GUIDE TO GROUNDWATER WITHDRAWAL APPROVALS

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Environment and Labour

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GUIDE TO GROUNDWATER WITHDRAWAL APPROVALS

1. INTRODUCTION

1.1 Background

Under the Environment Act, the Activities Designation Regulations (Division I) require a water withdrawal approval ("Water Approval") if a groundwater withdrawal exceeds 23,000 litres per day. In order to obtain a withdrawal approval, a completed application form and supporting documentation must be submitted to Nova Scotia Environment and Labour (NSEL). Section 6 of the application form specifies that the supporting documentation must include a Qualified Persons Assessment Report. For groundwater withdrawal approvals, the Qualified Persons Assessment Report consists of a hydrogeological study.

The purpose of this guide is to describe the minimum submission requirements, supporting documentation and the criteria used by NSEL to evaluate groundwater withdrawal applications.

The hydrogeological study must be completed to the satisfaction of NSEL and must clearly evaluate the potential effects of the proposed withdrawal on existing groundwater users and the environment. The report must be prepared by, or under the direction of, a qualified hydrogeologist. In this guide, a "qualified hydrogeologist" is a person with hydrogeology training and experience, and licenced to practice in Nova Scotia by a scientific or engineering organization, such as the Association of Professional Geoscientists of Nova Scotia (APGNS) or the Association of Professional Engineers of Nova Scotia (APENS).

1.2 Approach to Groundwater Allocation

In allocating groundwater withdrawals, NSEL endeavours to ensure that groundwater resources are developed in a sustainable manner. In other words, water resources are to be developed and used in a beneficial manner that can be maintained indefinitely without causing unacceptable environmental, economic or social consequences. Groundwater withdrawal approvals are one of the primary mechanisms used by NSEL to ensure that groundwater resource development is sustainable.

The following guiding principles are used in allocating groundwater withdrawals:

1. Withdrawals from the aquifer must be sustainable (i.e., can be maintained indefinitely without causing unacceptable environmental, economic or social consequences);

2. New groundwater withdrawals should not cause any significant adverse effects to existing groundwater users or the environment. Note that existing users are not required to modify operations if their water withdrawals interfere with water levels in newly installed wells.

3. Groundwater allocations are based on a "first-come, first-served basis" with priority given to drinking water applications. Priority is also given to existing withdrawal approvals over new applications. For new approval applications that are being processed, those received at the earliest date will be given priority over those received at a later date.

4. Groundwater allocations are based on the applicant's current water needs, rather than potential future needs. The applicant must demonstrate the need for the volume of water requested. The applicant cannot typically reserve water for future use beyond the expiry date of the approval, up to 10 years under the Approvals Procedure Regulations.

2 HYDROGEOLOGICAL STUDY REQUIREMENTS

The hydrogeological study typically includes the information summarized in Table 2-1 and described in the following sections. A submission checklist of the minimum general requirements of a hydrogeological study is presented in Appendix A The checklist in Appendix A must be completed and submitted with the hydrogeological study. The hydrogeological study is to be submitted in electronic format and hard copy.

2.1 Description of Site and Water Supply Details

2.1.1 Site Description

A description of the site, including: site location, topography, drainage, proximity to watercourses, proximity to neighbouring wells, PID number, UTM coordinates (NAD83), municipal land use zoning, as well as actual land use of subject property and neighbouring properties.

2.1.2 Well(s) or Well Field Description

The location and description of all wells in the well field or on the property, including: well log details, wellhead completion, production records, water levels and history of any well interference or other concerns.

2.1.3 Description of Intended Water Use

A description of the intended use of the water, including the type of activity carried out on-site (e.g., commercial, industrial, agricultural, etc.) and water requirements. If this application relates to an amendment of an existing water approval the reason for the change in withdrawal rate should be discussed (i.e., changes to the activity, or amendments, additions, or deletions).

Current water needs should be presented separately from projected water needs. Projected needs should fall within a 10 year period (i.e., the duration of a water withdrawal approval). Justification must be provided for projected needs. If water requirements increase in the future a request to amend the approval can be made.

