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Division of Water
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PUMPING TEST PROCEDURES FOR WATER WITHDRAWAL APPLICATIONS

Department regulations require that pumping test results be submitted as part of any Water Withdrawal Application involving new or additional groundwater sources or reassessment of previously permitted wells. In reviewing any such application, the Department must determine if the proposed well(s) will adequately meet the needs of the applicant and if others who may rely on the same aquifer will be adversely affected. The requirements that follow have been designed to produce the accurate and complete information that is vital to these determinations and whether modifications to the application or conditions in a potential permit are required.

Applicants are advised to submit their pumping test plans to DEC prior to conducting a pumping test if the proposed test will deviate from these procedures in a substantive way.

FOR INFORMATION AND ASSISTANCE
Water Quantity Management Section (518) 402-8238
Email: DOWinformation@dec.ny.gov

IMPORTANT NOTE: Before starting construction, it is advisable to submit a location map of the proposed new wells and any related construction to the Division of Environmental Permits in the appropriate DEC Regional office for a determination for whether that construction requires any other DEC permits, such as for disturbance of protected streams, protected freshwater wetlands, or for storm water runoff from a construction site. Other factors to consider when siting a project include flood plain location, agricultural districts, conceptual wellhead protection/recharge areas, existing or potential groundwater contamination sources, and existing subsurface utility corridors whose location could provide a preferential path for groundwater flow or contamination.

1. **TIME OF YEAR** – The pumping test of unconfined sand and/or gravel aquifer wells must be conducted during a time of average or below average seasonal stream flow conditions; that is, when "normal" groundwater gradients have not been reversed or significantly altered. Typically, this eliminates the months of March, April, and May. Tests conducted during the winter must not be affected by snow melt. Pumping tests for rock wells or confined sand and/or gravel wells not significantly influenced by overlying unconsolidated ground or surface water may be conducted during any month of the year, however the applicant must demonstrate that the test well(s) will not be affected by spring recharge.

2. **TEST PUMPING RATE** – NYS DEC's expectation is that a constant pumping rate will be a fundamental part of the test design. Any deviation from this philosophy must be discussed with NYS DEC prior to carrying out the test. Therefore, major changes in pumping rate must not occur as part of a **72-hour constant rate pumping test** unless prior agreement with the Department is obtained.

   Varying the pumping rate may diminish the usefulness of early-time data. The early data can be used to determine transmissivity, satisfy various test assumptions, reveal delayed yield, well storage, problems with the pump, and more. Significant changes in pumping rates will mask these effects. Later changes in pumping rate could cause inaccuracy in long term drawdown projections.

   During the first hour of the test, **failure to pump within 10 percent of the test pumping rate for any reason will require termination of the test**, recovery of water levels to static, and a restart of the test. Later pump failures must be demonstrated to have no significant effect on the data or a similar termination and restart will be necessary.

   When the most efficient or maximum design pumping rate is uncertain, a **step-drawdown test** must be conducted prior to the 72-hour constant rate test. Before proceeding to the 72-hour test, water levels must be allowed to recover to static levels. The scientific literature is unequivocal on this point.

   The **pumping test must be performed at or above the pumping rate for which approval will be sought** in the water supply application. If **multiple wells** are to be pumped simultaneously to achieve the necessary yield, the test must incorporate such a pumping plan. To reproduce the anticipated stress on the aquifer, the pumping test must take place when **nearby wells** normally in operation are active. Other pumping wells in the test area must be **monitored.** For complex tests it is highly recommended that the Department be consulted prior to finalizing the pumping test plan.

   The pumping rate must be **measured accurately and recorded frequently**. A decrease in discharge from a pump will normally occur with increasing drawdown as the pump works against a greater hydraulic head and increasing friction in the system. This effect must be compensated for during the test. Pumps and generators must be **inspected and known to be in good operating condition** prior to test start. Interruption of a test will require an extension of test time or may

invalidate the results thus requiring a repeat of the test.

