EXECUTIVE SUMMARY REPORT: SCREENING TOOL TO IDENTIFY LOW RISK WITHDRAWALS FROM LAKES IN ALBERTA AND NORTHEAST BRITISH COLUMBIA

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AMENDMENT RECORD

This report has been issued and amended as follows:

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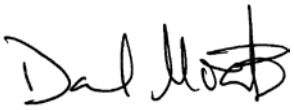
1	Summary document	20160331		
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1.0 INTRODUCTION

Hatfield Consultants (Hatfield) is pleased to present Petroleum Technology Alliance Canada (PTAC) and the British Columbia Oil and Gas Research and Innovation Society (BC OGRIS) with this executive summary report, which provides an overview of the screening tool development project (the Project). The final objective of the Project was to develop a desktop screening tool to determine low risk lake withdrawal limits for use in Alberta and Northeast BC.

The Project was completed under PTAC Recipient Agreement 15-WIPC-06, using funding from the Alberta Upstream Petroleum Research Fund (the "AUPRF Fund") and the BC OGRIS.

This executive summary outlines:

- The general approach undertaken to develop screening limits;
- Literature review activities;
- Environmental considerations incorporated into the screening tool; and
- The final suggested criteria to screen proposed lake withdrawals (the screening tool).

1.1 PROJECT DEVELOPMENT CRITERIA

The Project is intended to provide background information on water withdrawal guidance and policy, and provide suggested limits for lake withdrawals (the screening tool). The suggested approach to establishing screening withdrawal limits should not be interpreted to be prescriptive, as other approaches may also be appropriate and defensible.

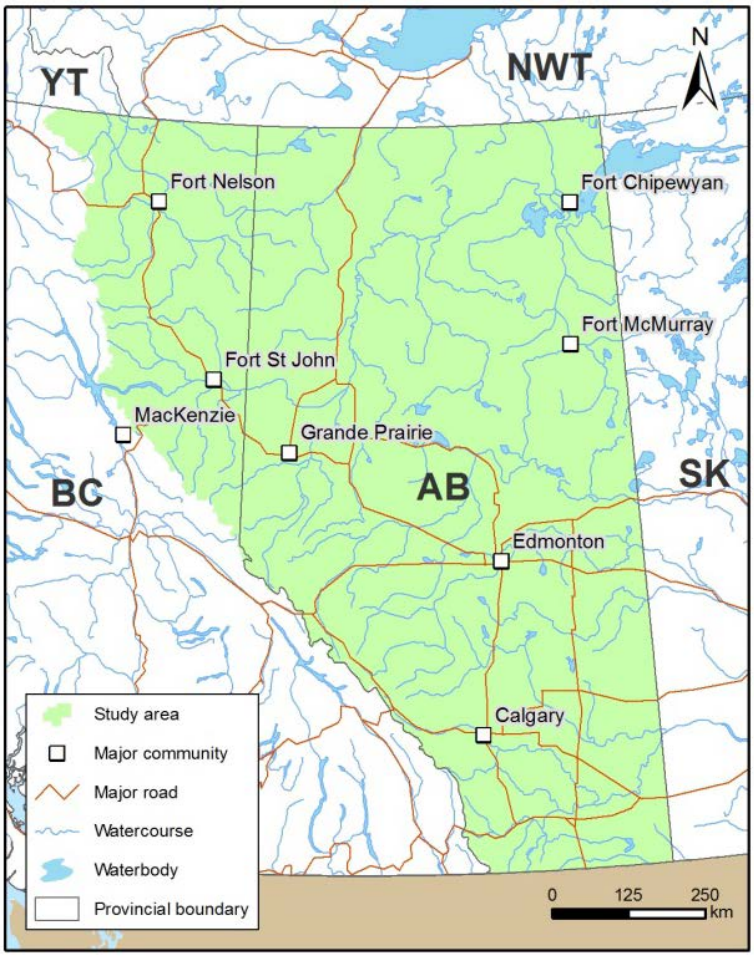
The screening tool is intended to:

- Be desktop based, practical, and defensible;
- Use readily available information, to the maximum extent possible;
- Incorporate key environmental considerations into low risk or short term water diversion applications in Alberta and Northeast BC, as outlined in policy and guidance;
- Identify withdrawal limits that are expected to have a low risk for unacceptable impacts to environmental values; and
- Support water diversion applications (e.g., short term use of water, water licenses, temporary and permanent diversion licenses) in Alberta and Northeast BC.