Table 2-1: Summary of Hydrogeological Study Information

Study Information	Description
Site Description	• Site Description • Well Field Description • Intended Water Use • Groundwater Withdrawal Details • Existing and Previous Approvals
Description of Hydrogeology	• Local and Regional Geology • Local and Regional Hydrogeology • Local Surface Water Features
Pumping Test Information	• Pumping Test Analysis • Water Quality Analysis
Evaluation of Potential Impacts	• Sustainable Yield • Well Interference Effects • Groundwater Quality Effects • Sea Water Intrusion • Groundwater-Surface Water Interaction
Monitoring and Contingency Plans	• Monitoring Plans • Contingency Plans
Other Requirements (may be required for certain types of withdrawals)	• Well Survey • Public Consultation
Supporting Figures and Data	• Site Location Map and Site Plan • Aerial Photos • Well Logs • Pumping Test Data and Graphs • Laboratory Reports • Groundwater Level Data • Well Production Records

2.1.4 Description of Proposed Groundwater Withdrawal

For all production wells, details must be provided regarding the proposed groundwater withdrawal rates including: the maximum rate (averaged over a 72 hour period); the average daily pumping rate (averaged over a 30 day period); the 30 day withdrawal volume; and, the annual withdrawal volume.

The maximum pumping rate requested cannot exceed the rate used during the constant rate pumping test. In addition to pumping rates, the 30 day and annual water withdrawal volumes from the well must also be identified. See Table 2-2 for an example of how withdrawal rates and volumes will be approved.

Table 2-2: Example of Groundwater Withdrawal Rates & Volumes for a Well Field

Production Well(s)	Pumping Rate (litres/day)		Withdrawal Volume (litres)	
	Maximum [1] (over 3 days)	Average [2] (Over 30 days)	30 day [3]	Annual[4]
PW1	30000	25000	750000	9125000
PW2	30000	25000	750000	9125000
Total Well field [5]	**60,000 litres/day**	**50,000 litres/day**	**1,500,000 litres**	**18,250,000 litres**

Notes:

1 Maximum allowable pumping rate is based on the rate used in the 72 hour pumping test.

2 Average allowable pumping rate is based on the demonstrated water needs of the applicant and sustainable yield.

3 30 day withdrawal volume = Average pumping rate multiplied by 30 days.

4 Annual withdrawal volume = Average pumping rate multiplied by the number days pumped per year (i.e. 365).

5 Total well field = sum of all production wells (excluding backup wells).

The report must identify the duration of the water withdrawal and the total volume of water withdrawn over a year (i.e. average daily pumping rate multiplied by number of days pumped). If the withdrawal is seasonal, identify the months of the year to which the withdrawal applies. For example, a municipal well is typically designed to pump continuously throughout the year. Therefore, in this case, the annual withdrawal volume is the average pumping rate times 365 days per year. In contrast, for an irrigation supply well designed to pump for 90 days of the year the annual withdrawal volume would be the average pumping rate times 90 days.

If there is more than one well on the site, or the application is associated with a well field comprised of several wells, then a total withdrawal rate for the well field must be specified. This shall include the maximum rate (averaged over a 72 hour period) and the average pumping rate (averaged over a 30 day period) combined from all wells. The total well field rate excludes any backup well which will not be pumped at the same time as other wells. The average pumping rate requested cannot exceed the demonstrated water needs (Section 2.1.3).

2.1.5 Description of Previous or Existing Groundwater Withdrawal Approvals

A description of existing and previous approvals related to the subject site, along with an assessment of any groundwater monitoring data, quantity or quality, collected as part of the existing or previous approvals.

2.2 Description of Hydrogeology

2.2.1 Geology

A detailed description of the local bedrock and surficial geology, including, but not limited to: structure, stratigraphy, depth, thickness, composition, texture, known relevant weathering/ alteration/ structural features (i.e. joints, fractures, faults, or bedding planes), water bearing potential and lateral continuity.

2.2.2 Hydrogeology

A detailed description of the local hydrogeology, including, but not limited to: aquifer types, identification of hydrostratigraphic units, and the hydraulic characteristics of each unit, such as hydraulic conductivity, porosity, effective porosity, transmissivity, storativity/specific storage, anisotropy, hydraulic head, seasonal fluctuations, vertical and horizontal hydraulic gradients, groundwater flow direction, boundary conditions, recharge, discharge and a discussion of the overall groundwater quality.

The location and description of all wells in the well field or on the subject property, including, but not limited to: well log details, wellhead completion, production records, water levels, history of complaints, problems and well interferences.

2.2.3 Surface Water Features

Identify the primary, secondary and subwatershed(s) where the well(s) or well field is located. A description of the local surface water features within 500 m of the wells, including, but not limited to: the type of surface water feature (i.e. stream, pond, or wetland), distance to the well, water levels, flow rates, seasonal variation, surface water quality, drainage patterns, flood risk and annual precipitation rates.

2.3 Pumping Test Information

2.3.1 Pumping Test Description

A 72-hour pumping test is typically required for each pumping well included in a groundwater withdrawal application (requirements of the Well Construction Regulations NS Reg. 58/95). **Water withdrawal rates in excess of the maximum pumping test rate will not be granted.** This requirement should be considered in the early stages of the water supply development so that pumping test rates can be planned to meet or exceed the requested withdrawal rate.

