



Supplementary Information for Water Source Wells

December 2023
Version 1.5



About the Regulator

The BC Energy Regulator (Regulator or BCER) is the single-window regulatory agency with responsibilities for regulating oil and gas activities in British Columbia, including exploration, development, pipeline transportation and reclamation.



The Regulator's core roles include reviewing and assessing applications for industry activity, consulting with First Nations, ensuring industry complies with provincial legislation and cooperating with partner agencies. The public interest is protected by ensuring public safety, protecting the environment, conserving petroleum resources and ensuring equitable participation in production.

Vision, Mission and Values

Vision

A resilient energy future where B.C.'s energy resource activities are safe, environmentally leading and socially responsible.

Mission

We regulate the life cycle of energy resource activities in B.C., from site planning to restoration, ensuring activities are undertaken in a manner that:



Protects public safety and the environment



Supports reconciliation with Indigenous peoples and the transition to low-carbon energy



Conserves energy resources



Fosters a sound economy and social well-being



Values

Respect is our commitment to listen, accept and value diverse perspectives.

Integrity is our commitment to the principles of fairness, trust and accountability.

Transparency is our commitment to be open and provide clear information on decisions, operations and actions.

Innovation is our commitment to learn, adapt, act and grow.

Responsiveness is our commitment to listening and timely and meaningful action.

Additional Guidance

As with all Regulator documents, this document does not take the place of applicable legislation. Readers are encouraged to become familiar with the acts and regulations and seek direction from Regulator staff for clarification.

The Regulator publishes both application and operations manuals and guides. The application manual provides guidance to applicants in preparing and applying for permits and the regulatory requirements in the planning and application stages. The operation manual details the reporting, compliance and regulatory obligations of the permit holder. Regulator manuals focus on requirements and processes associated with the Regulator's legislative authorities. Some activities may require additional requirements and approvals from other regulators or create obligations under other statutes. It is the applicant and permit holder's responsibility to know and uphold all legal obligations and responsibilities. For example, Federal Fisheries Act, Transportation Act, Highway Act, Workers Compensation Act and Wildlife Act.

Throughout the document there are references to guides, forms, tables and definitions to assist in creating and submitting all required information. Additional resources include:

- [Glossary and acronym listing](#) on the Regulator website.
- [Documentation and guidelines](#) on the Regulator website.
- [Frequently asked questions](#) on the Regulator website.
- [Advisories, bulletins, reports and directives](#) on the Regulator website.
- [Regulations and Acts](#) listed on the Regulator website.

In addition, this document may reference some application types and forms to be submitted outside of the Application Management System but made available on the Regulator's website. Application types and forms include:

- Heritage Conservation Act, Section 12
- Road use permits
- Water licences
- Master licence to cut
- Certificate of restoration
- Waste discharge permit
- Experimental scheme application
- Permit extension application

Table of Revisions

The Regulator is committed to the continuous improvement of its documentation. The table below summarizes revisions to the Supplementary Information for Water Source Wells document. Revisions are posted to the documentation section of the Regulator’s website at the beginning of every month and are effective one month after posting, unless otherwise noted. For more information about the Regulator’s monthly revisions, and for details of this month’s revisions, please visit the [documentation section](#) of the Regulator’s website.

Stakeholders who would like to provide input or feedback on Regulator documentation may send comments to ServiceDesk@bc-er.ca.

Version Number	Posted Date	Effective Date	Chapter Section	Summary of Revision(s)
	July 8, 2015	August 1, 2015	2.3 2.4 2.5	Add Section 2.3 – 2.5: Permit Amendments for Changes to Existing OGAA Wells and Converting a Water Supply Well to a Water Source Well.
3.0			Add confidentiality period for reports and data submitted to the Regulator for water source wells.	
3.2.1			Any required reports including presentation, interpretation, or analysis of data shall be prepared by a qualified professional.	
1.3				No content change: formatting only
1.4	October 8, 2019	November 1, 2019	3.1 and 3.1.2.4	Updated the content to provide further clarification.
1.5	Dec. 19, 2023	Dec. 19, 2023	Various	Replace BCOGC with BCER; OGAA with ERAA; new logos, references and associations

