HALIFAX
REGIONAL MUNICIPALITY

GUIDELINES FOR GROUNDWATER ASSESSMENT AND REPORTING

PART 1 GENERAL

1.1 OBJECTIVES

These Guidelines are intended to provide general administrative and technical guidance to Subdividers applying for subdivision approval, and prescribe a set of minimum requirements for preparing Groundwater Assessment reports. These Guidelines are not intended to provide detailed methodologies for conducting a Groundwater Assessment, as there are a number of acceptable methods, and these should be developed and justified by the Qualified Person on a site-specific basis.

The objectives for groundwater assessment and reporting are as follows:

1. To identify and minimize potential impacts of the proposed development on existing groundwater users and sensitive features (e.g. groundwater recharge areas, wetlands, and groundwater fed streams); and

2. To help ensure that future owners of homes and lots in areas that are not serviced with central municipal water have a high probability of obtaining adequate quantities of potable water for domestic consumption over both the short and long-term.

A Groundwater Assessment is not intended to provide a guarantee that future home owners will have an adequate supply of potable water, but rather to provide a qualified opinion of the likelihood of obtaining an adequate supply of potable water.

The guidelines will also provide consistency in the review of development proposals, and ensure that a Qualified Person submits a subdivision application with the necessary technical information.

1.2 APPROVAL PROCESS

A Groundwater Assessment Report shall be required as part of the Development Agreement and Subdivision Approval processes for Open Space Design Developments where they are to be serviced by groundwater. The Groundwater Assessment Report must be prepared by, or under the direction of, a Qualified Person.

A **Qualified Person** means either a Professional Engineer licensed to practice in the Province of Nova Scotia under the *Engineering Profession Act*, R.S.N.S. 1989, c. 148, as amended from time to time, or a Professional Geoscientist licensed to practice in the Province of Nova Scotia under the *Geoscience Profession Act*, S.N.S. 2002, c.7, as amended from time to time.

1.3 REPORT NOT REQUIRED

HRM may waive certain requirements of the groundwater assessment, where an approval is required pursuant to Provincial Regulations that imposes a more stringent requirement on the Subdivider. An example of such an approval is a water withdrawal approval ("Water Approval") under the Division I of the Activities Designation Regulations, enacted pursuant to the Nova Scotia *Environment Act*, for a well that exceeds 23,000 litres per day.

1.4 REVIEW PROCESS

A Level I Groundwater Assessment Report consists of a Description of Hydrogeology and Site Characterization as outlined in Part 2, sections 2.1 and 2.2

A Level II Groundwater Assessment Report consists of additional information as provided for in Part 2, section2.3, and generally includes test well installation and/or water quality testing.

The Level I Groundwater Assessment Report will be subject to a review by HRM, and will be required as a minimum for consideration of a Development Agreement.

HRM may request a Level II Report from the Subdivider, including a mitigation plan to address potential groundwater quality or quantity concerns.

HRM will rely on a Qualified Person to review the Hydrogeological Assessment Reports, and provide hydrogeological expertise as required.

A review of the Groundwater Assessment Report will not be carried out until a complete report has been submitted that meets the requirements of these Guidelines. A letter from HRM will advise the Subdivider regarding any report deficiencies.

Approval shall be withheld if, in the opinion of HRM, the report does not provide a complete groundwater supply assessment and evaluation of potential effects in accordance with the objectives specified in Section 1.1 of these Guidelines.

PART 2 STUDY COMPONENTS FOR GROUNDWATER ASSESSMENT

2.1 DESCRIPTION OF HYDROGEOLOGY

The objective of this work component is to characterize the local geology and hydrogeology and will include, but is not limited to, the following:

- Review and compile local well records from the most recent version of the Provincial Well Logs Database;
- Review and compile pumping test results from the most recent version of the Provincial Pumping Test Database for the proposed aquifer source;
- Review and summarize available water quality analyses for the proposed aquifer source;
- Review of available groundwater studies and/or literature on the area;
- Consult with all appropriate provincial agencies and well contractors familiar with the area to obtain information on local groundwater resources;
- Assess local bedrock and surficial geology, including 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, based on existing information;
- Assess local hydrogeology, including identification of hydrostratigraphic units and the hydraulic and hydrochemical characteristics of each unit based on existing information;
- Identify primary, secondary and tertiary sub-watersheds of the proposed development site, and assess surface water features within 500 metres of the site boundaries, including the types of surface water features and the location of the surface water features relative to the site. Providing the information is available, surface water features should also be assessed for water levels, flow rates, seasonal variation, surface water quality, drainage patterns, flood risk and annual precipitation rates; and
- If available, review subdivision Stormwater Management Plans with respect to water budget information and the potential for water quality impacts to local aquifers.