1.2 SCREENING TOOL APPLICATION AREA

The intended application area for this tool is defined as the province of Alberta and Northeast BC (Figure 1), which includes the portion of BC north of about 54 degrees latitude, extending roughly north from Willison Lake to the Yukon border. The Northeast BC boundaries are the same as those used in the NorthEast Water Tool (NEWT 2015). The screening tool is intended to be applicable to gauged and ungauged lakes with surface areas greater than 0.1 km^2.

Figure 1 Intended Tool Application Area: Alberta and Northeast British Columbia.



2.0 APPROACH

The development of the tool included the following steps:

1. High level review of lake withdrawal guidance and policy in Alberta, BC, and other selected jurisdictions (literature review);
2. Identification of specific environmental considerations for water permitting in Alberta and BC;
3. Assessment of available hydrometric and climatic data sources for Alberta and BC;
4. Compilation of Alberta and BC lake level data and assessment of “baseline” conditions for Alberta and Northeast BC lakes, including historical lake level fluctuations and climate normals;
5. Development of a preliminary draft tool, outlining environmental considerations and screening criteria;
6. Presentation and discussion of the preliminary tool at a technical workshop. Workshop invitees included government staff from the Alberta Energy Regulator (AER), Alberta Environment and Parks (AEP), BC Ministry of Forests, Lands and Natural Resource Operations (FLNRO), and BC Oil and Gas Commission (OGC), and representatives from industry and private consultancies;

7. Revision of the preliminary tool to reflect workshop comments and feedback; and

8. Finalization of a preliminary screening tool.

3.0 RESULTS

3.1 JURISDICTIONAL REVIEW

A high level review was completed to provide an indication of pertinent environmental and lake withdrawal policies and guidance applied in selected North American, European, African and Australasian jurisdictions. That review included a literature (i.e., web) search and interviews with regulators. The jurisdictions reviewed included: Alaska, Northwest Territories (NWT) and Nunavut, Florida, United Kingdom (UK), New Zealand and South Africa.

The review suggested that approaches to lake water allocation tend to fall into one of two general groups, depending on the context and objectives:

- Broad-based "rules of thumb" for changes in lake level or percentage of under-ice volume. These are intended to be easily applied, and are often used as a coarse scale initial screening for risk. These rules are more likely to be used in areas where water resources are relatively abundant and demand is relatively low (i.e., areas of low risk for mining of the water resource), such as Alaska and the Canadian North (although exceptions to the rules may be made for specific higher-risk sites). Documentation for these rules is generally not extensively reported.

- Site-specific standards that are established in accordance with government tools and objectives. These standards often incorporate, as a first step, a classification of risk and/or identification of priority waterbodies, and are frequently based on information from multiple sources that include expert opinion, water balance modeling, and/or hydrologic/hydraulic modeling. They are commonly practiced in areas where all or a portion of the jurisdiction faces significant water supply pressures (e.g., Florida, UK, New Zealand, South Africa) and tend to be relatively time- and labour-intensive to apply.

However, jurisdictions often provide flexibility on a case-by-case basis (e.g., for non-priority waterbodies) and may allow the use of multiple approaches from either category, depending on level of risk and ecological sensitivity.

3.1.1 Alberta

The AER has drafted informal guidance for setting allocation limits for up to 500,000 m^3/year on ungauged lakes. AEP has also developed guidance to protect instream flow needs. These Alberta policy and guidance documents suggest that key considerations for temporary and term license applications should include: water supply and demand; littoral and riparian habitat; and downstream environmental flow needs.

3.1.2 British Columbia

The BC Ministry of Environment has developed draft guidance for lake withdrawals, and guidance and policy documents related to water allocation and instream flow needs. The BC OGC also has specific

guidance relating to Short Term Use of water applications. These BC policy and guidance documents suggest that key considerations for short term water use and license applications include: water supply and demand; aquatic and littoral (shoal) habitat; overwintering fish; and downstream environmental flow needs.

3.2 READILY AVAILABLE DATA SOURCES AND TOOLS

Readily-available hydroclimatic datasets were reviewed and summarized. These include data sources for runoff, lake evaporation, and precipitation.

4.0 SCREENING TOOL CONSIDERATIONS

Based on an evaluation of the environmental factors considered in current Alberta and BC water licensing decisions, and existing policy and guidance, the screening tool was developed to include the following four considerations:

- Water availability;
- Impacts to habitat (aquatic and riparian);
- Impacts to overwintering fish; and
- Impacts to downstream environmental flow requirements (or instream flow needs).