Table of Contents

Preface	7
About.....	7
Document Structure	7
Document Scope	7
Compliance and Enforcement.....	7
Chapter 1: Overview.....	8
1.1 Introduction.....	8
1.2 Additional Manuals and Guidelines.....	9
1.3 Overview of Regulatory Requirements for Water Source Well Drilling and Construction	10
Chapter 2: Permitting Requirements.....	11
2.1 Well Permits for Water Source Wells.....	11
2.2 Investigative Use Permits for Water Source Test Well Drilling.....	12
2.3 Permit Amendments for Changes to Existing ERAA Wells	12
2.4 Reactivation of a Suspended Water Source Well	13
2.5 Converting a Water Supply Well to a Water Source Well	14
Chapter 3: Guidance for Hydrogeological Assessment for Shallow Water Source Wells.....	15
3.1.2.1 Background Information Review.....	17
3.1.2.2 Pumping Test Program Objectives.....	17
3.1.2.3 Duration of Pumping Test.....	17
3.1.2.4 Groundwater Monitoring Well(s)	18

3.1.2.5 Surface Water Monitoring 18

3.1.2.6 Data Collection Requirements 19

3.1.2.7 Water Quality Sampling and Analysis 20

3.1.2.8 Data Interpretation 20

3.1.3 Water Source Well Evaluation Report 22

3.1.4 Long Term Monitoring Program 23

3.2 Deep Water Source Wells 23

3.2.1 Data Collection and Submission..... 23

3.2.2 Long Term Monitoring Program 24

Appendix A: Water Source Well Summary Form..... 25

Preface

About

The Supplementary Information for Water Source Wells document provides a reference for water source well permit applicants and permit holders. The document covers requirements and procedures for applying for and obtaining a water source well permit, and provides guidance for conducting a hydrogeological assessment in support of an application for a water licence under the Water Sustainability Act. The document has been prepared to be as comprehensive as possible; however it is not all encompassing and may not cover all situations. Where circumstances or scenarios arise and are not covered by the document, contact one of the Regulator's Permitting and Authorizations Managers for assistance.

Document Structure

This document begins with an overview of permitting requirements for water source wells. This document also provides technical and regulatory guidance regarding requirements for water source wells related to drilling, hydrogeological assessment and data collection, monitoring and reporting.

Document Scope

The document is limited in scope to the Regulator's water source well permitting framework and the authorities and requirements established within the [Energy Resource Activities Act](#) (ERAA), as well as Regulator's requirements for hydrogeological testing and reporting pertaining to issuance of water licences for groundwater use under the Water Sustainability Act. Carrying out oil and gas and related activities may require additional approvals from other regulators or create obligations under other statutes. It is the permit holder's responsibility to know and uphold all of their legal obligations.

Compliance and Enforcement

This document does not replace legislation or affect legislative requirements. All permit holders are ultimately responsible for ensuring they understand and meet all requirements of the Energy Resource Activities Act and their permits. Should a person not comply with ERAA, the Regulator may take compliance and enforcement actions. For more information

regarding the Regulator’s Compliance and Enforcement processes, please refer to the [Compliance and Enforcement Manual](#).

Chapter 1: Overview

1.1 Introduction

A water source well is defined in the [Petroleum and Natural Gas Act](#) (PNGA) as a “hole in the ground drilled to obtain water for the purpose of injecting water into an underground formation in connection with the production of petroleum or natural gas”. Water source wells are wells under the [Energy Resource Activities Act](#) (ERAA), and are subject to the Act and its Regulations, and require well permits under ERAA. The BC Energy Regulator is responsible for the authorization and regulation of water source wells. Water source wells also fall under the definition of a “water supply well” under the [Water Sustainability Act](#) (WSA), and are subject to regulatory requirements under the WSA.

This document presents information regarding water source wells, and water source test wells (i.e., test wells drilled for the purposes of locating suitable water source wells). This document specifically covers:

- Permitting requirements for water source wells and water source test wells.
- Technical guidance related to hydrogeological assessment, data submission, and monitoring for water source wells that is required to support the application for a water licence issued by the Regulator under the Water Sustainability Act (WSA).

Additional guidance on the WSA water licence application full package requirements (which include a water management plan, consultation and notification information, and other documentation), as well as water licence application submission instructions are provided in the Regulator’s [Water Licence Application Manual](#).

