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Appendix 10, TOGS 3.2.1
(Public Water Supply Permit Program Application Processing)

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RECOMMENDED PUMP TEST PROCEDURES FOR WATER SUPPLY APPLICATIONS

Department regulations require that pump test results be submitted as part of any Water Supply Application involving a new or additional groundwater source (6 NYCRR 601.5(f)(12)). To approve any such application, the Department must determine that the proposed well or wells will adequately meet the needs of the applicant without adversely affecting others who may rely on the same aquifer. The recommendations that follow have been designed to produce the accurate and complete information that is vital to these determinations.

APPLICANTS ARE ADVISED TO SUBMIT THEIR PUMP TEST PLANS TO DEC PRIOR TO CONDUCTING A PUMP TEST, PARTICULARLY IF THE PROPOSED TEST PROCEDURES WILL DEVIATE FROM THESE RECOMMENDATIONS.

FOR INFORMATION AND ASSISTANCE
Call the Public Water Supply Program in the Bureau of Water Permits:
James Garry (518) 402-8101 or Michael Holt (518) 402-8099

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 as to 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 sub-surface utility corridors (whose location could provide a preferential path for groundwater flow or contamination).

1. **TIME OF YEAR -** The pump test of unconfined sand and/or gravel aquifer wells should 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. Pump 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. The applicant should demonstrate that the test well(s) will not be affected by spring recharge.

2. **TEST PUMPING RATE -** The pump 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 should incorporate such a pumping plan. To reproduce the anticipated stress on the aquifer, the pump test should be done when nearby wells normally in operation are running. Pumping of other wells in the test area should be monitored.

   A constant pumping rate should be maintained throughout the test. The pumping rate should be measured accurately and recorded frequently. It should be noted that a decrease in discharge from the pump will normally occur with increasing drawdown, as the pump works against a greater hydraulic head and increasing friction in the system. These effects should be compensated for during the test. The flow rate should be held to within 5 percent of the of the design pump rate.

   During the first hour of the test, any **failure to pump within 10 percent of the test pump 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 have no significant effect on the data or a similar termination and restart is necessary.

   The pumping rate should be measured accurately and recorded often enough to demonstrate compliance with the above standards.

3. **LENGTH OF TEST -** Regardless of the type of aquifer, pump tests shall be conducted for a **minimum of 72 hours** at a constant pumping rate.

   (a) A minimum of six hours of **stabilized drawdown** must be displayed at the end of the test. Stabilized drawdown is defined herein as 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 (i.e., static water level to bottom of well) over at least a six hour period of constant pumping flow rate; the plotted measurements shall not show a trend of decreasing water level.

   (b) If **stabilized drawdown is not achievable**, the test period may be extended or semi-log extrapolation of drawdown versus time (or other similar methods) may be employed to demonstrate the ability of the aquifer to supply a pumping rate equal to the desired yield (which must be equal to or less than the pump test yield) on a long

term basis. Normally, an extrapolation of six months of pumping with no assumed recharge must be compared against the level of water remaining above the pump intake at the end of the period (see paragraph No. 13). This type of evaluation may be used in lieu of satisfying the objectives of section 3.(a) of this document at the discretion of NYSDEC.

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

(d) Excessive **rainfall** may require extension or rescheduling of the test.

4. **PRE-TEST CONDITIONS -** No pumping should be conducted at or near the test site for at least 24 hours prior to the test. Static water levels at the pumping well and observation wells should be measured at least daily for one week prior to the start of the test and again immediately prior to the start of 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 as it relates to the test accuracy.

5. **DISCHARGE OF WATER -** Water discharged during the pump test should be conducted away from the pumping well in a down gradient direction and at sufficient distance to eliminate recharge of this water to the aquifer. The discharge line and discharge point must be shown on the site plan referenced in paragraph No. 14. 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 caveats of paragraph No. 15).

6. **MEASURING SCHEDULE -** Water levels in observation wells and at the pumping well should be measured to give 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

7. **OBSERVATION WELLS -** At least three observation wells should be monitored during the pump test. The horizontal distance between each observation well and the pumping well should 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") should 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). One observation well should be located outside of the expected influence of the pumping well; this observation well should serve to monitor background conditions during the pump test. The remaining observation wells should be placed so as to best define the hydrogeologic characteristics of the aquifer with respect to the pumping well. In some cases a representative sample of nearby homeowner wells should be monitored during the pump test, regardless of whether the anticipated zone of influence will extend to those wells.

