

DRAFT ORDINANCE FOR HIGH-RISK POTABLE GROUNDWATER WELLS

1.0 INTENT AND PURPOSE

It is the intent and purpose of this ordinance to establish requirements for prospective developers proposing to construct developments within the State of Rhode Island that will rely on groundwater wells as a potable water source. This ordinance requires prospective developers to conduct an appropriate level of evaluation and documentation to effectively demonstrate that groundwater sources are sufficient to provide the required quantity of potable water suitable to sustain the proposed development without negatively impacting existing developments.

2.0 APPLICABILITY

The requirements documented herein are applicable to all proposed residential, commercial, and/or industrial developments that will utilize new or existing potable groundwater wells and will be constructed within State of Rhode Island municipalities that have voluntarily adopted this ordinance.

3.0 DEFINITIONS

Refer to *Applied Hydrogeology*, Fourth Edition, C.W. Fetter, 2001 for definitions of technical terminology included in this ordinance.

4.0 INITIAL REQUIREMENTS

4.1 Preliminary Report

As part of the proposal for the development, the prospective developer will be required to prepare a Preliminary Report which, at a minimum, must document the following information related to the proposed development:

- Proposed land usage
- Development acreage
- Number of units
- Maximum number of potable water wells to be installed and/or used
- Storage capacity of wells including calculations and assumptions
- Maximum yield requirements for each well including method, parameters, and assumptions used to calculate
- Anticipated water uses
- Description of anticipated irrigation systems

The Preliminary Report must also include the following information related to the size of the proposed development and surrounding area:

- Site-specific and regional soil classifications and unconsolidated zone geology
- Site-specific and regional bedrock geology
- Site-specific and regional topography
- Locations of nearby surface water bodies, wetlands, and springs
- Regional monthly precipitation and evapo-transpiration rates
- Description of surrounding land use
- Population and density of existing, neighboring developments
- Construction logs for existing, neighboring potable water wells

A to-scale site plan(s) of the proposed development and surrounding area that depicts the following features must be provided with the Preliminary Report:

- Parcel layout of proposed development with lot boundaries
- Locations of proposed buildings
- Locations of potable water wells to be installed within proposed development
- Locations of septic systems and other potential sources of pollution to be installed within proposed development
- Locations of nearest existing development(s) showing buildings, wells, septic systems, cesspools, and other potential sources of contamination
- Surficial geology mapping
- Bedrock geology mapping
- Topographic contours
- Surface water features
- Anticipated extents of lawns and landscaped areas for proposed development
- Anticipated extents of wooded areas or open space for proposed development

Completion of the Preliminary Report is the responsibility of the prospective developer. The Preliminary Report will be submitted to the municipal planning board, or other appropriate municipal agency, for review. The planning board will use the Preliminary Report to evaluate the potential impacts that the proposed development may have on the quantity of potable water available to occupants of neighboring, existing developments and the proposed development.

4.2 Risk Evaluation Checklist

The prospective developer will also be required to complete the attached Risk Evaluation Checklist ([Attachment A](#)) for submission to the municipality. Completion of the checklist in conjunction with the Preliminary Report will facilitate evaluation of the level of risk that the proposed development may pose to the quantity of available potable groundwater. Supporting information related to responses documented in the completed checklist must be provided in the Preliminary Report required by [Section 4.1](#) of this ordinance.

4.3 Risk Determination

Based on information documented in the Preliminary Report and the results of the Risk

Evaluation Checklist, the municipality will determine whether or not the proposed development is considered “Low Risk” or “High Risk” with respect to the potential impacts that the development will have on the quantity of available potable groundwater.

Prospective developers of low risk developments will be required to comply with the “Well Testing and Certification Ordinance” adopted by the municipality for certification of low risk wells. In contrast, prospective developers of high risk developments will be required to comply with both the “Well Testing and Certification Ordinance” for certification of low risk wells for each individual proposed well and the aquifer testing requirements documented in the following sections of this ordinance.