NYS DEC recognizes that occasionally minor variation is unavoidable. For example, when water levels in the pumping well decline at a rate faster than expected, changes in the pumping rate can result. Thus, for the purposes of determining whether a given yield is sustainable (the primary goal of a NYS DEC pumping test) some variation in pumping rate may be acceptable. Even so, the test analysis report must address this variation in a scientifically disciplined manner including the impact on the ability of the pumping test to determine the test well's sustainable yield.

Measurement of pumping rate must be carried out in accordance with Section 6.b.

3. **LENGTH OF TEST** – Regardless of the type of aquifer, pumping tests shall be conducted for a minimum of 72 hours at a constant pumping rate. The following points must be addressed.

    a. A minimum of six hours of **stabilized drawdown** must be displayed at the end of the test. Stabilized drawdown is defined herein as:

        i. a water level that has not fluctuated by more than plus or minus 0.5 foot for each 100 feet of water in the well over at least a six-hour period of constant pumping flow rate. The water column is measured from pre-test static water level to the top of the deepest water bearing fracture that contributes at least 10% of total well yield,

        and,

        ii. plotted measurements that have not shown a trend of decreasing water level.

            Note: Stabilization can often be incorrectly attributed to hydrogeologic factors such as precipitation or snowmelt recharge, a recharge boundary due to a minor surface water body (e.g., small headwater streams or ponds), or limited leakage from overlying or underlying formations. In these cases, the test must be extended as per Section 3.c, below.

    b. If **stabilized drawdown is not achievable during the 72-hour test period** other methods may be employed to demonstrate the ability of the aquifer to meet withdrawal demands.

        i. Continue the test period until stabilization occurs, or

        ii. Construct a semi-logarithmic plot showing a 180-day projection of the time-drawdown curve. See Sections 13.b and 13.e. Water level in the test well must remain above the intake plus a margin of 5% but no less than 5 feet of the pre-test water column, or

iii. For other methods, pre-approval by the Division of Water is highly recommended to ensure acceptance of the test. All methods must be described in the final test report.

c. Positive (recharge) or negative (barrier) **boundary conditions** encountered during the test must have a record of at least 24 hours.

d. Excessive **rainfall** normally will require extension or rescheduling of the test unless it can be clearly demonstrated that it provided no immediate recharge to the aquifer in which the test wells are located.

e. For **multiple wells** in close proximity to each other, a rigorous 72-hour test must be performed on at least one well. After the initial test, additional tests on the other nearby wells may be **shortened to 24 hours** if all the following conditions are met:

i. All wells are in a relatively "homogenous" sand and gravel aquifer;

ii. Results of the first test are unambiguous;

iii. Well logs prove the wells are in the same formation;

iv. The wells are of substantially identical construction (e.g., diameter, depth, and screened section);

v. All other nearby production wells were monitored during the first test.

vi. Wells that must be pumped simultaneously to meet anticipated demand must be tested simultaneously. See Section 8 for additional detail.

4. **PRE-TEST CONDITIONS** – No pumping should be conducted at or near the test site for at least 24 hours prior to the test. If on-site or nearby pumping cannot be curtailed due to system supply needs or other factors, this must be noted and discussed in the final report as it relates to the test accuracy. Static water levels at the pumping well and observation wells must be measured at least daily for one week prior to the start of the test, including immediately prior to the start of the test.

5. **DISCHARGE OF WATER** – Water discharged during the pumping test must be conducted away from the pumping well in a down gradient direction and at sufficient distance (at least 300 feet away) to eliminate recharge of this water to the aquifer. The discharge line and discharge point must be shown on the site plan referenced in Section 14(i). If the aquifer is confined or if it can be otherwise demonstrated that discharged water will not recharge the aquifer being tested, a more convenient method of discharge can be used (within the caveats of Section 15).