2.2 SITE CHARACTERIZATION

- The objective of this work component is to identify existing water users and sensitive features, and to document any local water quantity and quality issues. The site characterization work will include, but is not limited to, the following:
- Identify wells and springs within the assumed groundwater influence area, which will be a minimum of 500 metres from the site boundaries, and discuss any water shortage/well interference problems experienced at existing wells in the area. The extent of the

assumed groundwater influence area should be determined based on the site geologic and hydrogeologic conditions, the quantity of groundwater required, and the potential for impacts;

- Document any permitted water withdrawal approvals within the assumed groundwater influence area through a Provincial Environmental Registry request;

- Determine if there are, or have been, any land uses or activities in the assumed groundwater influence area that may potentially contaminate, or have contaminated, groundwater resources (e.g., landfills, gas stations, dry cleaners, other commercial/industrial facilities, etc.); and

- Identify land uses and large water users on 1:10,000 scale mapping within the assumed groundwater influence area.

2.3 ADDITIONAL INFORMATION

Following a review of information collected under Sections 2.1 and 2.2, HRM may prescribe additional information, including but not limited to information contained below.

A well survey may be prescribed by HRM to collect baseline monitoring information if there is a high potential for interference effects to existing wells. The presence of off-site wells within 500 metres of the proposed development site boundaries, and/ or a documented history of well interference problems in the local area, may be considered indicative of a high potential for well interference effects to occur. The recommended procedure for conducting a well survey is provided in Appendix A-1.

2.3.1 TEST WELL INSTALLATION

The objective of this work component is to locate and construct suitable test wells for aquifer testing, including pumping tests and water quality analyses. Test wells may be either dug or drilled wells, as appropriate to the proposed aquifer source.

The minimum number of test wells will be:

- 3 for sites up to 15 hectares in area;
- 4 for sites more than 15 and up to 25 hectares;
- 5 for sites more than 25 and up to 40 hectares; and
- For sites of more than 40 hectares, one additional test well for each additional 20 hectares or portion thereof.

The test wells must be located such that the hydrogeological conditions across the site are adequately represented. HRM may require additional test wells depending on the site hydrogeological conditions. Hydrogeological conditions that may require additional test wells

include evidence of historical groundwater contamination in the local area, a large number of off-site wells within 500 metres of the proposed development site boundaries, the presence of sensitive features such as wetlands or streams that may be impacted by the development, or evidence of significant hydrogeological variability across the site.

Existing water wells located on-site, or within 100 metres of the proposed development site boundaries, may be used as test wells if the well owner agrees to participate in the program, the well construction characteristics are known (e.g. total depth, casing length, completion, geologic formations intercepted), the wells are installed in the same aquifer as the other test wells, and the wells are fully incorporated into the testing program. Notwithstanding, there will be at least one new or existing test well located on the site.

The test wells will be located and constructed to permit the prediction of the quality and quantity of groundwater supplies, as required to supply the proposed development. If past or present land uses on or adjacent to the property are a concern, the test well(s) should be strategically located in a manner that permits a proper assessment of potential land-use impacts. At least two of the test wells must be located within 150 metres of each other to facilitate observation well requirements during the pumping test and to permit the calculation of aquifer properties (see Section 2.3.3).

Test well construction must comply, at a minimum, with Provincial Regulations. More stringent standards, such as increased casing length and full annular space grouting of casing, may be necessary in some cases.

Test well installation should be fully supervised by a Qualified Person, and detailed information on the site geology should be collected and recorded during the test well installation program.

After the groundwater assessment study is completed, the test wells may be used as water supply wells on the individual lots, if practical. Test wells that are not intended to be used as water supply wells must be decommissioned in accordance with the Provincial Regulations, unless they are designated as dedicated long-term observation wells.