5.0 AQUIFER TESTING REQUIREMENTS

5.1 Aquifer Test

Prospective developers for developments deemed to be high risk will be required to conduct and document an aquifer test prior to receiving approval for the development. The attached document entitled “Examples of an Aquifer Test Scope of Work and Usage Mitigation Measures” (Attachment B) describes the overall goal of the aquifer test, quantitative aquifer characteristics that must be determined by the aquifer test, the scope of work for a typical aquifer test, and additional aquifer evaluations that may be required as part the aquifer test.

5.2 Hydrogeologic Report

The results of the aquifer test will be presented in a Hydrogeologic Report to be completed in accordance with the minimum requirements described in Attachment B. The Hydrogeologic Report will be submitted to the municipality for review. Pertinent information included in the Preliminary Report (see Section 4.1 of this ordinance) and related to the site-specific and regional hydrogeology and the potable water demand requirements of the proposed development must be included in the Hydrogeologic Report, as appropriate.

Based on the information documented in the Hydrogeologic Report, the municipality may determine that the aquifer characteristics determined as part of the testing are representative of the actual aquifer conditions and that the testing effectively demonstrated effect that groundwater removal associated with the proposed development will have on potable water supplies. However, if the aquifer testing or the Hydrogeologic Report is deemed deficient, the municipality may require the developer to conduct additional testing.

6.0 FEE

A fee of \$_____ must be paid by prospective developers of high risk proposed developments concurrently with submission of a Hydrogeologic Report. The submission fee will be deposited into an account established by the municipal treasurer. Outside consultants retained by the municipality to assist in review of the hydrogeologic report will be compensated from this account.

7.0 APPROVALS

Based on the results of the aquifer testing, the municipality may determine that available potable water supplies are sufficient to meet the needs of the proposed development without negatively impacting the quantity of water available to existing developments. As such, the development may proceed as proposed.

In contrast, the results of the aquifer testing may confirm that anticipated well yield will not meet the demands of the proposed development and/or the proposed development will result in excessive reduction in the quantity of potable water available to existing developments. Thus, the municipality may not allow the development to proceed without reduction of the development magnitude or implementation of groundwater usage mitigation measures, some examples of which are included in Attachment B.

ATTACHMENT A

POTABLE GROUNDWATER WELLS RISK EVALUATION CHECKLIST

QUESTIONS RELATED TO SUPPLY OF POTABLE GROUNDWATER

Is anticipated aquifer for the proposed development within bedrock formation(s)?

	Yes	No
Is anticipated aquifer within unconsolidated formation(s)	Yes	No
Is anticipated aquifer within the same geologic unit as aquifers utilized by existing developments?	Yes	No
Do nearby surface water features go dry or lose one or more feet of depth during dry seasons?	Yes	No
Do topographic divides exist between proposed development and existing developments?	Yes	No
Based on regional topography, is proposed development up-gradient of an existing development?	Yes	No
Have complaints related to water supply problems been reported to municipal officials by residents of existing, neighboring developments?	Yes	No
Were complaints reported at the same time of year?	Yes	No
Were complaints related to reduction in well yield?	Yes	No
Provide the lowest yield of the ten closest existing wells, for which yield data is included in monitoring well completion reports.	_____gallons per minute	

QUESTIONS RELATED TO POTABLE GROUNDWATER DEMAND FOR THE PROPOSED DEVELOPMENT

Is anticipated aquifer for the proposed development within bedrock formation(s)?
 Yes No

Is anticipated aquifer within unconsolidated formation(s)
 Yes No

Is anticipated aquifer within the same geologic unit as aquifers utilized by existing developments?
 Yes No

Do nearby surface water features go dry or lose one or more feet of depth during dry seasons?
 Yes No

Do topographic divides exist between proposed development and existing developments?
 Yes No

Based on regional topography, is proposed development up-gradient of an existing development?
 Yes No

Have complaints related to water supply problems been reported to municipal officials by residents of existing, neighboring developments?
 Yes No

Were complaints reported at the same time of year?
 Yes No

Were complaints related to reduction in well yield?
 Yes No

Provide the lowest yield of the ten closest existing wells, for which yield data is included in monitoring well completion reports.
_____gallons per minute

