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AQUIFER TESTING GUIDANCE

I. INTRODUCTION

This document provides guidance for the aquifer test that is required in Susquehanna River Basin Commission (Commission) Regulation 18 CFR §806.12. A project sponsor must complete an aquifer test according to a pre-approved testing plan for a well prior to submission of an application requesting to withdraw or increase a withdrawal of groundwater.

The Commission supports sustainable economic development in the basin and evaluates withdrawal applications for the long-term protection of water resources. Aquifer testing results are used to help evaluate the aquifer, the local groundwater basin, and the production capability of the well, ensuring that the resources are adequate to supply the needs of the project without significant adverse impact to the water resources of the basin. The Commission may consider factors, including but not limited to, the following in its consideration of adverse impacts: lowering of groundwater or streamflow levels; rendering competing supplies unreliable; affecting other water uses; causing water quality degradation that may be injurious to any existing or potential water use; affecting fish, wildlife, or other living resources or their habitat; causing permanent loss of aquifer storage capacity; or affecting low flow of perennial or intermittent streams.

The aquifer test procedures must incorporate monitoring of a type and frequency that is sufficient to allow evaluation of the above factors. The Commission recommends that a project sponsor retain a project hydrogeologist with substantial experience in the siting, drilling, testing, and permitting of water supply wells for the groundwater development project.[1]

<u>An aquifer test plan must be reviewed and approved by Commission staff before a project sponsor undertakes the testing specified in Commission Regulation 18 CFR §806.12 to support a groundwater withdrawal application.</u> Unless otherwise specified, Commission approval of an aquifer test plan is valid for two years from the date of approval.

[1] Note that projects must comply with laws of member jurisdictions, including professional licensing requirements. Currently, projects in Pennsylvania must use the services of a licensed professional geologist who is legally qualified to practice in Pennsylvania.

Commission staff will review an aquifer test plan only when it is administratively complete. A submittal is considered to be complete when all the items on the Application for Aquifer Test Plan Approval have been completed, including submission of the appropriate fee.

The Commission will approve an aquifer test plan only for a completed and fully developed well. The well must be constructed to the final total depth and borehole diameter, with permanent casing set and grouted in place.

II. WAIVERS AND MODIFICATIONS

This guidance contains conservatively rigorous aquifer test procedures and monitoring that are likely to result in Commission staff approval of an aquifer test plan under Commission Regulation 18 CFR §806.12. Aquifer test plans need only address site conditions. Further, there are instances where modifications of the guidance are desirable to the project sponsor and can still meet the goals of the Commission. **A project sponsor may request a waiver or modification of any requirement, provided the request and explanation is made in writing at the time that the aquifer test plan is submitted.** Commission staff will review requests for modifications and waivers, and notify the project sponsor of its findings.

For wells[2] requiring approval under Commission Regulations §806.4(a)(2)(i) and (ii), and withdrawing a consecutive 30-day average of 100,000 gallons per day (gpd) or more, a request to waive the constant-rate aquifer test must be accompanied by long-term historic operational data demonstrating reliable production at the requested rate with minimal impacts to existing users and the environment, as well as background information, the hydrogeologic description, and the groundwater availability analysis (Parts 1 through 3 of the Application for Aquifer Test Plan Approval); a justification for the waiver; a proposal for an alternative action or procedure; and the appropriate review fee.

For wells[2] requiring approval under Commission Regulations §806.4(a)(2)(iii) and (iv), and withdrawing or requesting to withdraw less than a consecutive 30-day average of 100,000 gpd, a request to waive the constant-rate aquifer test must be accompanied by background information (Part 1 of the Application for Aquifer Test Plan Approval); a well log showing lithology and water-bearing zones, well construction, and the static water level; a topographic map showing the well location, GPS coordinates of the location, and geology; a description of the pump setting, including pump type, horsepower, rated capacity, and depth of intake; and a map identifying sensitive features including wells, streams, ponds, and wetlands within a 100-yard radius of the proposed production well being tested.

For medium capacity wells[2] ranging from 0.020 million gallons per day (mgd) (14 gallons per minute [gpm]) to 0.100 mgd (69 gpm), in addition to the above, must submit the following: the hydrogeologic description and the groundwater availability analysis (Parts 2 and 3 of the Application for Aquifer Test Plan Approval).

