 13 titled Seton Lake Erosion Mitigation Program is as follows:
 - (a) *Monitor what erosion sites, other than heritage or cultural sites, around Seton Lake are affected by Seton Lake fluctuations resulting from operation of the generating facilities.*
 - (b) *Determine what actions are required to protect those sites from further erosion.*
 - (c) *Determine what mitigation plans can be developed to address such erosion sites*
 - (d) *Monitor if the actions implemented to mitigate erosion at the sites are effective.*

2.0 Monitoring and Related Physical Works Program Rationale

2.1 Background

This program is intended as a cooperative effort between BC Hydro and St'át'imc for addressing moderate and high-risk erosion issues on the shorelines of Seton Lake and the riverbanks along Seton River.

BC Hydro plans to deliver the above Order requirements under two projects, referred to collectively in this TOR as the Seton Erosion Management Projects.¹

2.2 Links to Other Related Programs

This project is related to BC Hydro's Reservoir Archaeology Program (RAP). The RAP program is a long-term province-wide program intended to create archaeology management plans for each reservoir in order to manage ongoing risks to heritage sites. It is undertaken as a requirement under the BC Heritage

¹ This project and the related BRGWORKS-2 project are sometimes referred to as SLEMP (Seton Lake Erosion Mitigation [Management] Project). To prevent confusion with the reference to SLEMP in Clause 12 of the Bridge WUP Order, in written submissions, both BRGWORKS-2 and BRGMON-15 will be referred to as the Seton Erosion Management Projects. However, we recognize that SLEMP may still be used in discussions about these projects.

Conservation Act and implemented under a Memorandum of Understanding with the Province.

As a long-term program, the RAP timeframe is anticipated to extend beyond the duration of this TOR and WUP projects. Nonetheless, for the duration of the WUP projects, as the RAP program progresses on Seton Lake, relevant information from the RAP will be provided to BRGMON-15 as it becomes available and vice versa. In part due to the parallel nature of these programs, iterative processes have been built into the Methods in Section 6.0 below.

2.3 Seton Erosion Management Projects Objectives

The overall objective of both Seton Erosion Management Projects is to identify and manage the priority high and moderate risk shoreline and riverbank erosion sites that are impacted by the operation of the Bridge-Seton Generation facilities. The erosion sites may be adjacent to heritage, cultural and aesthetic resources, and other non-heritage sites on Seton Lake and Seton River. The options to manage the erosion may include monitoring and/or may involve mitigation – depending on the particular risks and characteristics of the site.

More specifically, the objectives of each of the two projects are as follows:

- **BRGMON-15:** To identify and prioritize shoreline and riverbank erosion sites (both heritage and non-heritage) arising from BC Hydro operations of the Bridge Seton Generation Facilities (on Seton Lake and Seton River), leading to recommendations for either mitigation, monitoring, and/or other risk management options to implement under the WUP. (Phases 1 and 3).
- **BRGWORKS-2:** To protect priority sites identified in Phase 1 on Seton Lake and Seton River by installing effective erosion mitigation physical works (Phase 2).

3.0 Monitoring Project Outcomes

The expected outcomes of the BRGMON-15 project are as follows:

- a better understanding of the importance/priority of sites to St'át'imc that are being impacted by shoreline/riverbank erosion arising from BC Hydro generation operations;
- recommended conceptual mitigation plans for priority erosion sites to take forward into BRGWORKS-2 for further development; and
- a developed monitoring plan for sites where immediate action is not required, for higher risk sites prior to mitigation implementation, or for sites that have been mitigated under BRGWORKS-2 to evaluate efficacy for the duration of the WUP project.

4.0 Management Questions

The key management questions focus on the identification of the locations where shoreline/riverbank erosion has impacted or has the potential to impact a site, and whether the erosion is due to operations of the BC Hydro facilities. These management questions help inform the scope of the related physical works projects.