This document does not pertain to wells that are not intended to be operated as water source wells under ERAA. Other types of water wells (e.g., water supply wells drilled for the purposes of supplying water for drilling, camps, testing or maintenance of pipelines, etc.) are regulated under the [Water Sustainability Act](#). (refer to [Section 2.5](#) for information on converting existing water supply wells to water source wells). Wells providing domestic water supply may also be regulated under the [Drinking Water Protection Act](#).

This document is not intended to take the place of applicable legislation. ERAA and its applicable regulations, which include but may not be limited to the [Drilling and Production Regulation](#) and the [Environmental Protection and Management Regulation](#), can be reviewed on the Regulator’s website. The Water Sustainability Act (WSA) and WSA regulations, including the Groundwater Protection Regulation and the Water Sustainability Regulation, can be reviewed on the Provincial government website. The user is encouraged to read the full text of legislation and each applicable regulation. It is the responsibility of the applicant or permit holder to know and comply with all of their legal responsibilities.

Water source wells, and water source well projects or facilities, pumping at rates greater than or equal to 75 L/s may be reviewable projects under the [BC Reviewable Projects Regulation](#) and thus subject to additional requirements under the [BC Environmental Assessment Act](#).

1.2 Additional Manuals and Guidelines

The following manuals and guidelines provide additional information regarding regulatory and permitting requirements related to water source wells, and can be referenced on the Regulator’s website:

- [Well Permit Application Manual](#)
- [Water Licence Application Manual Crown Land Application Manual](#)
- [Well Drilling Guideline](#)
- [Well Completion, Maintenance and Abandonment Guideline](#)
- [Well Data Submission Requirements Manual](#)
- [Water Service Wells Summary Information](#)
- [Environmental Protection and Management Guide](#)
- [Directive 2010-07 – Reporting of Water Production and Flow Back Fluids](#)

Please Note:

Production of water does not require ownership of the subsurface tenure in the completed zone; however, some water source wells have produced sufficient rates of associated natural gas, typically evolving from solution in water with pressure loss, to require capture and conservation. In such a case, the primary product of the well is defined as “gas” (despite the well purpose being water), requiring valid petroleum and natural gas tenure for the formation over the complete gas spacing area.

1.3 Overview of Regulatory Requirements for Water Source Well Drilling and Construction

Water Source Wells are wells under ERAA and must be drilled and completed in accordance with ERAA regulatory requirements including Drilling and Production Regulation (DPR). Water source wells also fall under the definition of a “water supply well” in the Water Sustainability Act, and therefore must comply with the drilling and construction requirements of the Groundwater Protection Regulation (GWPR), where applicable.

A summary of GWPR requirements is provided below; however, the water source well permit holder or applicant is encouraged to review the specific requirements of the GWPR and the DPR to ensure compliance. It is the permit holder’s responsibility to comply with all regulatory requirements.

Water source wells that extract “shallow” groundwater above the depth threshold defined in Part 5 of the Water Sustainability Regulation described here as:

- all groundwater < 300 m deep; and
- all groundwater between 300 m deep and < 600 m deep that lies above the “base of fish scales” geological marker or an older marker as defined in the WSR that distinguishes between sedimentary bedrock of Lower Cretaceous age and Upper Cretaceous age,

must comply with all applicable sections of the GWPR, including those related to driller and pump installer qualifications, well construction and placement of annular seals, well disinfection, well record submission to the provincial database, and affixing a well plate to the well, controlling and reporting artesian flow, introducing foreign material into a well, and responsibility for water supply wells on Crown Land.

Water source wells that extract “deep groundwater” as defined in the Water Sustainability Regulation are exempted from Sections of the GWPR, other than sections pertaining to controlling and reporting artesian flow, introducing foreign material into a well, and responsibility for wells on Crown Land.

Chapter 2: Permitting Requirements

The following sections outline the Regulator’s permitting requirements related to water source wells and water source test wells. Guidance for completing and submitting permit applications can be referenced in the indicated application manuals on the [Regulator’s website](#).

2.1 Well Permits for Water Source Wells

All water source wells require well permits under ERAA. The [Water Licence Application Manual](#) outlines procedures for completing and submitting well permit applications for water source wells.

The BCER decision maker may specify conditions in the well permit in addition to ERAA regulatory requirements. Such condition and may be related to well construction, siting, operation, maintenance, testing, mitigation measures, abandonment, reporting and data submission or any other requirements the Regulator considers necessary for the safe operation of the well and for the protection of the environment.