6. **MEASURING SCHEDULE** –

   a. Water levels in observation wells and at the pumping well must be measured to provide at least ten observations of drawdown within each log cycle of time, beginning one minute after the start of pumping. A suggested schedule of measurements at all wells is as follows:

Time After Pumping Started	Time Intervals
0 to 15 minutes	1 minute
15 to 50 minutes	5 minutes
50 to 100 minutes	10 minutes
100 to 500 minutes	30 minutes
500 to 1000 minutes	1 hour
1000 to 5000 minutes	4 hours

   b. Test discharge pumping rate – **during the first hour of the test the pumping rate must be measured, adjusted, and recorded continuously.** Following this period measurements can be recorded less often if the drawdown rate has slowed and pumping has stabilized. At all times during the test, pumping rate observations and recordings must be conducted at least every hour.

   c. Recovery period measurements – see Section 9.

   d. Weather measurements – see Section 10.

   e. Surface water measurements – see Section 11.

   f. Water quality sampling – see Sections 12 and 13.

7. **OBSERVATION WELLS** – Whenever possible, at least three observation wells should be monitored during the pumping test. The horizontal distance between each observation well and the pumping well shall be measured to the nearest 0.1 foot. The vertical elevation of a fixed reference point on each observation well and on the pumping well (e.g., "top of casing") must be established to the nearest 0.01 foot and reported in NAVD 1988 (or in NGVD of 1929 if this is the standard at the test site). If three or more observation wells are available, one observation well must be located outside of the expected influence of the pumping well; this observation well will serve to monitor background conditions during the pumping test. The remaining observation wells must be placed to best define the hydrogeologic characteristics of the aquifer with respect to the pumping well. In some circumstances a representative sample of nearby homeowner wells must be monitored during the pumping test including nearby wells that may be outside the anticipated zone of influence.

   Observation wells should be just large enough to allow accurate and rapid measurement of water levels. **Small diameter wells are recommended** because the volume of water contained minimizes time lag during ongoing drawdown. Existing, larger diameter wells can be utilized if they are in good condition and were

properly installed.

For **unconfined aquifers**, one well should be located approximately 30 feet from the pumping well, a second well should be no farther than 300 feet from the pumping well, and at least one additional observation well should be placed beyond the 300-foot radius. For thick confined aquifers that are considerably stratified, at least two observation wells should be placed within 700 feet of the pumping well and at least one observation well located further than 700 feet from the pumping well.

Observation wells must be screened in, or open to, the same formation as the pumping well. When appropriate, additional observation wells beyond the specified minimum number may be screened in, or open to, formations above or below the one tapped by the pumping well to determine if there is any hydraulic connection between formations. Water levels in nearby water bodies must be measured prior to and during the test. Weir flow measurements must be conducted for small streams (see Section 11).

8. **MULIPLE PRODUCTION WELLS** – For cases in which an applicant is seeking approval for multiple production wells, all such wells must be monitored during the test. In addition, the test must be conducted in a way that will obtain information pertinent to the operational needs of the wellfield. If wells might have to be operated simultaneously to meet demand, the test must be designed to produce data representative of these conditions. See Section 3.e for additional detail about multiple wells.

9. **RECOVERY PERIOD** – Water level measurements must be collected during the recovery period for all wells using the same procedure and time pattern followed at the beginning of the pumping test (see Section 6). Measurement must commence at least one minute prior to shutdown of the pumping well and continue for at least 12 hours or recovery to the static water level. Water level measurements should be made to the nearest 0.01 foot. To obtain accurate data during the recovery period, a check valve must be installed at the base of the pump column pipe in the pumping well to eliminate backflow of water into the well. Water level measurements must also be collected during the recovery period in all potentially affected offsite monitoring wells, such as homeowner wells.

10. **RAINFALL MEASUREMENT** – Rainfall must be measured to the nearest 0.01 inch and recorded daily at or near the site for one week preceding the pumping test, during the test, and during the recovery period. A log of weather conditions during this period must also be kept, including barometric pressure recorded on the same schedule as rainfall. Weather station data available from within a reasonable distance of the test site can be utilized. Current precipitation must be compared to historic precipitation records to determine impact on the test results.