2.3.2 WATER QUANTITY TEST

The objective of this work component is to perform pumping tests of the aquifer, including groundwater sampling of the test wells, to:

- Calculate aquifer properties, such as transmissivity and storativity;
- Identify the type of aquifer and aquifer boundaries;
- Determine the sustainable yield;
- Determine the potential for interference to existing groundwater users and sensitive features; and
- Assess water quality and requirements for water treatment where applicable (Section 2.3.6).

2.3.3 PUMPING TEST

The test wells must be fully developed prior to performing the pumping tests. A test well may be considered fully developed when a minimum of suspended solids is observed in the groundwater, and field parameters such as temperature, specific conductance, and pH have stabilized.

For sites with drilled test wells, initial step drawdown pumping tests must be performed in all test wells to estimate well yields, assess well efficiency, and to determine the optimum rate for a constant rate pumping test. The step drawdown pumping tests must include a minimum of four pumping intervals consisting of a minimum period of thirty minutes each.

For sites with dug test wells, a short-term pumping test (e.g. NSEL recommended 'Index' method) must be performed in each test well to determine the optimum rate for a constant rate pumping test.

The test wells must be fully recovered prior to proceeding with the constant rate pumping test.

The constant rate pumping test must be performed in at least one of the test wells. Multiple constant rate pumping tests may be prescribed by HRM depending on the size of the proposed development site.

The constant rate pumping test(s) must begin with a static water level and must be performed at a fixed rate (±5%) for a minimum period of 24 hours of continuous pumping (no stoppages). The other test wells will be used as observation wells during the pumping test(s). The pumping rate used during the 24-hour pumping test must be based on the results of the step drawdown pumping tests (or short-term pumping tests in the case of dug test wells).

The pumping tests will be completed by a certified pump installer in consultation with a Qualified Person.

The pumping test(s) must include continuous and regular water level measurement both during and after pumping until 95% recovery occurs, or until sufficient data have been collected to establish the recovery curve. Water levels must be monitored in pumping well(s) and observation wells.

The 24-hour pumping test(s) must include monitoring of field parameters, such as temperature, specific conductance and pH, at regular intervals.

During the pumping test(s), the discharge must be diverted an appropriate distance and direction away from the wellhead to prevent artificial recharge.

Surface water bodies within 60 metres of the pumping well(s) will be monitored during the pumping tests(s) in order to determine potential interference or adverse effects. Monitoring will include at a minimum, but not be limited to, measurements of water level, and if feasible or applicable, discharge and field water quality parameters, such as temperature, specific

conductance and pH.

2.3.4 WATER QUALITY SAMPLING

At least one set of water samples must be collected from each test well. Samples must be collected from the pumpingwithin the last hour of the end of the step drawdown or constant rate pumping test, and analyzed for bacteria (minimum of total coliform and *E. coli* counts), general chemistry, metals, fluoride, and VOCs (Methodology EPA 624).

A list of the minimum general chemistry and metals parameters to be tested for is provided in Section V of the Provincial Guidelines for Monitoring Public Drinking Water Supplies. Additional parameters may be required by HRM or the Qualified Person depending on the local geology, the adjacent land uses and the potential for contaminant impacts.

There must be no chlorine residual prior to any testing for water quality. Chlorine residual tests must be performed at the wellhead immediately prior to the collection of bacteriological samples. Chlorine residuals must be reported.

2.3.5 LONGER DURATION PUMPING TESTS

In sensitive areas (such as 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), or where aquifers are unconfined (e.g. dug wells), longer duration pumping tests may be prescribed by HRM.

During a longer duration pumping test (e.g. 72-hour pumping test), it is recommended that additional water samples for chemical and bacterial quality should be collected at appropriate intervals (e.g. 1 hour and 36 hours during a 72-hour pumping test) to record any changes in water quality that may occur during the pumping test.

2.3.6 WATER QUALITY AND TREATABILITY ASSESSMENT

The objective of this work component is to assess the groundwater quality and the requirements for water treatment.

The Health Canada Guidelines for Canadian Drinking Water Quality (GCDWQ) will be used as the standard in assessing the quality of the drinking water supply. The water quality will also be assessed in terms of expected natural background quality for the hydrostratigraphic unit(s) being evaluated.

The GCDWQ may be exceeded provided that domestic treatment systems are available that can adequately treat these parameters to below the GCDWQ limits.