In addition to a well permit, unless the water source well accesses “deep groundwater” as defined in the Water Sustainability Regulation, the permit holder must obtain a Water Sustainability Act water licence issued by the Regulator (refer to the [Water Licence Application Manual](#), and Section 3 of this document). Water licences must be obtained prior to initiating production at a water source well.

Notes:

- The Regulator does not issue permits under ERAA for water supply wells that do not fall under the Petroleum and Natural Gas Act definition of a “water source well”. Such water supply wells are wells under the Water Sustainability Act (WSA), and, although WSA permits are not required for drilling, such wells must be drilled and operated in accordance with the WSA, the Water Sustainability Regulation, and the Ground Water Protection Regulation.
- The Regulator recommends for all water supply well drilling in Northeast B.C. consultation with a qualified professional (ie. the Association of Professional

Engineers and Geoscientists of BC) occurs to ensure due diligence in relation to safety and the potential for shallow gas, and environmental protection.

2.2 Investigative Use Permits for Water Source Test Well Drilling

Water source test wells (i.e., test wells drilled for the purposes of locating suitable water source wells) may be drilled on Crown land to depths up to 300 metres under an Investigative Use Permit (IUP) through a Crown land application. Procedures for IUP applications for water source test well drilling can be referenced in the Crown Land Application Manual.

IUPs will be issued for a maximum of five water source test wells and for drilling locations within one area less than four kilometres squared, unless approval is obtained from the Regulator. IUPs issued for water source test wells may include conditions related to well drilling, abandonment, or other requirements as determined by the statutory decision maker.

Regulatory requirements of the [Water Sustainability Act Groundwater Protection Regulation](#) apply to water source test wells.

Following drilling, a well permit application must be submitted to the Regulator for each water source test well the applicant would like to operate as a water source well. Water source test wells that are approved as water source wells will be wells under ERAA and subject to ERAA regulations and the permitting requirements outlined above ([Section 2.1](#)).

The drilling of water source wells targeting depths greater than 300 metres, or those not on Crown land drilled to any depth, even if drilled for investigation purposes, cannot be authorized through an IUP, and require a well permit.

2.3 Permit Amendments for Changes to Existing ERAA Wells

Permit amendments are required for converting an existing ERAA well into a water source well (any depth), or modifying an existing water source well to access a new depth (deeper or shallower). The procedure is outlined below:

- The permit holder shall submit a Notice of Operation (NOO) to the Regulator’s IRIS database indicating the intent to convert the well to a water source well or change the production zone depth in the “Summary of Proposed Work”.
- With respect to the NOO, the permit holder may conduct activities related to the completion of the water source well, and may conduct hydrogeological or other testing to evaluate the water source (the aquifer formation) and the well productivity.
 - During well testing, water may be produced from the well over a total cumulative pumping period of not more than 10 days. Water produced during well testing must not be discharged to the environment unless prior approval is obtained from the Regulator. The permit holder may contact Sean Babulic, Sean.Babulic@bc-er.ca, regarding discharge approvals.
- Prior to operating the well as a water source well, the permit holder shall submit a Completion/Workover Report Form and a Well Permit Amendment Application Form to the Regulator (both forms available at [here](#)). The Well Permit Amendment Application Form shall indicate the intent to use the well as a water source well (Section N-15), changes to depth, objective formation, objective fluid type, etc., (in Section F), and other required information.
- Unless the well accesses “deep groundwater”, as defined in the Water Sustainability Regulation, the permit holder must also obtain a Water Sustainability Act water licence issued by the Regulator (refer to the [Water Licence Application Manual](#) and Section 3 of this document).

2.4 Reactivation of a Suspended Water Source Well

Well permit holders shall notify the Regulator’s Hydrogeologist prior to reactivating a water source well from suspended status, and, unless the well accesses “deep groundwater”, as defined in the Water Sustainability Regulation, must have a Water Sustainability Act water licence issued by the Regulator (refer to the [Water Licence Application Manual](#)).

Reactivation of a water source well must be conducted in accordance with Section 3.3 of the [Well Completion, Maintenance and Abandonment Guideline](#).