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[2] For wells that are part of a well field, please contact Commission staff for guidance about requests to waive or modify testing requirements.

III. PLAN COMPONENTS

The plan should consist of pretest information unless waived as described in Section II above, including a hydrogeologic description and a groundwater availability analysis, and the aquifer test procedures and monitoring. Nearly all of the information required to complete these sections is needed and developed by the project hydrogeologist during a groundwater development project. The plan components are described in general terms, below, and further developed in the Application for Aquifer Test Plan Approval, which will lead the project hydrogeologist through the completion of a thorough and approvable aquifer test plan.

A. Hydrogeologic Description

A thorough understanding of the hydrogeologic setting is critical to both the selection of a productive and sustainable well site, and to the development of an aquifer test monitoring network. The hydrogeologic setting description should include the topographic setting; geologic structure; identification of recharge and discharge areas; dominant flow paths; a description of texture, mineralogic composition, and competence of the aquifer(s); and the dominant permeability types.

B. Groundwater Availability

Typically, the project hydrogeologist will perform the groundwater availability analysis prior to any well siting and drilling to insure that adequate water is available. Commission Regulation §806.12(b) states that the plan must include an analysis of groundwater availability during a 1-in-10-year recurrence interval. The Commission will consider the aggregate and cumulative effects of the existing and proposed withdrawals within a watershed, and will limit approvals to insure the sustainability of the stream/aquifer system based on this standard.

The analysis must include a delineation of the contributing groundwater basin and calculation of recharge to that basin. Recharge rates, based on 1-in-10-year drought recharge statistics or 60 percent of the average annual recharge rate (which approximates a 1-in-10-year annual drought), must be used in the analysis. Calculations should be based on the best available recharge rate information.[3]

C. Aquifer Test Procedures

The aquifer test is comprised of four parts:

- Step test (if required under Section D below);
- Background monitoring (48 hours);
- Constant-rate aquifer test (72 hours); and
- Recovery monitoring (24 hours or 90 percent recovery).

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[3] Commission staff is available to provide guidance on recharge rates and other groundwater availability related issues.

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During the aquifer test, monitoring should be focused on the area of influence, especially along high permeability trends where potentially significant impacts to other groundwater users or the environment are most likely to occur. This approach minimizes unnecessary monitoring and reduces the overall costs to perform an aquifer test.

D. Step Test

A step test provides information on the efficiency of the well over a wide range of pumping rates and the short-term maximum yield, it allows characterization of the uppermost water-bearing zones, and provides sufficient data to allow a selection of an appropriate rate for a constant-rate aquifer test. If the proposed production well is to be used as one of the two monitoring points in a distance-drawdown analysis, then a step test is necessary to provide information on the efficiency of the well. The testing parameters (step duration and number of steps), considering the well's and aquifer's performance, should be proposed in the aquifer test plan for review and approval by Commission staff. Generally, the step test should be performed at pumping rates that start at approximately 25 percent of the blown/bailed yield or the desired yield, whichever is less, and progress to higher rates in approximately equal steps until the water level fails to equilibrate during the step period.

Upon completion of the step test, the pumping may be continued at a selected rate to provide additional information on the time-drawdown behavior of the well, the well efficiency, and potential drawdown impacts. The step test should be monitored with a data logger through recovery. Commission staff suggests that select locations in the test monitoring network be active during the step testing, and be used to fine-tune the monitoring.

All monitored water levels and flow rates should be 90 percent or more recovered from step test pumping prior to the start of background monitoring.

E. Background Monitoring

A period of 48 hours of background monitoring should be performed immediately preceding the start of the constant-rate test. The purpose of the background monitoring is to establish pretest hydrologic conditions and trends (asymptotic groundwater or surface water recession). All of the monitoring locations must be operative throughout the background monitoring period. The results are used to identify background drawdown (from other wells), and groundwater and surface water recession trends occurring during the constant-rate test.

F. Constant-Rate Aquifer Test

The constant-rate test allows the evaluation of the aquifer, the local groundwater basin, and the proposed production well to supply the requested quantity of water and the potential impact of the proposed withdrawal on existing water supplies and environmental resources. This is accomplished by pumping the proposed production well at a rate greater than or equal to the desired rate of withdrawal and observing the induced changes in groundwater levels, surface water bodies, and wetlands. Aquifer test duration may vary depending on site-specific and use-specific parameters, and must accomplish the goal stated above. The duration of pumping should be sufficiently long to establish the hydrologic changes and trend characteristics of the proposed production well operation, aquifer, and groundwater basin (recommended 72 hours).