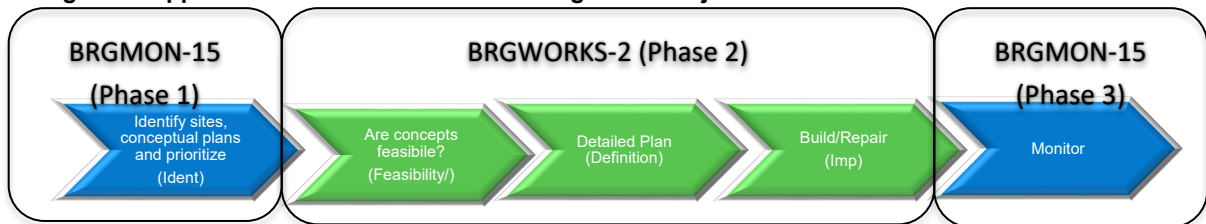
The primary management questions to be addressed by the scope and duration of this project are as follows:

- 1) What sites (including both cultural and heritage, and other than cultural and heritage) sites around Seton Lake and on Seton River are or have the potential to be affected by erosion arising from the operation of the generating facilities?
- 2) What is the priority of identified shoreline/riverbank sites for potential shoreline erosion mitigation?
- 3) For the priority shoreline/riverbank erosion mitigation sites, what are the potential mitigation options to protect these sites from further erosion? What other management option (e.g., monitoring options) may be recommended in lieu of mitigation?
- 4) Following any mitigation (if implemented under this program), have the mitigation or management actions been effective?
- 5) If a site was not mitigated, are there changes in the site conditions that warrant revisiting mitigation recommendations?

5.0 Approach: Monitoring and Physical Works Proposal

The approach and relationship of the BRGMON-15 and BRGWORKS-2 projects is shown in Figure 1. It is anticipated there may iterative processes within and potentially across the phases. Additionally, the processes may be parallel for the Lake and the River. A process diagram is included in Appendix A.

Figure 1: Approach to the Seton Erosion Management Projects



Physical works projects typically progress sequentially through the following stages: Identification, Feasibility, Definition, Implementation, and Monitoring/Maintenance. BRGWORKS-2 includes Feasibility, Definition, and Implementation². BRGMON-15 includes Identification and Monitoring as described further below.

BRGMON-15
(Phase 1)

- 1) **Identification/Conceptual Design:** This step is where the shoreline/riverbank erosion sites are identified, prioritized and where erosion mitigation is recommended, including development of conceptual design(s) and cost estimate(s). BC Hydro is working closely with St'át'imc to identify common priorities and agreement on recommendations, including preferred conceptual designs, where appropriate.

² This process may be scaled further for lower complexity projects. In these cases, Feasibility and Definition phases will be combined, with detailed design directly following conceptual design.

BRGWORKS-2
(Phase 2)

- 2) **Feasibility:** This stage typically includes additional investigations and studies to determine the full feasibility of the conceptual mitigation designs identified in the previous step. The outcome is a preliminary design for the mitigation, plus appropriate cost estimates.
- 3) **Definition:** This phase includes further planning, such as archaeological, safety, environmental with associated permitting, plus detailed design (e.g., tender-ready drawings). BC Hydro will make additional submissions to the CWR once there is detailed design, particularly if there are significant changes in cost, design or prioritization from what is included in this TOR.
- 4) **Implementation:** In this stage, the final preparations and the actual construction of the mitigation works occur. This stage typically includes the Issue for Construction (IFC) drawings, and the receipt of the final permits and approvals (initiated in previous stages). It will also include final construction planning and contracting. Following construction, it there will also be final construction and project completion reporting.

BRGMON-15
(Phase 3)

- 5) **Monitoring inspections (following mitigation):** Following the completion of the construction, a program of monitoring inspections will be developed to ensure that the physical structures function as designed for the duration of the WUP project.³
- 6) **Ongoing monitoring of the site (no mitigation):** Should it be determined that mitigation is not recommended or not feasible at a site (in 1 or 2 above), ongoing monitoring may be recommended (and implemented under BRGMON-15) to monitor the site conditions for the duration of this WUP project.