2.5 Converting a Water Supply Well to a Water Source Well

The Regulator does not guarantee a previously drilled water well will be approved as a water source well; however, if a company would like to use an existing water supply well as a “water source well” as defined in the BC Petroleum and Natural Gas Act the company must:

- submit a well permit application to the Regulator and obtain a well permit;
- obtain a WSA water licence, unless the water source well accesses “deep groundwater” as defined in the Water Sustainability Regulation; and
- comply with all regulatory requirements, including requirements under ERAA and the WSA, any conditions specified in the well permit or the water licence.

Please Note:

The drilling of water supply wells to depths greater than 300 metres, where there is known potential for future application for an ERAA well permit for the well, is not consistent with the intent of the ERAA regulatory framework or the Regulator’s water source well permitting framework outlined in this document.

Production of water does not require ownership of the subsurface tenure in the completed zone; however, some water source wells have produced sufficient rates of associated natural gas, typically evolving from solution in water with pressure loss, to require capture and conservation. In such a case, the primary product of the well is defined as “gas” (despite the well purpose being water). As such, a valid petroleum and natural gas tenure for the formation over the complete gas spacing area and a permit issued for the (natural gas) well issued under ERAA may be required.

Chapter 3: Guidance for Hydrogeological Assessment for Shallow Water Source Wells

As defined in the WSA Water Sustainability Regulation, water licences are required for ERAA water source wells, for the use of “shallow” groundwater above the depth threshold defined in Part 5 of the Water Sustainability Regulation described here as:

- All groundwater < 300 metre deep
- All groundwater between 300 m deep and < 600 metre deep that lies above the “base of fish scales” geological marker or an older marker as defined in the WSR that distinguishes between sedimentary bedrock of Lower Cretaceous age and Upper Cretaceous age.

A hydrogeological assessment is required to be conducted and submitted in support of a WSA water licence application for “shallow” water source wells. This section provides technical guidance for conducting a hydrogeological assessment in support of a water licence application. Additional information regarding the full package requirements and application procedures for water licences can be referenced in the Regulator’s Water Licence Application Manual.

3.1 Hydrogeological Assessment Overview

The primary purpose of the hydrogeological assessment is to support that the application is consistent with the requirements of the Water Sustainability Act with regard to:

- determining the sustainable water yield of the well, to ensure that the licensed withdrawal does not impair the long-term sustainability of the aquifer;
- determining whether the aquifer is likely to be hydraulically connected to a stream, to determine what licence conditions are necessary to ensure that the environmental flow needs of the stream are not impaired; and
- ensuring that the water rights are not impaired for individuals who hold rights under the Water Sustainability Act.

The information and analysis provided by the hydrogeological assessment must be sufficient, as determined by the statutory decision maker, to address the above WSA requirements. The statutory decision maker may, upon the review of the submitted hydrogeological assessment, require the submission of additional data, testing, and/or information to support the application.

The hydrogeological assessment program must be designed for the purpose noted above by a qualified professional (defined below) and should include the following general components.

1. Background Information Review
2. Field Investigation (i.e., Pumping Test)
3. Data Interpretation
4. Preparation of a Hydrogeological Assessment Report

Guidance regarding requirements for a hydrogeological assessment in support of a licence application is being developed by the BC Ministry of Environment. Until the time that Provincial guidance is published, water licence applicants for water source wells can refer to guidance for hydrogeological assessment requirements provided in the following subsections.

In this document “qualified professional” means a member in good standing of a profession regulated in British Columbia and who is recognized by the profession as being qualified to work in an area of practice for which an opinion or advice is required. A qualified professional must possess an appropriate combination of formal education, knowledge, skills, and experience to conduct a technically sound and rational assessment for the area of practice, and be familiar with applicable regulations, standards, policies, protocols and guidelines.

3.1.2 Hydrogeological Assessment Components

Considerations for the development of the hydrogeological assessment program are outlined below as a general guideline. Additional information may be requested by the decision maker to support a licence application.

3.1.2.1 Background Information Review

A background review of the regional and local hydrogeological system and setting should be completed. The review should include compilation of available and relevant desktop information regarding the topography, surficial and bedrock geology, surface water features and hydrology, hydrogeology, mapped aquifers, wells, climate, and land use activities within two kilometres or more of the water source well location.

The background review should also include a field reconnaissance. The field reconnaissance should be completed at a level of detail appropriate to confirm the desktop information with respect to features such as:

- Topography;
- locations and characteristics of surface water features;
- surrounding property use; and
- neighbouring property water use (surface water licences, water supply wells, springs, dugouts, etc.)