11. **SURFACE WATER MEASUREMENTS** – Fluctuations in surface water stages (or stream flow) for all surface waters, including wetlands, within 1000 feet of the pumping well should be measured to the nearest 0.01 foot. Measurements must be made using, as appropriate: weirs, staff gages (with stilling wells as necessary),

nested piezometers, etc. Weir flow measurements must be conducted for small streams. The horizontal distance between each observation point and the pumping well must be measured to the nearest 0.1 foot. The vertical elevation of a fixed reference point on each observation point must be established to the nearest 0.01 foot and reported in NAVD 1988 (or in NGVD of 1929, if this is the standard at the test site). Measurements must be read and recorded at least once daily for one week prior to the start of the test and at least twice per log cycle after the first ten minutes for the duration of the test. Measurements should be made more frequently if surface water levels are changing rapidly. The degree and nature of hydraulic connection with the surface water body must be quantified.

12. **FOR PUBLIC WATER SUPPLIES** The NYS Department of Health (NYS DOH) must be consulted on all issues related to the following:

    a. WATER QUALITY SAMPLES - Comprehensive water samples must be obtained from the pumping well during the last hour of pumping. Samples must be analyzed to establish acceptable quality as per NYS DOH requirements.

    b. WELLS UNDER THE DIRECT INFLUENCE OF SURFACE WATER - If the pumping well is or may be hydraulically connected to a surface water body, water samples from the well must be analyzed in the field at least once every four hours for the following parameters: pH, temperature, conductivity, and hardness. Further, representative water samples from the surface water body must be measured at both the beginning and the end of the pumping test and analyzed for the same parameters. For public water supplies, the NYS DOH must be consulted on all issues related to groundwater under the influence of surface water.

    c. REDUNDANCY - The total developed groundwater source capacity, unless otherwise specified by the reviewing authority, shall equal or exceed the design maximum day demand with the largest producing well out of service.

13. **ANALYSIS OF PUMPING TEST DATA** – In order to accurately analyze pumping test data it is necessary to use the methods and formulae appropriate for the hydrogeologic and test conditions encountered at, and specific to, the pumping test site. Knowledge of the hydrogeologic conditions of the area is necessary to ensure the use of appropriate techniques of analysis. Accordingly, analysis of pumping test data must be carried out by a hydrogeologist, professional engineer with hydrogeologic training, or other appropriately trained evaluator.

    a. **Data Correction** - Water level data, graphs, and interpretations must be corrected as appropriate or deemed significant for the effects of ambient water level trends; partially penetrating production well(s); partially penetrating observation wells; delayed yield from unconsolidated aquifers; aquifer thickness, recharge and/or impermeable boundaries; barometric pressure changes; changes in stage in nearby surface water bodies; recharge events

(rainfall, snow melt) during the week preceding the test, during the test, or during the recovery period; influence from nearby pumping wells; and any other hydrogeologic influences. All such data and calculations must be included in the test information report.

b. Theoretical **time drawdown graphs** must be prepared from the recorded drawdown by setting time equal to the length of the pumping test and groundwater withdrawal equal to the pumping test production rate. The graphs must be constructed on semi-logarithmic scale with time plotted on the log scale. Additionally, a semi-logarithmic plot showing a 180-day projection of the time-drawdown curve must be constructed on semi-logarithmic scale with time plotted on the log scale. Based on these graphs and the remaining standing water in the well at the end of the pumping test, a maximum safe pumping rate (yield) must be established for each production well or for the well field if simultaneous pumping of multiple production wells is planned (taking into account well interference). Water level in the test well must remain above the intake plus a margin of 5% but no less than 5 feet of the pre-test water column.

c. Theoretical **distance-drawdown graphs** must be prepared by plotting the drawdown in each observation well versus the distance of those wells from the pumping well. The graphs must be set time equal to the length of the pumping test and groundwater withdrawal equal to the pumping test production rate. The theoretical cone of depression so determined should be used to establish the area of influence of the well(s). It is highly recommended that the following **wellhead protection areas** be delineated using all available information (e.g., published hydrogeologic information, local knowledge, pumping test results, etc.) and best professional judgment: 60-day time of travel area, zone of contribution area or recharge areas (for confined or bedrock aquifers), and aquifer boundary area. Note that for bedrock wells (which do not normally hold to porous principles) the zone of contribution is often an irregular shape extending much farther in some directions than others. Thus it is difficult to delineate a zone of contribution for bedrock wells. Estimates should be made based on contributing watershed, gradient, the nature and orientation of fractures/lineaments, and best professional judgment. Some bedrock aquifers if extensively fractured can be treated or simulated as an unconsolidated aquifer.