The pumping test shall be completed by a certified pump installer in consultation with a qualified hydrogeologist. An initial step drawdown test is recommended in order to determine the optimum constant rate for the 72-hour test. The flow rate for the pumping test must be equal to or greater than the requested withdrawal rate on the approval application. The pumping test must include continuous and regular water level measurements both during and after pumping until 95% recovery occurs, or until sufficient data have been collected to establish the recovery curve. During the pumping test, the discharge water must be diverted away from the wellhead to prevent artificial recharge. Surface water bodies within 60 metres of the pumping wells should be monitored during the pumping test in order to determine potential adverse effects.

For municipal or other water supply systems in which several wells will be pumped simultaneously during normal operation, a multiple well test with observation wells will typically be required in addition to individual well tests. Also, a longer duration pumping test may be required for some municipal and large industrial users. The overall intent is for proponents to design a site specific program that fulfills the Well Construction Regulation yield determination testing requirements as well as adequately assessing the overall effects of the anticipated groundwater withdrawal upon the aquifer.

The details of the pumping test must be outlined in the report, including, but not limited to:

- name of certified pump installer supervising test and hydrogeologist
- construction details of the pumping well(s)
- observation well(s) details (number, location, and construction)
- pumping test set-up details (pump size, pump depth, flow control and measurement)
- type of test (step, constant rate, recovery)
- other monitoring stations (e.g., stream station or tidal monitoring site)
- static water levels for pumping well and observation wells
- date and time when pumping started and ended
- field observations (e.g. pH, conductivity, temperature)
- weather observations during tests (barometric pressure, rainfall etc.)
- pumping flow rate adjustments.

NSEL may require the monitoring of one or more observation wells during the pumping test. The observation wells should be completed in the same aquifer as the pumping well, and should be large enough to allow accurate and rapid measurement of water levels. Small-diameter wells are best because the volume of water contained in a large-diameter observation well may cause a time lag in drawdown changes. Most observation wells are constructed with screens from 1.5 to 3 metres in length; however, longer screens may be desirable, depending on the degree of stratification. Appropriate placement of the observation wells is critical. Drawdown data collected from observation wells that are too close to the pumping well may be distorted; however, locating observation wells too far away may be outside the cone of influence, and may cause boundary conditions to go unnoticed.

As described in Section 2.4.2, water supply wells within 500 metres of the site should be identified. An assessment of the potential for well interference on these wells due to the proposed new pumping well should be conducted. If the potential for well interference is evident then quantitative monitoring and evaluation of water levels in such wells during the pumping test is warranted.

2.3.2 Pumping Test Analysis

A detailed analysis/interpretation of the pumping test and step drawdown test data is required. This analysis should include, but is not limited to: graphical analysis of the data, calculations for aquifer characteristics, such as transmissivity and storativity/specific yield, identification of boundary

conditions, assessment of the potential drawdown at various times and selected distances from the pumping well, predicted drawdown in the pumping well compared to the amount of available head and to the pump intake depth. The rational for selecting a specific analytical method(s) along with assumptions and limitations, must be clearly stated.

The report should include an assessment of the climatic conditions before, during, and after the pumping test (i.e., precipitation, barometric pressure, and tidal oscillations), and how climatic changes may have impacted the pumping test data. The climate data used during this assessment must be included in the report.

2.3.3 Water Quality Results

Water quality data must be collected from each pumping well during the pumping test, including the collection of water quality samples and measurement of field parameters. The data should be presented in a table comparing results with guidelines. The report must include an interpretation of the water quality analysis, and an assessment of whether or not the water quality is sufficient for the intended use.

A water quality sample must be collected near the end of the pumping period. The laboratory analysis should include, as a minimum, bacteria, general chemistry, metals, and fluoride. If the water is for a public drinking water supply, parameters must include, at a minimum, those specified in the *Guidelines for Monitoring Public Drinking Water Supplies*, following the recommended sampling protocols in that document. Additional parameters may be required, depending on site-specific details. For example, if the site was once a gasoline service station, an analysis for petroleum hydrocarbons may be necessary.

All water quality analysis must be conducted at an accredited laboratory. A list of approved laboratories is available on the NSEL website at: www.gov.ns.ca/enla/water/labs.htm. In addition to water quality samples and field measurements, historical water quality data, when available, should also be evaluated to identify water quality trends.