It is the Subdivider's responsibility to show that the proposed treatment concept is appropriate, and shall consider, at a minimum the capital, operating, and maintenance costs, the space

requirements for the equipment, the water demands of the treatment system such as backwashing, the requirements for water quality monitoring and system maintenance, and the local availability and use of the treatment technology.

HRM will not comment on the acceptability of the various proprietary treatment systems available.

Where water treatment systems will require a significant additional amount of water, these amounts must be added to the required yield of the wells.

PART 3 GROUNDWATER ASSESSMENT REPORTING

A report must be prepared that provides an overall assessment of the source to provide adequate quantities of potable quality groundwater for domestic consumption over both the short and long-term, without causing unacceptable impacts to existing water users and the environment. The methods of analysis used by the Qualified Person should be documented and justified in the report.

3.1 REPORT CONCLUSIONS

The report will identify the future use of test wells and will provide, as a minimum, the following conclusions:

- State the expected range of well yields and aquifer properties in the proposed subdivision;
- State whether or not the groundwater source can provide a sustainable water supply to homeowners in the proposed subdivision based on projected needs for all water uses and for peak demands;
- State the expected effects of the groundwater withdrawals associated with the proposed subdivision on any existing water wells and the environment;
- State whether or not water wells in the proposed subdivision are expected to meet the Health Canada Guidelines for Canadian Drinking Water Quality, and whether groundwater quality is expected to change over time;
- If groundwater quality is not expected to meet the GCDWQ, list the parameters that are expected to exceed the guidelines and the long term viability of the required treatment to meet the GCDWQ; and
- State whether water quality in wells in the proposed subdivision is expected to be within background values for the hydrostratigraphic unit(s) being evaluated.

3.2 REPORT RECOMMENDATIONS

The report will provide, as a minimum, the following recommendations:

- Minimum lot sizes;
- Well construction with respect to well depth, casing length and grouting;
- Well spacing to minimize well interference problems;
- Lot yield (estimated recharge) and sustainable pumping rate;

- Phasing of development, including the necessity and scope of supplemental reports to update hydro geological information from previous phases.

- If applicable, a description of the recommended water storage system(s) and any special water treatment devices that may be necessary for their proper functioning; and

- Mitigation measures, including contingency plans where applicable, to address any identified water quality or quantity concerns. Examples of potential mitigation measures are provided in Appendix A-2.

3.3 SUPPORTING DOCUMENTATION

The required supporting documentation for the submission of a Groundwater Assessment report is outlined below.

Section	Supporting Documentation
2.1 Description of Hydrogeology	Characterization of local geology and hydrogeology, including geological mapping and relevant well records, pumping test results, water quality results, and surface water/ watershed characteristics.
2.2 Site Characterization	Identification of land-uses, environmental concerns, sensitive features and existing well users on the proposed development site and within the assumed groundwater influence area.
2.3 Additional Information	Results of field survey of existing well users within the assumed groundwater influence area (if required by HRM).
2.4 Test Well Construction	Test well locations and well construction characteristics, including logs prepared by the well contractor and the Qualified Person.
2.5 Water Quantity Test	Details on pumping test procedure and pumping test data; Detailed analysis/ interpretation of pumping test data, including aquifer type, properties, and boundaries, hydraulic gradients and flow patterns, and a justification of the method used and the assumptions associated with the selected method(s) of analysis;

	Details regarding the estimation of the theoretical long-term sustainable yield of the aquifer relative to water requirements of proposed subdivision, including a justification of the methodology used (e.g. 20 year safe yield calculation) and associated assumptions; Description of proposed storage systems (if applicable); Details regarding the assessment of the potential for interference with other groundwater users, including a justification of the methodology used (e.g. distance-drawdown calculation) and the associated assumptions;
2.5 Water Quantity Test (continued)	Details regarding the assessment of the hydraulic relationship between surface water and groundwater resources, and the potential for water withdrawals to impact baseflow to nearby watercourses and sensitive areas (e.g. wetlands); and An evaluation of the potential for sea water intrusion if the site is located within 500 metres of sea water.
2.6 Water Quality and Treatability Assessment	Details on the water sampling protocol; Groundwater quality sample results compared to the GCDWQ and the expected background groundwater chemistry; Laboratory analysis certificates; Details regarding the assessment of the potential for changes in groundwater quality (e.g. due to nearby sources of contamination); Description of rationale for selected water treatment alternative (if applicable) and expected capital and maintenance costs; and Mapping of groundwater flow direction and discussion of risk associated with proposed on-site sewage disposal systems to supply wells.