The process will be followed for each site with input from St'át'imc and as approved by the CWR. Where possible, BC Hydro will look for efficiencies (e.g., bring forward a number of sites to subsequent phases at the same time). However, it is possible that as the RAP program progresses (within the duration of this WUP project), new sites will be identified. These will be considered for re-prioritization on a case-by-case basis within the considerations of the Order. Consequently, there may be multiple sites at different steps in the above process.

6.0 Methods – Identification and Prioritization (Phase 1)

Task 1 Project Coordination

Project coordination involves the general administrative and technical oversight of the project. This will include but not be limited to: 1) budget management; 2) staff, contractor and sub-contractor management; 3) logistic coordination particularly for community meetings; 4) technical oversight of field and analysis components; and 5) liaison with regulators, as appropriate.

³ As mentioned previously, as the RAP program is a long-term program, re-integration with the RAP will be considered when the WUP projects complete.

Task 2: Erosion assessment and document the erosion impact zone

The first step is to identify the zone around the reservoir/Lake/River that due to the combination of elevation, shoreline aspect and morphology, is or may be at risk of erosion from the water levels and wave action on Seton Lake, and flow control on Seton River. There are a number of historical documents that can be used as reference, which combined with modern Geographic Information System (GIS) tools, would result in a defined mapping of the impact zone. Specific tasks are likely to include:

- Literature review of historical data and collection of new data, as required:
 - Review of all identified relevant reports and documents;
 - Specific consideration will be given to the appropriateness of the approach proposed by Penner (1993; 2000) which involves using a numerical model developed for predicting and assessing future shore erosion impacts around lakes and reservoirs;
 - Air photography, cadastral, and orthophotographic/topographic elevation data, reservoir elevation data, available wind records, historic discharge data from Seton dam, river gauge stations, etc.; and
 - Determine appropriate flood elevations and take into consideration BC's flood hazard land use Management Guidelines.
- From the above, develop an appropriate mapping tool(s) and prepare a report that documents the impact zone.

Task 3: Inventory sites (heritage and non-heritage sites) within the impact zone and characterize by a common set of indicators/characteristics

As with the first task, the inventory of existing sites that are located within the impact zone relies on a number of different sources: historical information, local knowledge, previous reports (which document site conditions at different points in time). Additionally, field visits may be necessary to validate site locations and current geomorphic conditions, validate previous assumptions, etc.

Specific tasks include:

- Review previously documented sites and previously undocumented sites within the impact zone:
 - Review previous historical reports, local knowledge, site specific information, etc.;
 - Review any recent updates to the historical reports, particularly heritage information; e.g., RAP additions/clarifications. As the RAP updates previously documented reports and sites, relevant site information within the impact zone will be incorporated into the inventory; and
 - With community input, identify other previously undocumented sites that may be within the impact zone (see also Task 7 Community meetings below).

- Characterize all sites using a common set of characteristics
 - To the extent possible, sites will be characterized using a common set of relevant indicators or physical characteristics (for example geological conditions, geomorphology, topography, exposure to prevailing wind/wave/current flows, erosion susceptibility risk factors, etc.); and
 - For non-heritage or archaeology sites, while maintaining appropriate levels of confidentiality on St'át'imc knowledge, characterize the nature or meaning of each site from a St'át'imc perspective for use in subsequent prioritization exercises.
- If necessary, site visits may be required at this step to gather additional information related to key sites. Site visits may be attended by both professional engineers and archaeologists, as appropriate. During site visits the following activities may be included:
 - Review the geological/geomorphological conditions;
 - Determine the current activity of erosion and the exposure to potential erosive forces;
 - If possible, document any changes to the site based on historical information (photos, etc.), to further refine the site characteristics;
 - Confirm the nature of the site if a culture and heritage site, and confirm the site characteristics for further community discussions;
 - If appropriate, complete a topographic survey and collect data for potential use in the conceptual designs (Task 5) if the site is expected to be high priority (Task 4); and
 - Note that it may be necessary to obtain permissions from property owners (and other necessary permits) prior to visiting sites.