QUESTIONS RELATED TO POTABLE GROUNDWATER DEMAND FOR THE PROPOSED DEVELOPMENT

Indicate the most applicable range of individual wells to be located within the Development:

- 1 to 5 wells
- 5 to 10 wells
- 10 to 20 wells
- Greater than 20 wells

Indicate the most applicable range of households/facilities to be located within the proposed development:

- 1 to 5 households/facilities
- 5 to 10 households/facilities
- 10 to 20 households/facilities
- Greater than 20 households/facilities

Indicate the most applicable range for the average size of households located within the proposed development:

- 1 to 2 bedroom households
- 2 to 3 bedrooms households
- 3 to 4 bedroom households
- Greater than 4 bedroom households

Indicate the most applicable well density for the proposed development (excluding area that has been identified as “open space” area of the proposed development):

- One well per 3.0 acre or more
- One well per 1.0-3.0 acre
- One well per 0.5-1.0 acre
- One well per 0.5 acre or less

Indicate the most applicable range for the average storage capacity for an individual proposed well:

- Greater than 600 gallons
- 400 to 600 gallons
- 200 to 400 gallons
- Less than 200 gallons

Indicate the most applicable range for the distance from the proposed development to the nearest existing well:

- Greater than 0.5 mile
- 0.25 to 0.5 mile
- 0.1 to 0.25 mile
- Less than 0.1 mile

Provide the anticipated daily demand for the development, based on size of proposed development: _____gallons per day per acre

QUESTIONS RELATED TO GROUNDWATER DEMAND OF EXISTING DEVELOPMENTS

What is the supply of water to existing developments located to the north, south, east, and west and within a 0.25-mile buffer from the boundaries of the proposed development (indicate all that apply)?

NORTH

___ Individual wells ___ Community well ___ Public water

SOUTH

___ Individual wells ___ Community well ___ Public water

EAST

___ Individual wells ___ Community well ___ Public water

WEST

___ Individual wells ___ Community well ___ Public water

Indicate the most applicable well density for existing developments within a 0.25-mile buffer from the boundaries of the proposed development.

- ___ One well per 3.0 acre or more
- ___ One well per 1.0-3.0 acre
- ___ One well per 0.5-1.0 acre
- ___ One well per 0.5 acre or less

Provide the daily demand, based on area, for existing developments within a 0.25-mile buffer from the boundaries of the proposed development: _____ gallons per day per acre

ATTACHMENT B

POTABLE GROUNDWATER WELLS

EXAMPLES OF AN AQUIFER TEST SCOPE OF WORK AND USAGE MITIGATION MEASURES

AQUIFER TESTS

Introduction

In order to evaluate aquifer characteristics, the availability of water, and the potential for high-risk developments to negatively impact the quantity of potable groundwater available to occupants of neighboring, existing developments, the prospective developer will be responsible for conducting an aquifer test. The aquifer test should be of sufficient scope to allow determination of the following aquifer characteristics:

- **Hydraulic conductivity:** a coefficient describing the magnitude of water movement restriction through the aquifer
- **Radius of influence:** the area around a discharging well where the water table or potentiometric surface is lowered as a result of pumping of the well
- **Storativity:** the volume of water the aquifer releases or takes into storage per unit surface area of the aquifer, per unit change in head
- **Transmissivity:** the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient
- **Well yield:** the quantity of water per unit of time which may flow or be pumped continuously from a well

The overall goal of the aquifer test will be to determine the effect that long-term groundwater removal associated with the proposed development, particularly during periods of peak demand and/or low yield, will have on the quantity of potable water available to both the proposed development and existing developments within the radius of influence. The aquifer test should also demonstrate that the yield of the anticipated aquifer is sufficient to meet the needs of the proposed development.

The aquifer test will require installation of a pumping well(s) within the boundaries of the proposed development and multiple on-site and/or off-site observation wells. In general, the aquifer test should include at least three observation wells. Depending on the number of potable water wells anticipated for the proposed development and the hydrogeology of the anticipated aquifer, additional observation wells may be warranted. A geologic log documenting the depth and types of observed soil and bedrock, including estimated yields for all water-bearing unconsolidated or fracture zones, should be prepared during installation of each well.