G. Recovery Test

The recovery test allows confirmation of the constant-rate test results and aids in the evaluation of the potential impacts and the sustainability of the proposed withdrawal. The recovery test immediately follows the constant-rate test and consists of monitoring the recovery of water levels and flow rates at all of the monitoring locations, following pump shutoff. The duration of the recovery test is a minimum of 24 hours or until groundwater levels have recovered to 90 percent of their pretest levels, minus groundwater recession. The measurement interval for the first 15 minutes of recovery should be 1 minute or less.

H. General Performance Requirements

1. The generally recommended <u>length of the aquifer constant-rate test is 72 hours</u>. A longer or shorter test may be appropriate to evaluate aquifer and well capabilities, as well as potential impacts to existing water supplies and the environment. The project hydrogeologist must recommend an adequate pumping test length demonstrating due diligence for site characterization and long-term protection of the resource, and provide a rationale for that recommendation. However, the duration may need to be increased during the test in response to ongoing test results.

2. Aquifer tests must be performed on wells that are considered to be completed and fully developed. Wells exhibiting incomplete development characteristics (i.e., turbidity spikes or unexplained water level fluctuations) may require an extension of the pumping phase or retesting. In carbonate, unconsolidated, or deeply weathered formations, continuous turbidity monitoring will be necessary, and the proposed monitoring methodology should be described in the aquifer test plan. Wells exhibiting well development episodes during the testing must demonstrate development-free performance during the last 72 hours of testing.

3. Discharge from the proposed production well must be routed such that recirculation does not occur. This typically results in a discharge point 300 to 500 feet down dip (bedding, schistosity, etc.) from the proposed pumping well, but may be 2,000 feet or more in karst-prone carbonate formations. <u>Recirculation will invalidate the test and will require retesting.</u>

4. Prior to discharging any wastewater, drilling wastes, or raw water from the proposed production well to any surface water feature, the project sponsor must first obtain any required approvals from the appropriate state or local water management or other agencies. The approval(s) must be forwarded to the Commission prior to the start of testing.

5. The background, pumping, and recovery phases of aquifer testing must be conducted during a period of asymptotic groundwater and surface water recession (base flow).

The test should not be conducted during or shortly after a precipitation event that could result in a rapid change of water level or flow.

6. Following the step test, the aquifer must be 90 percent or more recovered prior to the start of the 48-hour background monitoring period.

7. The background monitoring must immediately precede the constant-rate test.

8. The proposed production well may be pumped at any rate desired, but must be pumped at a constant rate for the test duration specified in the approved plan (recommended 72 hours). The Commission will not approve the well for operation at a rate higher than the average tested rate.

9. The pumping rate of the proposed production well must be monitored with an appropriate flow measurement device that is accurate to within 5 percent. The flow rate should be held constant to within 5 percent of the target flow rate for the duration of the test or the test will likely not qualify as a constant-rate test and may have to be rerun.

10. Valving must allow adjustment of the pumping rate to within the required tolerances.

11. The flow rate (gallons per minute) and cumulative flow (total gallons pumped) should be recorded at a minimum of once per hour.

12. <u>All flow rate adjustments must be documented with a measurement of flow before and after adjustment, the time at which the adjustments were made, and a rationale for the adjustment.</u> This information must be included in the hydrogeologic report.

13. If a well exhibits unexpectedly excessive drawdown, testing should be suspended. After full recovery, the test should be restarted.

14. Any change in the trend of the time-drawdown curve, such as might be caused by a positive/recharge boundary or negative/barrier boundary encountered during the test, must have a record of at least 24 hours. Therefore, any boundary condition encountered during the last 24 hours of pumping will require that the test be extended.

15. A test with a declining pumping rate due to excessive drawdown or inadequate pump capacity will be considered a failed test and will require retesting.

16. The aquifer test plan reviewer must be notified at least two working days prior to the start of testing by e-mail or telephone.

17. The project sponsor may be required, at its expense, to provide temporary water supply if an aquifer test results in interference with an existing water use.