The information compiled through the background information review should be used in the development of a pumping test program, and in the development of a conceptual hydrogeological model of the aquifer system.

3.1.2.2 Pumping Test Program Objectives

A constant rate pumping test program should be developed to allow assessment of:

- hydraulic properties of the aquifer;
- potential groundwater boundary influences;
- long-term sustainable yield of the aquifer near the water source well;
- distance-drawdown relationships; and
- potential impacts to existing wells, surface water bodies, and the environment.

3.1.2.3 Duration of Pumping Test

The duration of the pumping test shall be determined by the qualified professional to be appropriate to support the water licence application, and should consider site specific factors including aquifer type and characteristics, anticipated pumping rate, boundary conditions, other water supply wells, or any other relevant factors. The duration of the pumping test should be sufficient to provide data to evaluate the long term sustainable well yield (typically 48 to 72 hours, depending on site specific factors).

3.1.2.4 Groundwater Monitoring Well(s)

Groundwater monitoring (observation) wells should be installed for monitoring during the pumping test at depths and locations determined by the qualified professional. At least one groundwater monitoring well, completed in the same aquifer as the water source well, should be installed.

A suitable groundwater monitoring well is typically located between 15 metres and 150 metres from the water source well, with location and offset distance determined after consideration of site specific conditions and anticipated pumping rate. Monitoring well construction must be completed under the direction of a qualified professional and must be completed in accordance with the BC Groundwater Protection Regulation. Guidance regarding suitable groundwater monitoring well design and installation procedures for environmental investigations can be referenced in: British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples (2003).

Well owners within one kilometre, of the water source well, or an appropriate distance determined by the qualified professional, should be notified of the pumping test. Monitoring of water levels in surrounding groundwater wells may be completed to support the hydrogeological assessment if permission is obtained from the land owner.

3.1.2.5 Surface Water Monitoring

The potential for hydraulic connection of the pumped aquifer to surface water bodies, including streams, lakes, ponds, springs, and wetlands, should be monitored during the pumping test to support the assessment of hydraulic connectivity. Surface water bodies, that in the opinion of the qualified professional, could be hydraulically connected to the aquifer at the water source well shall be monitored. Surface water monitoring methods may include flow measurements, water level measurements,

visual observations, pneumatic piezometers, observation wells, and/or chemical analysis as deemed appropriate for the hydrogeological assessment by the qualified professional.

3.1.2.6 Data Collection Requirements

Over the pumping test program, the following data should be recorded:

- Weather conditions over the testing period.
- Handling procedures for pumped water.
- Geodetic elevations of the water source well top of casing and all groundwater monitoring wells.
- Water level (hydraulic head) in the water source well and all groundwater monitoring wells before the pumping test is initiated. Initial water levels shall be established by consistent consecutive measurements.
- Pre-test monitoring data for surface water bodies requiring monitoring during the pumping test.
- Production flow rate throughout the test (should be equal to or greater than the anticipated required use and not vary by more than five per cent of the set test rate throughout the test). Any adjustments to the flow rate should be recorded.
- Information regarding pumping of any neighbouring water wells, if available.
- Water levels in the water source well and groundwater monitoring well(s) should be measured relative to geodetic datum, at intervals in accordance with standard professional practice, adequate to determine aquifer parameters and boundary influences. Water level monitoring frequency may be higher at the start of pumping and at the start of recovery, and may decrease over time based on the well response. If automated data loggers are used, then the interval should be set to one minute or less.
- Water level recovery measurements collected for as long as the production well is pumped, and until the water level has recovered at least to within 90 per cent of the non-pumping water level.
- Data for monitored surface bodies at appropriate intervals during the test and during recovery.

- Field water quality parameters of pH, electrical conductivity, and temperature periodically measured throughout the test.
- Other data as determined by the qualified professional to meet the objectives of the pumping test and hydrogeological assessment.