REFERENCE DOCUMENTS

Fracflow Consultants Inc. 2004. Screening-Level Assessment of the Groundwater Resource Potential of Bedrock I HRM: a component of HRM's Wastewater Management Options Study. Appendix C in HRM Options for On-site & Small Scale Wastewater Management, Final Report #03-134, prepared for HRM by Land Design Engineering Services, March 2005.

Nova Scotia Ground Water Association, 2004. Presentation to Halifax Regional Municipality Regarding Groundwater Availability in HRM.

Miramichi Planning District Commission, 2000. Water Supply Assessment Guidelines for Subdivisions Serviced by Individual Private Wells.

MOE, 1996. Procedure D-5-5 Technical Guideline for Private Wells: Water Supply Assessment

MOEE, 1995. MOEE Hydrogeological Technical Information Requirements for Land Development Applications. Ontario Ministry of Environment and Energy, April 1995.

NSEL, 2004. Guide to Groundwater Withdrawal Approvals. May 2004.

NSEL, 2005. Guidelines for Monitoring Public Drinking Water Supplies. December 2005.

NSEL, 2005. On-Site Sewage Disposal Systems Technical Guidelines. November 2005.

APPENDIX A-1

WELL SURVEY PROCEDURE

Survey existing wells within the assumed groundwater influence area, which will be 500 metres from the site boundaries, or more according to site geologic and hydrogeologic conditions, the quantity of groundwater required, and the potential for impacts.

Perform water quality sampling of existing wells within the assumed groundwater influence area (general chemistry, metals, bacteria).

If a well user is absent at the time of the survey, an effort must be made to obtain information at a later date. The location of any well users that do not provide their consent to participate in the survey should be noted.

Identify the locations of existing water wells and springs within the assumed groundwater influence area (include GPS coordinates).

Identify existing improperly abandoned wells on mapping if located during survey (include GPS coordinates if possible).

Wells located in the Provincial Well Logs Database will be cross-referenced with wells identified during field survey.

Prepare a table containing:

- Civic address and PID number;
- Type of source (dug, drilled, spring, other);
- Well status (abandoned, in use);
- Condition of the wellhead and area around the well;
- Approximate distance from well to proposed development;
- Depth, construction and completion details (if available);
- Name of well driller (if available);
  Original non-pumping water level (if available) and current non-pumping water level (if wellhead accessible);
- Depth to top of aquifer (if available), amount of available head (if wellhead accessible);
- Pump intake depth (if wellhead accessible);
- Maximum pumping rate (if available);
- Water uses;
- General water quality characteristics and treatment;
- Water quality/ quantity issues (note any wells that have had water added by water hauler);
- Wastewater disposal system location and details (if available);
- Discharge sites of roof drainage, sump pumps, and treatment unit(s) (if applicable); and
- Site drainage, ditches, storm sewers (if applicable).

APPENDIX A-2

EXAMPLES OF POTENTIAL MITIGATION MEASURES

Potential mitigation measures include, but are not limited to, the following:

1. Larger lot sizes to reduce the concentration of withdrawals.

2. Smaller total number of lots to reduce the volume of groundwater withdrawals over the proposed development area.

3. Development of alternative water sources.

4. Communal supply with water treatment (operated according to 'Development Agreement' and conditions set out).

5. Designation of important recharge areas as green space.

6. Design of subdivision and individual lots to optimize groundwater recharge.

7. Minimum setback requirement of wells from wetlands, streams, or salt water.

8. Development of short or long-term monitoring plans, including specific 'triggers' for a contingency plan to prevent well interference, streamflow depletion, sea water intrusion, or other adverse effects.

9. Development of contingency plans to deal with validation and resolution of well interference and other claims. For example, if the development impacts off-site existing wells, the developer may be required to take corrective action (e.g. replace wells, deepen wells, lower pump setting, install storage, etc.).

10. Restrictions on non-consumptive water use (e.g. controls on open-loop groundwater heat pumps to minimize well interference effects).

11. Water conservation measures in subdivision homes, such as low flow shower heads, ultra low flow toilets, water-efficient appliances (e.g. front loading clothes washers), water metering at homes, etc.

12. Recommendations for wellhead protection measures.