IV. MONITORING GUIDANCE

The following sections provide guidance for monitoring a variety of features during aquifer tests. Sufficient monitoring points should be selected to adequately characterize drawdown in the k-max and k-min directions. Two points in each direction, excluding the proposed pumping well, are generally recommended.

A. Groundwater Monitoring

The selection of observation wells should be based principally on the expected area of influence, and on the distribution and construction of existing wells. In order to insure that a useful amount of drawdown is recorded, the wells being monitored generally should be no further than 2,500 feet away from the well being tested. It may be necessary to monitor wells outside the anticipated area of influence due to impact sensitivity or a high degree of uncertainty in the estimated area of influence or area of contribution.

All in-service observation wells should be monitored with digital data loggers. If monitoring a well that will likely be pumped during the testing, the water level transducers should be located deep enough to record the anticipated drawdown, but no deeper than 20 feet above the pump intake to avoid vibration and turbulence-induced interference. Observation wells not in service during the testing (all phases) may be manually monitored, although digital data loggers are recommended.

B. Surface Water Monitoring

A sufficient number of monitoring points should be selected to adequately characterize surface water impacts. These will generally be in the k-max or up-dip direction(s) and within 1,000 feet of the well being tested. It may be necessary to monitor sensitive water supplies (springs) and/or environmental resources outside the anticipated area of influence.

The discharge area of a karst aquifer (spring) must be monitored if the pumping rate will exceed 10 percent of the flow at the time of testing.

The selection of surface water resources to be monitored should be based on their distance from the well being tested, and on their proximity to high permeability features (fracture trends, gravel beds, etc.) that likely have an efficient hydraulic connection to the well being tested. Surface water bodies and wetlands must be monitored with a digital data logger. Levels from surface water bodies should be monitored from inside a stilling well. Monitoring of surface water features at distances greater than 1,000 feet may be required for the protection of sensitive, high-value surface water features.

1. **Ponds and wetlands.**

   a. <u>Ponds and wetlands without flow</u> should be monitored with wetland piezometers installed as hydraulically separated pairs of shallow and deep piezometers. The "shallow" piezometer should be screened within the root zone of the wetland, with the sand pack extended to the surface. The "deeper" piezometer needs to be constructed in a separate location (however, proximal) and screened in the higher permeability unconsolidated materials below the wetland. If no "permeable layer" is encountered, Commission staff recommends 2 feet of vertical separation between the bottom of the shallow piezometer screen and the top of the deep piezometer screen. Deep piezometer construction should consist of a sand-packed screened interval and a functional bentonite seal so that the screened interval is hydraulically isolated.

To aid in the determination of the final construction of the wetland piezometers and to better understand the wetland hydrology, the surficial materials in the area to be monitored should be investigated with a test borehole or examined in a natural exposure (streambank, ravine, etc.). The unconsolidated materials should be carefully logged for their physical and hydrogeologic characteristics (texture, structure, sorting, etc.). The descriptions should be used as the basis for determining the construction of the deep piezometers (i.e., the depth and length of screen).

b. Ponds and wetlands with flow should be monitored with an instrumented weir or flume, as appropriate, that allows the reliable measure of 10 percent of the test pumping rate or natural flow rate, whichever is smaller. The 10 percent rate must correspond to a change of at least 0.01 feet (approximately 1/8 inch).

2. **Streams and springs (flowing surface water).** The flow of streams and springs must be monitored by an instrumented weir or flume when the proposed rate of withdrawal is greater than 10 percent of the flow of the identified surface water feature at the time of the testing. Selection of the appropriate weir, flume, or other flow-recording device should be based on the anticipated range of flows within the surface water feature and the proposed pumping rate. The 10 percent change in rate of flow must correspond to a change of at least 0.01 feet (approximately 1/8 inch).

   If the proposed rate of withdrawal is less than 10 percent of the flow at the time of testing, then streambank piezometers may be utilized. The location of the piezometers should be based on site-specific hydrogeologic features such as the projections of high permeability trends (bedding, fracture traces, etc.). The piezometers must be in close hydraulic continuity with the coarse channel lag sediments, and must be constructed with a sand-packed screened interval and functional bentonite seal.

C. Water Chemistry

During the constant-rate testing, temperature, conductivity, turbidity, and any other agreed-upon chemistry measurements should be collected from the well being tested at a minimum of every 2 hours. Temperature and conductivity must be collected from all surface water features (streams, ponds, springs, and wetlands) being monitored at the start and end of the constant-rate test.