3.1.2.7 Water Quality Sampling and Analysis

A water quality assessment should be completed as part of a water source well evaluation. Water quality sampling should be conducted using standard environmental sampling protocols in accordance with the British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples (2003) , and as follows:

- Samples should be collected prior to the termination of test pumping. Prior to sampling, field measurements for pH, electrical conductivity, and temperature should be used to confirm the sample is representative of the aquifer formation through stabilized measurements.
- The sample should be analyzed for routine water quality parameters (pH, total dissolved solids, electrical conductivity, major cations and anions), total and dissolved metals, and dissolved gases (C1-C3).
- If dissolved methane is detected at concentrations greater than five mg/L more detailed isotopic analyses may be conducted to differentiate between biogenic and thermogenic sources. Methane isotopic sampling should be conducted using protocols described in The Free Gas Sampling Standard Operating Procedure for Baseline Water Well Testing (2009), prepared for Alberta Environment and Sustainable Resource Development.
- All water samples should be collected and preserved in accordance with standard environmental sampling protocol and shipped to an analytical laboratory accredited through the Canadian Association Laboratory Accreditation (CALA) for testing.

3.1.2.8 Data Interpretation

Interpretation of data collected during the background information review and pumping test should involve the following tasks.

A conceptual model of the aquifer system should be developed based on the background information review, drilling records, and the pumping test data. The conceptual model should indicate data or professional inferences regarding the aquifer system such as: geometry and hydrogeological properties, surface water – groundwater connectivity, aquifer-aquifer connectivity, groundwater flow directions and gradients, boundary conditions, or other relevant hydrogeological information.

The pumping test data should be analyzed graphically and interpreted to identify and locate suspected aquifer boundaries, leakage, changes in aquifer thickness, spatial changes in aquifer permeability, pumping in nearby wells, changes in discharge rate during the well test, delayed yield and barometric or other effects, where applicable. The pumping test data may be interpreted using either analytical solutions or a numerical model. The most appropriate analytical solution/model should be selected based on the available data and the conceptual hydrogeological model. Aquifer parameters such as transmissivity, hydraulic conductivity, and storage coefficient should be evaluated, and any assumptions, uncertainties, limitations, or deviations from this document should be identified.

A theoretical long-term safe yield analysis should be conducted using a method representing a long-term (20 year) development premise. The Modified Moell Method (van der Kamp and Maathius 2005), which is based on an evaluation of the amount of water that may be diverted for 20 years without lowering the water below the top of a confined aquifer, or more than two-thirds the saturated thickness of an unconfined aquifer, is an example of an acceptable model for this type of analysis. The Modified Moell Method can be referenced in van der Kamp, G. and Maathius, H., 2005, The applicability of “Q20” methods for determining sustainable groundwater yields, In Proceedings of the 58th Canadian Geotechnical and 6th Joint CGS/IAH Groundwater Specialty Conferences, Saskatoon, September 18- 21, Paper No. GS720.

Theoretical 20-year distance-drawdown predictions should be determined using the sustainable yield estimate with consideration of other groundwater pumping in the area. The distance-drawdown estimates should be used with other hydrogeological techniques to complete a potential impacts analysis to predict interference with other groundwater or surface water users, aquifer impacts, or other potential issues related to changes in groundwater recharge or impacts to ecologically sensitive areas.

Water quality data should be interpreted and compared with the federal Guidelines for Canadian Drinking Water Quality and the provincial approved groundwater quality criteria, where appropriate.

3.1.3 Water Source Well Evaluation Report

A hydrogeological assessment report, prepared by a qualified professional, should document the results of the hydrogeological assessment including the following components:

- Description of the project.
- Documentation of the background information review.
- Description of methodology and procedures for drilling, well installation, the pumping test, groundwater sampling, and data interpretation.
- Well design and geological conditions indicated on a well log, pump specifications, and pump intake depth.
- Pumping test data in graphical format, data analysis, and results.
- Tabulated groundwater quality data with applicable criteria, and appended laboratory analytical reports.
- Supporting maps, cross-sections, and figures showing the regional and local hydrological-hydrogeological context and the conceptual groundwater model.
- Conclusions and recommendations regarding potential impacts to the environment, other water users and rights holders, and aquifer protection (quantity and quality).
- Confirmation of registration of the water source well in the BC Wells Database and well plate number.
- Description of a proposed long term monitoring program (guidance provided in [Section 3.1.4](#)).
- Discussion regarding any assumptions, uncertainties, limitations, or deviations from this document.
- Completed Water Source Well Summary Form ([Appendix A](#)).

Digital files of the original water level monitoring data collected during pumping test should be retained by the applicant to be provided upon request.