The locations of the pumping and observation wells should be selected to be most representative of geologic conditions of the anticipated aquifer and any hydraulically connected

aquifers. The developer must be able to clearly demonstrate that the observation

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wells are hydraulically-connected to the pumping well and that the observation wells are

effective in determining the radius of influence, depending on geologic conditions. For bedrock aquifers, evaluation and documentation of local and regional fracture patterns through research or field work (i.e. fracture trace analysis, borehole logging, etc.) will be warranted prior to determining the most effective locations for the observation wells. Additionally, more observation wells may be necessary to obtain sufficient data to characterize the anticipated aquifer.

Components of an Aquifer Test

During the aquifer test, water will be pumped from the pumping well at a constant rate for a duration sufficient to be able to quantify the aquifer characteristics listed above. The observation wells will be monitored during pumping to determine the radius of influence and predict the effect that long-term pumping will have on wells in existing developments. In general, the aquifer test will consist of four phases as described below. It is recommended that the aquifer test take place between July and October to effectively account for seasonal lows in the water table or potentiometric surface in wells.

Step-Drawdown Test

The objective of this initial test is to determine the maximum yield that the anticipated aquifer is capable of providing from the pumping well. The step-drawdown test will consist of pumping the well at progressively higher pump rates. The well will be pumped at each pump rate until equilibrium is achieved, as determined by collecting water level measurements at regular intervals throughout the pumping duration. Equilibrium is achieved when the water level in the well stabilizes despite the continued pumping. This condition indicates that the aquifer is supplying water at a rate equal to the pump rate. When equilibrium conditions are observed, the pump rate should be increased and water levels should continue to be monitored until a condition of equilibrium is again achieved. As the test progresses and increasingly higher pump rates are used, eventually, the well will not stabilize and the water level will continuously drawdown. At this point, the aquifer is unable to yield the necessary volume of water to maintain the pump rate and the well will go dry if pumping at that rate continues.

The maximum yield for the aquifer is equal to the maximum pump rate that can be used while achieving equilibrium conditions. This information will be used to select the most appropriate pump rate to be used during the pumping phase of the aquifer test.

Background Phase

Depth to water in each well to be included as part of the aquifer test will be measured at a minimum frequency of once per hour for twenty-four hours, prior to the initiation of the pumping phase. This will allow evaluation of the influence that changes in background conditions (i.e. barometric pressure, tidal influences, etc.) and on-going, off-site groundwater removals will have on the aquifer. On the day that pumping will commence, depth to water measurements will be collected from all included wells to determine static water levels prior to the initiation of pumping.

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Pumping Phase

This phase involves pumping of water from the pumping well and monitoring of the waterlevel response in the observation wells and pumping well. The pumping rate to be used

should be selected based on the results of the step-drawdown phase.

The pumping will continue at the optimum discharge rate for a minimum of eight hours or until a volume of water equal to the peak daily demand for the proposed development (which is generally equal to twice the average daily demand) has been removed, whichever is longer. The pumping phase should not exceed a twenty-four hour period. The pump rate should not fluctuate by more than ten percent throughout the pumping phase. Additionally, the pumping phase must not be conducted during precipitation events in which total precipitation exceeds or equals 0.5 inches.

Depth to water measurements will be collected and recorded on a regular basis throughout the duration of the pumping phase. The measurements will be collected at varying frequencies, in accordance with the minimum requirements detailed in the following table:

Time since pumping

began/stopped

Minimum frequency of collection of depth to water measurements in pumping well and observation wells

0 to 5 minutes Every 0.5 minutes

5 to 10 minutes Every 1 minute

10 to 30 minutes Every 2 minutes

0.5 to 8 or more hours Every 5 minutes

Recovery Phase

The final phase of the aquifer test will include monitoring of the recovery of water levels in the observation wells and pumping well, after the pumping phase has been completed. The duration of the recovery phase will equal that of the pumping phase. Additionally, depth to water measurements will be collected and recorded from the observation and pumping wells in accordance with the frequencies documented in the above table.