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D. Precipitation

Precipitation should be monitored (on-site instrumentation is recommended) on a 12-hour interval through the background, pumping, and recovery phases of testing. Liquid precipitation should be recorded to the nearest 0.1 inch. Precipitation as snow should be reported in a liquid equivalent. An attempt should be made to note the duration (i.e., the start and stop times) of any precipitation events that occur during the aquifer testing.

E. Measurement Frequency

Digital data loggers should be used for all phases of testing and at all monitoring points (the proposed pumped well, proposed in-service observation wells, and other observation points). The data logger in the pumped well should be set to record on a logarithmic schedule during the pumping and recovery phases. Those in observation wells should be programmed to record water level measurements at regular, constant intervals not to exceed 10 minutes during the pumping phase. As a check of accuracy and proper function, manual backup measurements at each monitoring location should be collected every 6 hours and once each hour from the proposed pumping well. This recommendation may prevent a failed test or a test having to be rerun due to equipment failure. Data loggers should be synchronized (i.e., be set to the same time and be recording on the same minute mark), so that the data from all points are easily correlated.

APPLICATION FOR AQUIFER TEST PLAN APPROVAL

Directions

The aquifer test plan should consist of the following items, in the order presented below:

1. Title page (with the signature of the project hydrogeologist and seal, when applicable).
2. A completed copy of the Project Information form (SRBC Form #72; Attachment 1) and required plan review fee.
3. A completed (checked) copy of the Application for Aquifer Test Plan Approval, signed by the project hydrogeologist and sealed, when appropriate.
4. All of the completed items in the Application for Aquifer Test Plan Approval, labeled, and in the order shown.
5. Any additional information may be attached as an appendix.

Submit two bound copies and a .pdf version on compact disc of the aquifer test plan for review to the Susquehanna River Basin Commission (Commission). Aquifer test plans are reviewed in the order of receipt. Due to workload and scheduling, an aquifer test plan should be received by the Commission at least sixty (60) days prior to the proposed test date to assure adequate time for Commission staff's review.

SECTION 1. BACKGROUND INFORMATION

☐ General description of the proposed project. Describe the project, including but not limited to, information on the following:

1. Anticipated long-term owner and operator, if different;
2. Use;
3. Current water need (million gallons per day [mgd]);
4. Anticipated future water need (mgd);
5. Planned water storage (million gallons); and
6. Location of return flow outfall.

SECTION 2. HYDROGEOLOGIC DESCRIPTION

☐ Description of contributing aquifer(s); use the Aquifer Description Sheet for Items 1 and 2 (Attachment 2), and use Table 1 (Hydrogeologic Boundaries) for Item 3:

1. For the geologic formations/aquifers within the contributing groundwater basin, provide generalized lithologic descriptions and the dominant permeability types.
2. For the aquifer(s) that the water-bearing zones are located in, determine and describe the dominant type(s) of permeability (fractures, joints, faults, bedding planes, etc.), the spatial characteristics (spacing and orientation) of the features, and how these features relate to the area of influence. Site-specific information and structural data (that is, information obtained or measured in the field) will be needed in most cases to satisfy this requirement.

3. List and describe (Table 1) any potential boundary conditions, both restricting geologic features or aquitards (for example, diabase dikes, confining impervious beds) and sources of recharge (for example, streams, lakes, wetlands), referencing Figure 2 for locations.
4. Describe the geologic and hydrologic properties of and classify the overburden (for example, alluvium, colluvium, flood plain fines, glacial outwash, stratified drift, till, residuum, saprolite, etc.). This information may require examination of shallow road cuts, stream channel banks, drainage ditches, well logs, and geotechnical boring logs.

Table 1. Hydrogeologic Boundaries

Boundary Type	Feature	Figure 2 Designation

☐ **Figure 1. Construction and Hydrogeologic Well Log**

Provide a scaled diagram of the well to be tested, showing well construction and geology. The geologic description must include lithology, lithologic contacts, and the depth, yield, and lithologic characterization of water-bearing zones (fractures, conduits, clay seams, gravel beds, etc.). A textural and mineralogic description of the unconsolidated and weathered materials must be included. A driller's log is not acceptable. The driller and the project hydrogeologist should work together closely in the field so that the information in the well log is a synthesis of the data collected by each. The log must include the ground surface elevation (reported as feet above mean sea level).