3.1.4 Long Term Monitoring Program

A monitoring program should be designed and implemented for the period during which the water source well is active. The monitoring program should be designed to confirm conclusions made with regard to potential impacts to the environment and other water users/rights holders, and to verify the long term performance of the aquifer. The monitoring program should include the following components:

- Water level (hydraulic head) monitoring in the groundwater monitoring well(s).
- Annual groundwater sampling from the water source well and analysis for parameters consistent with previous analysis.
- Monitoring of surface water bodies or water wells if hydraulic connectivity with those surface water bodies or water wells is indicated as a result of the hydrogeological assessment.
- Required water withdrawal reporting in accordance with the Drilling and Production Regulation (Section 72).
- Any additional monitoring deemed necessary by the qualified professional.

3.2 Deep Water Source Wells

Water source wells that access “deep groundwater” as defined in the Water Sustainability Regulation do not require licences for water use. The operation of a deep water source well is regulated through provisions under ERAA including those in the Drilling and Protection Regulation, the Environmental Protection and Management Regulation, and conditions in the well permit, where applicable.

3.2.1 Data Collection and Submission

Testing and data collection associated with the requirements for deep water source wells should be conducted under the direction of a qualified professional. The data collection and submission requirements that may be specified as conditions in the well permits for water source wells accessing “deep groundwater” may include:

- Measurement of initial reservoir pressure at the water source well.
- Compilation of geological and geophysical logs, stratigraphic interpretation, and available hydrogeological information to develop a conceptual hydrogeological model to demonstrate hydraulic isolation of the deep

aquifer from overlying shallow groundwater, and to assess potential interference between other deep water source wells or disposal wells accessing the same aquifer system.

- Monitoring data from a dedicated shallow groundwater monitoring well installed by the permit holder for the purposes of monitoring for hydraulic connection between the shallow groundwater zone and the deep groundwater aquifer.
- The analysis of representative groundwater samples from the water source well for analysis of specified water quality parameters that may include pH, total dissolved solids, electrical conductivity, major cations and anions, total and dissolved metals, or other parameters.
- A completed Water Source Well Summary Form ([Appendix A](#)).

3.2.2 Long Term Monitoring Program

A long term monitoring program may be required as a condition of the well permit for the period during which the water source well is active. The monitoring program may include the following components:

- Water level (hydraulic head) monitoring in shallow groundwater monitoring wells.
- Annual groundwater sampling from the water source well, and analysis for parameters consistent with previous analysis.
- Annual measurement of reservoir pressure at the water source well.
- Monitoring program requirements may be amended over the period of operation of the water source well as determined by the Regulator based on review of the submitted monitoring data.

The water withdrawal reporting is also required in accordance with the Drilling and Production Regulation (Section 72).

Appendix A: Water Source Well Summary Form

Water Source Well Summary Groundwater Data Form (to be completed by the qualified professional and submitted with the Water Source Well Evaluation Report).

Data	Value, text, or "No data"
BCER Well Authorization Number	
Provincial Well Tag Number (WTN)	
UTM Northing (NAD1983)	
UTM Easting (NAD1983)	
Hydrogeological assessment report pdf submitted (Y/N)	
Ground surface elevation (m asl)	
Bottom elevation of well (m asl)	
Aquifer material description (unconsolidated or bedrock)	
Aquifer type (confined, unconfined, leaky)	
BC MOE Aquifer identification number	
Geological Formation	
Elevation of top of aquifer (m asl)	
Elevation of base of aquifer (m asl)	
Screen or intake top elevation (m asl)	
Screen or intake bottom elevation (m asl)	
Measured (non-pumping) hydraulic head (m asl)	
Date of hydraulic head measurement (YYYY-MM-DD)	
Reservoir pressure (kPa) and elevation (m asl) of measurement	
Date of reservoir pressure measurement (YYYY-MM-DD)	
Hydraulic Conductivity (m/s)	
Aquifer transmissivity (m ² /s)	
Aquifer storativity/specific yield (unitless)	
Aquifer porosity (unitless)	
Aquifer permeability (m ²)	
Calculated Long Term Sustainable Yield (Q20) (m ³ /day)	
Total Dissolved Solids - TDS (mg/L)	
Date of TDS analysis (YYYY-MM-DD)	