Specific methods to evaluate these four considerations were developed based on science-based rationale and approaches adopted in other jurisdictions. These methods are outlined in the following sub-sections.

4.1 WATER AVAILABILITY

It is recommended that a screening assessment of water availability be conducted to confirm that: (i) water withdrawals will not result in ongoing (i.e., year-on-year) net drawdown of the lake ('mining of the lake'), and (ii) there is water available for allocation (annual supply exceeds known demand).

On an annual basis, lake levels should not be reduced beyond what can be replaced by inflows. This immediately excludes withdrawals from lakes that are not predicted to have a mean annual spill or discharge. Mean annual discharge can be calculated using a simple water balance equation:

$$Q = A_L\left(P - E + R\left(\frac{A_W}{A_L} - 1\right)\right) \quad (1)$$

Where:

Q = mean annual discharge volume in a year (m^3); A_L = lake area (m^2); P = mean annual precipitation (m); E = mean annual evaporation (m); R = mean annual runoff (m); A_W = watershed area (m^2). A_w and A_L can be calculated using GIS software

The second consideration is also consistent with existing BC guidance and water management practice, where potential water allocations are evaluated based on water supply and existing licensed demand. In Alberta, a list of basin licenses can be obtained from AER / AEP. In Northeast BC, the total annual and inferred monthly demand from pre-existing water licenses can be determined from NEWT.

4.2 MAINTENANCE OF IN-LAKE OVERWINTERING FISH HABITAT

A key issue of concern related to winter withdrawals is a reduction in dissolved oxygen (DO) concentrations in water and resultant impacts to overwintering fish. Northeast BC and other jurisdictions currently impose simple rules of thumb for winter withdrawals to limit the potential for this occurrence, based on percentages of water depth or volume; however, there appears to be only limited rationale to support some of these rules.

For the Screening Tool application area, it is suggested that a defensible winter withdrawal limit would correspond to 10% of the under-ice depth of a lake. The Screening Tool also provides a winter limit based on a maximum measured depth and assumed maximum ice thickness, if site-specific information (bathymetry, ice thickness) is not available. The depth based limit is based on conservative assumptions of lake bathymetric profiles.

4.3 MAINTENANCE OF HABITAT AND ASSOCIATED VALUES

A number of simple rules of thumb have been used to restrict changes to habitat to within acceptable levels in North America and other jurisdictions. These rules include maximum lake level variations (e.g., < 10 cm, < 10% change in median lake level) and maximum reductions in shoal area or lake surface area (e.g., < 10% reduction in littoral habitat or shoal area, < 5% reduction in lake surface area).

For the purposes of desktop screening, it is suggested that a maximum drawdown might be the most practical way to specify a withdrawal threshold to maintain aquatic habitat and associated values. A maximum annual lake level drawdown of 10 cm is proposed as a screening threshold for the maintenance of habitat, as:

- It is consistent with existing guidance for Alberta and Northeast BC;
- It is a relatively small proportion of the typical annual fluctuation observed in Alberta lake levels. The median annual level variation in the Alberta study lakes was 0.35 m;
- It is a relatively small proportion of the observed range in monthly levels observed in Alberta lakes. Monthly levels were observed to range up to approximately 0.4 m over the period of record (i.e., the median lake in the dataset);
- An additional 10 cm drawdown generally will not decrease lake levels below their historic monthly minimum (i.e., observed lake levels were an average of 10 cm above the historic minimum 80% of the time, for 80% of the lakes in the Alberta dataset);
- A 10 cm drawdown would not be expected to reduce littoral area[1] or lake surface area by more than 10%, based on a minimum lake area of 0.1 km^2 and minimum lake bed slope of 100:1; and
- An annual maximum drawdown of 10 cm is not likely to have notable effects on plants, invertebrates, and the fish and wildlife species that rely on them. Vegetation and benthic macro-invertebrates can adapt to change occurring at a small spatial change, especially if that change is

[1] The littoral zone is defined as the zone between the high water mark and the bottom of the photic zone (Alberta Government 2014). For the purposes of this tool, the bottom of the photic zone is conservatively assumed to have a maximum depth of 5 m.

infrequent. Nor should a 10 cm drawdown over the course of a year affect riparian ecosystem components such as large trees for riparian raptors to nest in, or shorelines and vegetated islands used by nesting water birds.