☐ **Figure 2. Topographic Map with Contributing Geology**

Clearly identify the following on a map:

1. Saturated lithified and unconsolidated materials within the area of contribution of the proposed well.
2. Location(s) of recorded field measurements (water elevations, structural geologic features, lithologic changes, etc.).
3. Locations of surface water features.
4. Fracture traces.
5. Contributing aquifer(s) and the presence of any aquitards.
6. Potential boundary conditions that may be encountered during testing.
7. Location of hydrogeologic cross sections.

☐ **Figure 3a. Hydrogeologic Cross Section (strike-perpendicular)**
☐ **Figure 3b. Hydrogeologic Cross Section (strike-parallel)**

Provide strike-perpendicular and strike-parallel hydrogeologic cross sections at a scale ranging from 1:1 to 5:1. For wells sited in valley-fill sediments, the cross sections should be parallel and perpendicular to the trend of the main valley. For wells sited in horizontally bedded rocks or massive crystalline rocks, the cross sections should be oriented approximately parallel and perpendicular to the dominant direction of natural groundwater flow. Additional cross sections at vertical scales up to 5:1 exaggeration may be submitted as needed. The location of the cross sections should be indicated on Figure 2. The cross section must pass through the well to be tested, cover 1,000 to 5,000 feet of length, and also include any significant hydrogeologic boundaries (surface water features, dikes, etc.). The cross section should include the following:

1. Water table or piezometric surface;
2. Surface water bodies and wetlands;
3. Geologic structure (confirmed by on-site field measurements);
4. Aquifers, aquitards, and hydrogeologic boundaries;
5. Top of rock;
6. Unconsolidated deposits – thickness and extent;
7. Well bore, casing, pump intake, and water-bearing zones, or screened intervals;
8. Surficial materials that are a saturated part of the flow system; and
9. Key scale(s).

☐ **Figure 4. Estimated Area of Influence**

Provide a topographic map at an appropriate scale ranging from 1 inch = 1,000 feet to 1 inch = 2,000 feet delineating the estimated area of influence of the proposed production well. The area of influence should be based on the best available information regarding the aquifer properties (dominant types of permeability and their spatial characteristics such as bedding and fracture orientations, anisotropy, etc. and their approximate values), topography, hydraulic gradient, groundwater flow direction(s), recharge boundaries, confining boundaries, etc. The map must include the aquifer properties (bedding strike, fracture traces, joints, etc.) used in determining the area of influence.

☐ **Figure 5. Groundwater Contour Map**

Using the "Topographic Map with Contributing Geology" (Figure 2), provide a groundwater contour map of adequate scale (1 inch = 1,000 feet to 1 inch = 2,000 feet) using recent water level data (measured by project personnel) from on-site wells and proposed monitoring points (observation wells and surface water features). Indicate the approximate hydraulic gradient, direction(s) of groundwater flow, and date of measurements. <u>Clearly indicate the estimated area of influence for the proposed well (Figure 4), at the proposed pumping rate, on the groundwater contour map.</u>

SECTION 3. PHASE I GROUNDWATER AVAILABILITY ANALYSIS

☐ **Figure 6. Groundwater Basin Map (Phase I Groundwater Availability)**

Provide a topographic map with a delineation of the groundwater basin. The following must be included:

1. Useable scale (1 inch = 2,000 feet). At a minimum, maps must occupy an entire 8.5-by-11-inch sheet with margins. (Note, it is oftentimes necessary to use sheets that are larger than 8.5 by 11 inches to provide the necessary information on a useable figure.)
2. Compass (north arrow); topographic map names (source map identification); map scale bar.
3. Potential hydrogeologic boundaries (divides, discharge areas or points [springs], dikes, sharp permeability changes).
4. Production wells within the contributing recharge area of the proposed pumping well (residential, municipal, industrial, irrigation, etc.).
5. Permitted surface water withdrawals.