Task 4: Develop a ranked inventory of sites and make recommendations about mitigation or ongoing monitoring.

Taking the inventory of sites (Task 3) and the erosion impact zone (Task 2), develop agreed methods for ranking and prioritizing the sites with input from St'át'imc and BC Hydro and rank all erosion sites. It is anticipated that Structured Decision Making (SDM) tools will be used.

- The expectation is that the evaluation criteria will be developed collaboratively and will reflect the values of the communities as well as meet the intent of the Order and other relevant agreements.
- The deliverable(s) from this task is expected to be tool(s) that will be periodically updated and maintained as new information is identified. For example:
 - As information about potential mitigations (e.g., cost, etc.) is refined in subsequent phases, it is possible that the prioritization tool(s) will need to be updated and recommendations revisited; and
 - Similarly, as information from the RAP program emerges that may add sites or change the characteristics of a site, it is possible that prioritization may need to be adjusted accordingly.

- The outcome will be a list of clearly prioritized sites for subsequent consideration for monitoring or mitigation.

It is anticipated that there will be separate reports for the River and for the Lake and is possible that there may be different prioritization approaches for each

Task 5: Develop conceptual design option(s) or monitoring plans

For the priority site(s) that are identified in Task 4, develop conceptual level erosion protection/mitigation option(s) with sufficient plans and cross sections for planning and evaluation and with conceptual level cost estimates. The conceptual designs will be developed by a Professional Engineer (supported by relevant coastal, lacustrine and fluvial related geoscience and engineering experience), applying appropriate design standards. For shoreline/riverbank erosion mitigations at or near heritage sites, a registered Archaeologist will also be required for input into determining design requirements.

In developing the conceptual designs, it is anticipated that the work will include (but is not limited to) the following:

- Analyze all available data relevant to the site:
 - Prevailing climate (wind) and erosional conditions (additional information may be gathered in subsequent design phases);
 - Air photography, cadastral or orthophogrammetric/topographic elevation data to extract evidence of historical shoreline/riverbank retreat or accretion;
 - Reservoir hydrological records; and
 - Detailed analysis of river flows, flow regimes, velocities erosive potential etc.
- Site visits are expected (attended by professional engineers, geoscientists and archaeologists, as appropriate) particularly if information was not already gathered in Task 3. The tasks for site visits may include but are not limited to the following:
 - Detailed site surveys, including representative cross-sections across the shoreline/riverbank;
 - Perform a stability assessment as required, in accordance with best geotechnical engineering practices;
 - Verify shoreline/riverbank extents or morphologies, beach/bank materials and condition assessments of backshore areas not readily seen in air photography; and
 - Prepare report for review with conceptual design option(s) with cost estimates reflecting a range of options that incorporate the mitigation design objectives.
- As necessary, assumptions about possible mitigations that may have been included in the prioritization (Task 4) will be updated and recommendations adjusted as necessary.

- The conceptual option(s) will be further evaluated with community input and consensus recommendations will be taken forward for CWR approval to develop further under BRGWORKS-2.

Task 6: Develop monitoring plans

Monitoring plans for sites would be developed in the following three instances:

- Monitoring of sites where mitigation is not recommended or prioritized, but should to be inspected periodically to ensure the conditions are not changing;
- Prior to mitigation, while the design is being developed, there may be a need to monitor a site until the construction of mitigation can occur; Where possible, this should be coordinated with site visits related to the design process; and
- Following mitigation, it is anticipated that monitoring will be required to assess the effectiveness of the implemented mitigation works for the duration of the WUP project.