Observation wells should be just large enough to allow accurate and rapid measurement of the water levels. **Small diameter wells are recommended** because the volume of water contained minimizes time lag in drawdown changes. Existing 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 should be screened in, or open to, the same formation as the pumping well. 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 should be measured prior to and during the test. Weir flow measurements should be conducted for small streams.

8. **RECOVERY PERIOD -** Water level measurements should be collected during the recovery period for all wells using the same procedure and time pattern followed at the beginning of the pump test (see No. 7). Measurement should commence at least one minute prior to shutdown of the pumping well and continue for at least 12 hours. 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 should also be collected during the recovery period in all off-site monitoring wells, such as homeowner private wells.

9. **RAINFALL MEASUREMENT-** Rainfall should be measured to the nearest 0.01 inch and recorded daily at or near the site for one week preceding the pump test, during the test, and during the recovery period. A log of weather conditions

during this period should 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.

10. **SURFACE WATER MEASUREMENTS -** Fluctuations in surface water stages (or stream flow) for all surface waters within 500 feet of the pumping well should be measured to the nearest 0.01 foot. Measurements should be made using, as appropriate: weirs, staff gages (with stilling wells as necessary), nested piezometers, etc. The horizontal distance between each observation point and the pumping well should be measured to the nearest 0.1 foot. The vertical elevation of a fixed reference point on each observation point should 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 should 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 should be quantified.

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

12. **WELLS UNDER THE INFLUENCE OF SURFACE WATER -** Additionally, if the pumping well is, or may be, hydraulically connected to a surface water body, water samples from the well should 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 should be taken at both the beginning and the end of the pump test and analyzed for the same parameters. The NYS DOH should be consulted on all issues related to groundwater under the influence of surface water.

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

(a) **DATA CORRECTIONS -** Water level data, graphs, and interpretations should 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 should be included in the test information package.

(b) Theoretical **time-drawdown graphs** should be prepared from the recorded drawdown graphs. The graphs should be derived from the pump test data, setting time equal to 180 days and groundwater withdrawal equal to the pump test production rate. Based on these graphs and the remaining standing water in the well at the end of the pump test, a maximum safe pumping rate (yield) should 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).

(c) Theoretical **distance-drawdown graphs** should be prepared. The graphs should be derived from the pump test data, setting time equal to 180 days and groundwater withdrawal equal to the pump 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, pump 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 can be an irregular shape and extend much farther in some directions than others. Thus it is difficult to delineate 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** should be analyzed in a similar manner to drawdown data.

14. **SUBMISSION OF DATA -** Data submitted in support of a requested groundwater withdrawal should include:

- **raw pump test data** (legible) with:
  - identification of tested well
  - observation well identification
  - date, clock time, and elapsed time (minutes)
  - measuring point (top of casing) elevation
  - water level measurements including static water level
  - calculated drawdown
  - depth of pump intake
  - pumping rate measurements of tested well

The time scale of these measurements should approximate the logarithmic scale although, for later in the test, the time between

measurements should be increased. A spreadsheet file of this raw data may be submitted in place of a written record.

- **pre-test water levels** of the pumping well, observation wells, surface water;
- **nearby wells** pumping rate(s) and times on and off, surface water level and stream flow measurements, rainfall and weather information;
- **engineering diagrams** showing construction details (e.g. well casing, screen setting and casing stickup, etc.) and depths of pumping wells and observation wells;
- **geologic logs** (completed NYSDEC well registration reports);
- **graphs, formulae and calculations** used to estimate transmissivity, storage coefficient, and safe yield[1];
- **scaled site plan** showing
    - water level elevation controls (e.g., top of casing)
    - grade elevation for all wells
    - staff gages and other water measuring points
    - pump test discharge piping and discharge point
    - the location of nearby surface water bodies
    - and, if applicable, the 100-year flood plain and elevation;
- **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);
- **a topographic map** showing wellhead protection areas and the locations of existing or potential groundwater contamination threats; and
- **interpretations** including methodology, geologic sections of the area, references, and rationale.

All documentation submitted must be legible. 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.

[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 pump test report.