d. Recovery data must be analyzed in a manner similar to that used for drawdown data.

e. All graphs must be annotated to contain pumping rates, time of pump start and finish, depth of pump intake, record of precipitation, and other useful information. The scale of the Y-axis (water level/drawdown) must be expanded as much as reasonable to allow better resolution of small-scale water level fluctuations and slope.

14. **SUBMISSION OF DATA** – Data submitted in support of a requested

groundwater withdrawal must include:

a. **raw pumping test data** (preferably in electronic format) with the following included:

   i. identification of tested well(s)
   ii. identification of observation well(s)
   iii. date, clock time, and elapsed time (minutes)
   iv. measuring point (top of casing) elevation
   v. water level measurements including static water level
   vi. calculated drawdown
   vii. depth of pump intake
   viii. pumping rate measurements of tested well

   If possible, superfluous data points should be reduced. For example, presenting data points collected once per second or once per minute after the first hour unnecessarily clutters reports and spreadsheets and does not contribute to efficient analysis.

b. **The time scale** of these measurements should approximate the logarithmic scale although **for later in the test the time between measurements should be increased**. It is recommended that a spreadsheet file of this raw data be submitted in place of a written record.

c. **pre-test water levels** of the pumping well, observation wells, surface water;

d. **recovery** and other post-test water level measurements;

e. **pumping rate(s) of nearby wells** including times on and off, surface water level and stream flow measurements, rainfall and weather information;

f. **engineering diagrams** showing construction details (e.g. well casing, screen setting and casing stickup, etc.) and depths of pumping wells and observation wells;

g. **geologic logs** must be submitted. For potable water supplies, completed NYS DEC well registration reports must also be included. For bedrock wells the depth of primary fractures must be noted in the log;

h. **graphs, formulae, and calculations** used to estimate transmissivity, storage coefficient, and safe yield[1];

i. **scaled site plan** showing:
   i. water level elevation controls (e.g., top of casing)
   ii. grade elevation for all wells
   iii. staff gages and other water measuring points
   iv. pumping test discharge piping and discharge point
   v. the location of nearby surface water bodies

vi. and, if applicable, the 100-year flood plain and elevation;

j. **coordinates** presented in either latitude and longitude (in degrees, minutes, seconds, tenths of second) or UTMs for all production wells and any observation wells which are to remain, preferably in NAD 1983 (specify the method and datum used to locate the wells);

k. **a topographic map** showing the locations of existing or potential groundwater contamination threats. Delineation of a wellhead protection area is recommended; and

l. **interpretations** including methodology, references and rationale. All documentation submitted must be legible and professionally presented. Plans and maps should use shading, cross hatch patterns, symbology, etc., such that features are readily distinguishable and remain readable when photocopied in black and white.

15. **CONTROL OF DISCHARGED WATER** – Please note, it is not legal to discharge water into any water body or wetland if such discharge results in turbidity or erosion leading to turbidity or downstream flooding. Accordingly, if it is anticipated that discharged water will create flooding, erosion and/or turbidity, water must be directed to a holding area and released in a controlled manner to prevent such problems. The discharge of water in the act of drilling and testing a well is covered under NYS DEC Regulations, Subpart 750-01:

    Obtaining a SPDES Permit, §750-1.5 Exceptions: *Paragraph 11. Discharges of yield test, well test and cutting water from water well drilling operations provided such discharges are handled in accordance with best management practices and are for limited duration during well development only.*

[1] Note for bedrock investigations -- transmissivity and storage calculations in bedrock aquifers may be misleading due to failure of the media to meet the assumptions necessary for carrying out such calculations. However it may be legitimate to treat or simulate extensively fractured bedrock as an unconsolidated aquifer. These matters should be discussed in the pumping test report. In addition, any de-watering of major fractures must be noted and the consequences discussed.

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