Task 7: Community meetings

It is anticipated that for most of the tasks above, there will be regular and ongoing engagement with the affected St'át'imc communities jointly managed by St'át'imc and BC Hydro. It is anticipated that there may be community meetings included in many of the tasks above including, but not limited to:

- Tasks 2 & 3: Provide an opportunity for the community to provide additional sites of concern, particularly previously undocumented sites that may be within the impact zone;
- Tasks 4: Review site characteristics, provide additional characteristics, as appropriate, engage in a collaborative review, and agree ranking criteria, ratings, weightings, assessments and mitigation/monitoring recommendations;
- Task 5: Review conceptual design concepts and validate design criteria for the evaluation of conceptual options.

7.0 Methods – Monitor (Phase 3)

Task 8: Implement the monitoring program

This task is the implementation of the monitoring plans developed in Task 6 above:

- **For sites where mitigation is not recommended:**
 - Carry out monitoring according to the plan and schedule recommended in Task 6; and
 - Report findings.

- **For sites where mitigation has been recommended and implemented:**
 - From the engineering operations and maintenance plans or other structural inspection plans developed in BRGWORKS-2, continue to monitor site according to the agreed plan; and
 - Report findings as appropriate.

In either of these cases, should a significant change in conditions be identified then Task 4 may be revisited, with the prioritization updated accordingly, and conceptual designs may be developed (Task 5).

As necessary, the monitoring will be coordinated with the RAP for durations beyond the WUP project.

8.0 Schedule

The following table illustrates the current proposed schedule (including work completed to date). Changes to the schedule will be provided as updates in the Bridge WUP Annual Report, as required.

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Task 1: Project coordination											
Task 2: Identify erosion impact zone											
Task 3: Inventory and characterize sites within the impact zone											
Task 4: Develop/update ranked inventory and recommendations for mitigation/monitoring								as needed			
Task 5: Develop conceptual mitigation designs								as needed			
Task 6: Developing monitoring plans		River									
Task 7: Community meetings										as needed	
Task 8: Implementing monitoring plans		River	River								

9.0 Budget

Total Revised Program Cost: \$803,207.

The budget has been developed based on the following assumptions:

- Actual costs to date have been reflected in the budget table to date.
- Two additional years of engineering/archaeological field visits (Tasks 3 and 5) are included, for sites identified through the RAP and other programs, and for which further erosion evaluation is required.
- Community meetings will occur until mitigations are agreed and then as required thereafter. Where possible, reporting to the communities will be coordinated with RAP meetings for efficiency.
- The budget assumes up to conceptual designs for up to six sites will be developed:
 - Four have been completed at the time of this TOR revision.
 - Budget for two more sites has been included.
- In terms of site visits for Monitoring (Phase 3-Task 8):
 - It is assumed three sites/day can occur on one site visit.
 - River sites will be visited in alternate years unless a significant change in condition is noted or flows exceed a pre-determined threshold (four sites included).

- Lake sites:
 - High priority sites (three sites) will be monitored until mitigation work occurs.
 - Moderate risk sites (six assumed) will be monitored annually.
 - The total number of moderate risk sites will be determined by the ranked inventory (Task 4).
 - Post-construction monitoring will occur the year following to ensure stability, then in alternate years.
- Should more sites be identified in Task 3 through links with RAP, etc., additional budget submissions may be required for Tasks 4-8.