4.4 MAINTENANCE OF DOWNSTREAM ENVIRONMENTAL FLOW REQUIREMENTS

The requirement to maintain minimum instream flows for environmental needs is specified in both Alberta and BC policy. Existing Alberta and BC guidance indicate that withdrawals should not reduce natural, instantaneous stream flows by more than 15%. The Alberta guidance also specifies that daily flows should not be reduced below a minimum ecosystem base flow, corresponding to the 80th percentile exceedance of weekly or monthly flow.

Based on the pre-existing policy and guidance, it is suggested that the screening threshold to maintain downstream environmental flow needs within acceptable levels should correspond to a maximum 15% reduction in monthly lake outflows. It is proposed that the 15% criterion be applied to monthly outflows as opposed to a longer term period (e.g., open water period or annual), in order to better maintain the natural hydrograph and ensure withdrawals do not entirely occur within a short timeframe and at a sensitive time of the year (e.g., withdrawal of an annual allotment entirely within a low flow month or during a short time period coinciding with a critical life stage for a particular species).

The Screening Tool suggests desktop methods available to estimate monthly outflows could include:

- Use of a simple water balance equation and monthly values for runoff and climate variables to predict monthly lake outflow. In the absence of site-specific information, a “monthly disaggregation” approach is included in the Tool to allow conservative estimation of monthly runoff from lakes; or
- Other modelling approaches, such as regional analysis, or use of a distributed monthly water balance model.

These criteria may not be applicable during winter months when outlets may be frozen, and no lake outflow is present.

5.0 SCREENING TOOL WITHDRAWAL LIMITS

The Screening Tool was developed based on the considerations identified above, and a preliminary assessment of which of those considerations were expected to limit withdrawals.

Proposed withdrawals that are less than the proposed winter and monthly withdrawal limits in Table 1 are considered to pose a low risk of adversely impacting environmental values.

Table 1 Maximum lake withdrawal limit screening calculations.

Season	Withdrawal Limit	
WINTER (November to March)	***No predicted lake outflows*[a] –** Maximum winter withdrawal volume = *Either:* **10 cm x lake area**[b], minus existing winter allocation volume *or* **10% of under-ice lake volume**[c], minus existing winter allocation volume, *whichever is less*	***Lake outflows predicted –*** Maximum withdrawals must comply with both monthly and winter volume limits: Maximum, monthly withdrawal volume = **15% of monthly outflows**[d], minus existing monthly water allocation volume *and* Maximum winter withdrawal volume = **10% of under-ice lake volume**[b], minus existing monthly water allocation volume
OPEN WATER (April to October)	Maximum, monthly withdrawal volume = **15% of monthly lake outflows**[d], minus existing cumulative, monthly water allocation volumes	
ANNUAL TOTAL	Maximum, total annual withdrawal volume = lesser of: **Mean annual discharge** minus total annual allocation volume[e], *and* And maximum winter and open water period withdrawals, calculated above.	

(a) Requirements to maintain downstream flows may not be necessary if there are no predicted lake outflows.

(b) This criteria is intended to protect habitat, and is based on a maximum drawdown of 10 cm. Under static (no inflow or outflow) conditions, a withdrawal volume corresponding to 10 cm multiplied by the lake surface area would be expected to result in lake drawdown of 10 cm.

(c) This criteria is intended to protect overwintering fish, and is based on a maximum of 10% of under ice volume. If lake bathymetry data are unavailable, under-ice lake volume could potentially be estimated based on assumptions about lake profile. Assuming a conical profile, 10% of the under ice volume would be held in the top 3.5% of the water column.

(d) This criteria is intended to maintain downstream flows, and is based on a maximum reduction in monthly outflows of 15%. This criteria is also be expected to limit lake level drawdown to within an acceptable range (e.g., less than 10 cm drawdown and 10% reduction in littoral habitat), and protect habitat.

(e) The mean annual discharge (MAD) criteria is intended to minimize the potential for ongoing lake mining.

6.0 LIMITATIONS

A number of limitations were noted in the development of the Screening Tool, which relate to: data availability, spatial coverage and uncertainty in hydroclimatic data; variations in climate normal period; and, simplifying assumptions used to generate the Screening Tool criteria.

It is also noted that proposed withdrawals that exceed the withdrawal limits in this tool may still pose a low risk to environmental values; however, additional, site-specific information is required to more accurately assess potential impacts under these circumstances.