☐ **Table 2. Phase I Groundwater Recharge Estimate**

Using the delineated recharge area (Figure 6), complete the provided table (Table 2), which includes the following:

1. Name of aquifer.
2. Contributing groundwater recharge area, in square miles, per formation.
3. Recharge rates for the 1-in-2-year and 1-in-10-year drought return intervals. In the event that a published 1-in-10-year rate is not available, 60 percent of the 1-in-2-year rate may be used.
4. Estimated groundwater availability for the proposed groundwater withdrawal point (well). (Recharge rate[s] multiplied by the proposed contributing recharge area.) (Table 2)

Table 2. Phase I Groundwater Recharge Estimate

(a) Aquifer (Formation)	(b) Contributing Area from the Identified Formation (mi^2)	(c) 1-in-2-year Recharge Rate (mgd/mi^2)	(c) 1-in-10-year Drought Recharge Rate (mgd/mi^2)	(d) Available 1-in-10-year Drought Recharge (gpd)
				Total mgd

mi^2 – square miles
mgd – million gallons per day
gpd – gallons per day

☐ **<u>Recharge Rate Rationale and Reference (source)</u>**

Provide the rationale for selecting the applied recharge rate(s), along with the referenced source. Why is the chosen rate applicable to the project area?

☐ **<u>Table 3. Existing Groundwater Withdrawals</u>**

Identify withdrawals (groundwater or surface water users) within the identified groundwater basin for the proposed production well.

Table 3. Existing Groundwater Withdrawals

Owner	Withdrawal Identification on Figure 6	Withdrawal Quantity (mgd)	
		Existing or Registered	Permitted or Approved
		Subtotal mgd	Subtotal mgd
Total Groundwater Withdrawal		mgd	
mgd – million gallons per day			

☐ **<u>Table 4. Phase I Groundwater Availability</u>**

Calculate the available groundwater by subtracting the existing withdrawals (sum of Table 3) from the estimated availability (sum of Table 2). Provide a final estimation of the groundwater that is presumed to be available for withdrawal from the proposed production well.

Table 4. Phase I Groundwater Availability

Line		Total (mgd)
1	Groundwater Recharge (Table 2, total)	
2	Groundwater Withdrawals (Table 3, total)	
3	Phase I Groundwater Availability (Line 1 minus Line 2)	
4	Proposed Withdrawal (well being tested)	
5	Remaining Groundwater	
6	Percent Utilization of 1-in-10-year Drought Recharge (100 - [Line 5/Line 1])	
mgd – million gallons per day		

If Line 6 (Table 4) is greater than 50 percent, then the Phase II Groundwater Availability Analysis must be completed.

SECTION 4. PHASE II GROUNDWATER AVAILABILITY ANALYSIS

The Phase II groundwater availability analysis is required if the water budget indicates that greater than 50 percent of the available resources will be allocated with the addition of the new well. A Phase II groundwater availability analysis refines the Phase I groundwater availability analysis by including significant water returns (National Pollutant Discharge Elimination System [NPDES] discharges greater than or equal to 0.100 mgd) and recharge losses due to impervious cover.

☐ **Table 5. NPDES Discharges (0.100 mgd or greater)**

Table 5 is a listing of all NPDES permitted discharges greater than or equal to 0.100 mgd that are located within the delineated recharge area. These potentially add to the available water if the proposed production well draws water from the stream to which they discharge, as demonstrated by aquifer testing results.

Table 5. NPDES Discharges (0.100 mgd or greater)

NPDES #	Permit Holder	Permitted Discharge (mgd)
		Total mgd
Note: Water imported from outside the area of contribution must be documented by a note in Table 5.		

☐ **Figure 7. Map of Zoning and Impervious Cover**

Provide a map delineating existing zoning of the land within the contributing recharge area, as well as any proposed changes in land use.

☐ **Table 6. Impervious Cover Recharge Loss**

For each aquifer, list zoning/land use types, their area, percent impervious cover, and their area of impervious cover.

Table 6. Impervious Cover Recharge Loss

Aquifer	Land Use/ Zoning Type	Percent Impervious Cover	Area (mi^2)	1-in-10-year Drought Recharge Rate (mgd/mi^2)	Recharge Loss (mgd)
		Total Impervious Cover Recharge Loss			**mgd**
mi^2 – square miles mgd – million gallons per day					

☐ Table 7. Surface Water Withdrawals

List the surface water withdrawals exceeding 100,000 gallons per day (gpd) during any 30-day period annually, and calculate a total. This should include any seasonal agricultural and recreational withdrawals.