It may also be useful during the 72 hour pumping test to collect additional samples for evaluation. Often three sets of samples are collected (3 samples for bacterial quality and 3 samples for chemical quality). One sample should be collected in the first hour, one sample between 24 and 36 hours, and one sample during the last hour of the pumping test.

2.4 Evaluation of Potential Effects

The evaluation of potential effects should include an assessment of the following: sustainable yield, well interference effects, and water quality effects. However, site-specific conditions such as the potential for sea water intrusion, groundwater-surface water interaction or any other condition which has the potential to impact on existing groundwater users or the environment should be evaluated.

There are many methods available to evaluate potential effects, including field measurements and groundwater modelling (i.e., using analytical solutions such as the Theis Equation, or numerical models such as Modflow). Where possible, potential effects should be evaluated using quantitative hydrogeology. Larger withdrawals, such as municipal well fields, are more likely to warrant the use of numerical groundwater models. If groundwater models are used, the modelling process must be documented in the report and include a description of the model, assumptions and a justification for the input data used. For large scale projects the department may request, at the proponent's expense, a peer review.

2.4.1 Sustainable Yield

The sustainable yield of an aquifer may be defined as the total groundwater withdrawals that can be maintained indefinitely without causing unacceptable environmental, economic or social consequences.

In some cases, such as for municipal supplies, a water balance may be prepared to help assess whether the aquifer can sustain the proposed groundwater withdrawal. NSEL looks at the maximum cumulative withdrawal rates for an aquifer (i.e., total allocation for all groundwater users) to ensure that the sustainable yield for the aquifer is not exceeded. The sustainable aquifer yield is assumed to be no greater than 50% of the annual aquifer recharge, unless it can be demonstrated, to the satisfaction of NSEL, that additional withdrawals will not cause unacceptable effects. The 50% unallocated portion is retained to maintain base flow for surface water bodies.

2.4.2 Well Interference

The location of nearby groundwater users must be identified and the potential well interference effects on these wells must be assessed. At a minimum, this usually considers the closest off-site wells within 500 metres. This assessment could be based on such factors as proximity to the

proposed pumping well, the proposed pumping well withdrawal rates, well construction and known or predicted aquifer properties, among others. If there is a potential for well interference effects then these should be quantitatively assessed using direct field measurements, such as water level measurements, during the pumping test.

Additional quantitative predictions may be made with analytical and/or numerical groundwater models (e.g., Theis Equation, Modflow, etc.). Well interference predictions should be completed using conservative assumptions and input data. The predictions should include an evaluation of well interference effects during a 90 day drought (i.e., no precipitation for 90 days).

Based on the above evaluation, if significant well interference effects are expected then a contingency plan acceptable to NSEL may be required. Well interference effects are typically considered significant if they exceed 1.0 m at a drilled well or 0.25 m at a dug well.

2.4.3 Water Quality

The report must provide a detailed assessment of the potential for changes in groundwater quality. The assessment should consider potential effects from any nearby sources of contamination. This includes naturally occurring poor groundwater quality such as induced recharge from adjacent formations. The assessment should discuss the location of any sources of poor water quality with respect to the recharge area for the well(s) or well field and whether or not there will be a hydraulic gradient towards the well(s).

2.4.4 Sea Water Intrusion

An evaluation of the potential for sea water intrusion should be provided if the well is located within 500 m of sea water. Wells within this distance of sea water should not drawdown water levels below sea level, unless it can be demonstrated that a permanent hydraulic divide exists between the well and the sea water. Sea water sources may include, but are not limited to, the ocean, estuaries, tidal marshes and tidal-influenced rivers.

2.4.5 Groundwater-Surface Water Interaction

An evaluation of the potential for groundwater-surface water interaction should be completed if the well is located within 60 m of a surface water body. Stream-aquifer depletion effects may be

considered significant if baseflow is predicted to be reduced by more than 50%, or if the flows in the stream are predicted to drop below the established maintenance flow (if a specified maintenance flow is available).

2.5 Monitoring and Contingency Plans

2.5.1 Monitoring Plan

A long-term monitoring plan must be prepared in order to monitor the withdrawal rates/volumes and to assess potential effects of the water withdrawal. At a minimum, all groundwater withdrawal approval holders will be required to maintain flow monitoring records. Monitoring of other parameters, such as groundwater levels and groundwater chemistry, may also be required depending on site-specific conditions and potential effects.

All approval holders will be required to maintain records, which must be provided to NSEL upon request. Municipal water supply systems will be required to regularly submit monitoring results to NSEL. Other types of water withdrawals, such as large commercial or industrial water supplies, may also be required to regularly submit monitoring results to NSEL.