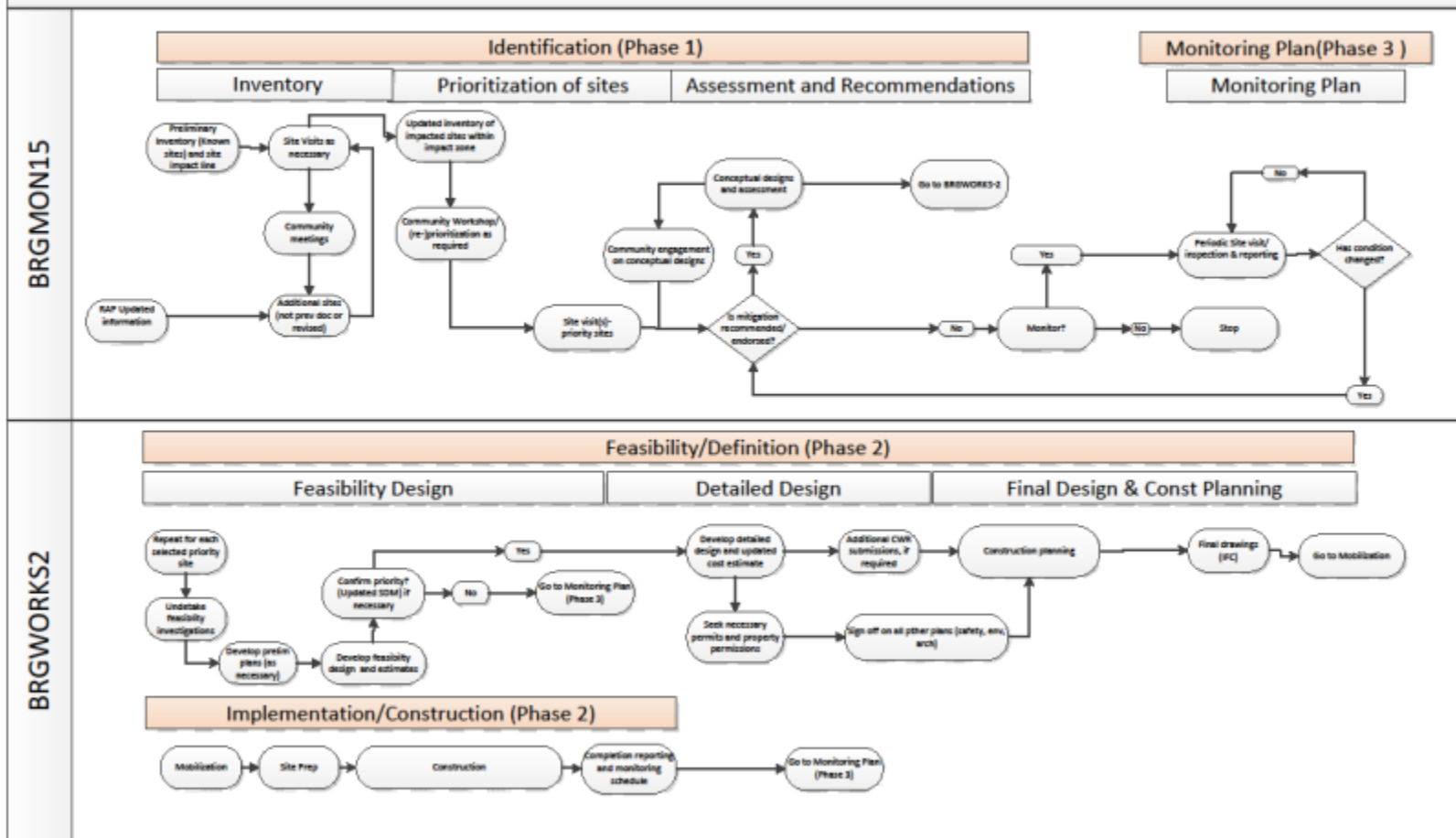
10.0 References Cited

Penner, L.A. (1993). Shore Erosion and Slumping on Western Canadian Lakes and Reservoirs, a methodology for Estimating future Bank Recession Rates. Environment Canada, Monitoring Operations Division, 100 pp.

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Appendix A

Seton Erosion Management Projects Flow Chart



Document Name: Seton Lake Erosion Management Program (SLEMP) Flow Chart

Last Updated: February 13, 2020 8:40 AM Page 1 of 1