Reporting

Upon completion of the aquifer test, the prospective developer will be responsible for completing a Hydrogeologic Report documenting the results of the aquifer test for submission to the municipality. This report must include all data obtained during the aquifer test including pumping rate, duration of pumping and recovery phases, and all depth to water measurements including time and date collected. Geologic logs documented during installation of the pumping and observation wells must be included. The site plan completed as part of the Preliminary Report (see Section 4.1 of the ordinance to which this document is attached) must be modified to depict the locations of the pumping and observation wells and included with the Hydrogeologic Report.

The Hydrogeologic Report must also include numeric quantities for each of the aquifer characteristics listed previously. Methods and calculations used to determine these aquifer characteristics must also be provided. The calculations should demonstrate that the aquifer characteristics were determined based on geologic conditions of the aquifer(s) and data collected during the aquifer test. For proposed developments utilizing bedrock aquifers, the results of the bedrock fracture evaluation, including the methodology for determining dominant fracture patterns and justification for the selection of observation well locations, must also be included.

Additionally, the average daily demand and peak daily demand for the proposed

development must be documented in the report. The calculations and assumptions used to calculate the daily demand estimates must also be included.

The Hydrogeologic Report must include conclusions regarding the ability of the anticipated aquifer to meet the needs of the proposed development during normal daily usage and periods of peak demand. Conclusions regarding the impact to nearby, existing wells during normal daily usage and periods of peak demand for the proposed development must also be included, with appropriate scientific justification.

USAGE MITIGATION MEASURES

For high risk developments, the developer or municipality may require implementation of water usage mitigation measures as part of the development. Implementation of these measures may be permissible in lieu of a reduction in the magnitude of the development. Usage mitigation measures may be appropriate to minimize water withdrawals for circumstances where the aquifer test has indicated that sufficient supply is not available to sustain both the proposed development, as proposed (assuming that usage mitigation measures were not initially included as part of the proposed development), and nearby, existing developments.

Some examples of usage mitigation measures include the following engineered or site design controls:

- Low flow water fixtures, nozzles, showerheads
- Low flow appliances including dishwashers, toilets, etc.
- Cisterns or rain water collection basins
- Grey-water recycling systems
- Irrigation system controls
- Supplemental water storage tanks, or other methods of increasing storage capacity
- Limits to the size of lawns and landscaped areas
- Restrictions on the types of plants/grasses that can be used in landscaped areas
- Limits to the size of or prohibition of pools, spas, jacuzzis, etc.

Prospective developers that elect to implement usage mitigation measures to limit withdrawals associated with the proposed development will be required to submit a revised Hydrogeologic Report that includes demand estimates that have been modified to account for these measures.

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POTABLE GROUNDWATER WELLS

MUNICIPAL GUIDANCE FOR THE RISK EVALUATION CHECKLIST

- 1) Provide the checklist to prospective developer for completion within a specified timeframe.
- 2) Review the completed checklist in conjunction with the developer's Preliminary Report to qualitatively evaluate risk associated with the proposed development. Risk evaluation should consider the specific municipality's risk tolerance, development goals, and priorities regarding potable groundwater usage.
- 3) Use responses in the checklist to determine whether or not potable water demand associated with proposed development and existing developments may exceed available groundwater supply. For estimating residential water demand, a household with moderate usage will typically require 110 gallons of water per day per bedroom. Evaluations of supply and demand should consider seasonal dry conditions and

periods of peak usage. The peak daily demand is generally equal to twice the average daily demand.

4) For proposed developments deemed to be “Low Risk”, require the prospective developer to comply with less comprehensive aquifer testing requirements, such as those detailed in the “Well Testing and Certification Ordinance.”

5) For proposed developments deemed to be “Moderate Risk”, consult with a professional hydrogeologist to review the checklist and Preliminary Report and make a determination on whether the project should be considered “Low Risk” or “High Risk”.

6) For proposed developments deemed to be “High Risk”, require the prospective developer to comply with the testing requirements documented in the “Ordinance for High Risk Potable Groundwater Wells.”