2.5.2 Contingency Plan

Applicants may be requested to prepare a contingency plan for mitigation of any effects. The plan should specify the circumstance(s) that will trigger the implementation of the contingency plan. It is desirable to have an Alternate Dispute Resolution (ADR) mechanism in place for resolving disputes.

2.6 Other Requirements

NSEL may require additional information, depending on the nature of the withdrawal. Situations that may trigger requests for additional information may include, but are not limited to: large water withdrawals (i.e., municipal water supplies or large industrial facilities) and withdrawals located in a sensitive setting (i.e., adjacent to a significant surface water feature, or in close proximity to a residential neighbourhood that relies on private wells for its domestic water supply).

2.6.1 Well Survey

The purpose of the well survey is to obtain baseline data, should any well interference complaints arise in the future. The scope and extent of the survey will vary. The survey would include, as a minimum, the closest off-site wells to the production well, but may extend to include all wells within a specified distance (i.e. 500 m radius is typical, but larger distances may be required).

The following information may be requested as part of the well survey:

- identification of nearby wells (including active, inactive, and abandoned wells)
- details of each well (e.g., age, depth, type, casing length, static level, yield, etc.)
- details of pumping system (submersible, shallow or deep jet, pressure tank, water treatment equipment);
- description of any problems (low yield or poor water quality)

More detailed information may also include:

- yield test (minimum of 1 hour pumping at 4 gpm with 1 hour recovery)
- water quality sampling (general chemistry, metals and bacteria)

2.6.2 Public Consultation

If the water withdrawal has potential to be the focus of public concern, then it is recommended that the applicant consult with stakeholders to identify and address those concerns prior to applying for a water withdrawal approval. Otherwise, the consultation may be required later, delaying review of an application because of section 7(3) of the Approvals Procedure Regulations which states:

> "Before approving an application, the Minister or Administrator may require that the applicant provide a consultative process in the area where the activity or the proposed activity is or will be located."

2.7 Supporting Data and Figures

A 1:50,000 site location map must be submitted to show a regional overview and a detailed, scaled site plan which includes: all on-site wells and off-site wells within 500 meters, buildings, residences,

property boundaries, watercourses, topographic contours (if available at this scale), and drainage features. An aerial photograph may also be included.

The NSEL well log must be provided for each pumping well and observation well. If the well log cannot be obtained, well construction details can be obtained by other means (i.e., well inspection with a well camera).

The applicant must submit all raw pumping test data, graphs, and a summary of the pumping test data and analysis in both hard copy and electronic format.

The report must include the relevant water quality analysis laboratory certificates.

APPENDIX A

SUBMISSION CHECKLIST
FOR
HYDROGEOLOGICAL STUDIES

Nova Scotia Environment and Labour
Submission Checklist for Hydrogeological Studies

Hydrogeological Study - General Requirements

Task	Sub-Task	Included in Report? (✔ = Yes)	Report Page No.
Site Description	Site Description	☐	Page No. ___
	Well field Description	☐	Page No. ___
	Description of Intended Water Use	☐	Page No. ___
	Groundwater Withdrawal Details	☐	Page No. ___
	Description of Existing and Previous Water Withdrawal Approvals	☐	Page No. ___
Description of Hydrogeology	Regional and Local Hydrogeology and surface water features	☐	Page No. ___
Pumping Test Information	Pumping Test Analysis	☐	Page No. ___
	Water Quality Analysis	☐	Page No. ___
Evaluation of Potential Impacts	Sustainable Yield	☐	Page No. ___
	Well Interference Effects	☐	Page No. ___
	Water Quality Effects	☐	Page No. ___
	Sea Water Intrusion	☐	Page No. ___
	Groundwater-Surface Water Interaction	☐	Page No. ___
Supporting Figures and Data	Site location Map and Site Plan	☐	Page No. ___
	Well logs	☐	Page No. ___
	Pumping test data and graphs	☐	Page No. ___
	Laboratory Reports	☐	Page No. ___

Notes on General Requirements

Withdrawal Approvals and Hydrogeological Studies are required for groundwater withdrawals greater than 23,000 L/day.
Hydrogeological Studies must be signed by a qualified hydrogeologist.
Reports and data must be submitted in hard copy and electronic copy.
A 72-hour pumping test and analysis is required for each pumping well included in the application.
Production well(s) must be pump tested at a rate greater than or equal to the requested withdrawal rate.
Well interference effects should be evaluated for wells within at least 500 m.
Sea water intrusion effects should be evaluated if the production well is within 500 m of sea water.
Groundwater-surface water interaction effects should be evaluated if the production well is within 60 m of a surface water body.
Other information may be required for large groundwater supplies. See main guide text.