Table 7. Surface Water Withdrawals

Owner	Identification on Figure 6 (map)	Withdrawal Quantity (mgd)
Total Surface Water Withdrawals		**mgd**
mgd – million gallons per day		

☐ Table 8. Phase II Groundwater Availability Analysis

The Phase I groundwater availability estimate is refined by subtracting out impervious cover recharge losses. For the wells being tested that demonstratably draw water from a stream, the withdrawals returned within the area of contribution (NPDES discharges >0.100 mgd) are added to the water resources available to the well, and the surface water withdrawals within the area of contribution are subtracted from the water resources available to the well being tested.

Table 8. Phase II Groundwater Availability Analysis

Line	Water Budget Component	Quantity (mgd)
1	Phase I Groundwater Availability (Table 4, Line 3)	
2	Impervious Cover Recharge Loss (Table 6, total)	
3	Phase II Groundwater Recharge (difference of Lines 1 and 2; see Note 1)	
4	Return Flows (Table 5, total)	
5	Sum of Lines 3 and 4	
6	Surface Water Withdrawals (Table 7, total)	
7	Total Water Available to the Well Being Tested (difference of Lines 5 and 6; see Note 2)	

mgd – million gallons per day

Notes:

1. The total water resources available to wells demonstrably drawing only upon groundwater is given on Line 3.
2. The total water resources available to wells demonstrably drawing some water from a stream is given on Line 7.

SECTION 5. AQUIFER TEST PROCEDURES

☐ **General Plan Description**

Provide short, concise answers to the following:

1. Estimated/desired rate of withdrawal;
2. Proposed pump setting (depth below ground surface);
3. Describe the flow control valving and metering;
4. Describe the proposed monitoring of water chemistry, including parameters measured, monitoring devices, and where samples will be taken (proposed pumping well, nearby streams, ponds, springs, and wetlands); and
5. Describe how precipitation will be monitored during the testing.

☐ **Figure 8. Map of Proposed Monitoring Locations**

On a topographic base map, indicate the locations of all of the proposed features to be monitored (wells, wetlands, ponds, streams, piezometers, weirs, etc.). All proposed locations should be identified on the map with a symbol for each type of monitoring point accompanied with a unique identification for each point. Surface water levels of all proposed monitoring points must be included on this map.

☐ **Table 9. Groundwater Monitoring Locations**

Provide as much of the following information as possible for each well or piezometer: well identification (property owner name, address, etc.), total depth, estimated yield, casing lengths, diameter, well construction (screened or open bedrock), depth to water/date , location (GPS latitude/longitude), wellhead elevation (feet above mean sea level), aquifer, and distance from proposed production well.

Table 9. Groundwater Monitoring Locations

Parameter	Description
Well Identification (property owner name, address, etc.)	
Total Depth (feet)	
Estimated Yield (gpm)	
Casing Lengths (feet)	
Diameter (inches)	
Well Construction (screened or open bedrock)	
Depth to Water (feet)/Date	
Location (GPS latitude/ longitude[1])	
Wellhead Elevation (feet amsl)	
Aquifer (geologic formation)	
Distance from Proposed Production Well (feet)	

[1]GPS coordinates should be based on NaD 1983 (in decimal degrees).
gpm – gallons per minute
amsl – above mean sea level

☐ **Table 10. Surface Water Locations**

Provide the following information: monitoring point identification, monitoring point construction (piezometers, stilling wells, weirs, flumes, etc.), estimated flow during test (when applicable), location (GPS latitude/longitude), elevation of monitoring device (wellhead for piezometers, top of weir, etc.), and distance from proposed production well.

Table 10. Surface Water Locations

Parameter	Description
Monitoring Point Identification	
Monitoring Point Construction (piezometers, stilling wells, weirs, flumes, etc.)	
Estimated Flow During Test (when applicable) (gpm)	
Location (GPS latitude/ longitude[1])	
Distance from Proposed Production Well (feet)	
[1]GPS coordinates should be based on NaD 1983 (in decimal degrees). gpm – gallons per minute	

Proposed Start of Testing:___________________________________
(Date)

Project Hydrogeologist:

Seal
(when applicable)

____
Print Name

____
Signature

____
Date

ATTACHMENT 1

The Project Information form, SRBC Form #72, has been replaced by the online Project Contact Information (PCI) form. Please go to https://www.srbc.net/regulatory/application-process/ to initiate the online aquifer testing plan, aquifer testing plan waiver, or PCI form.

ATTACHMENT 2

AQUIFER DESCRIPTION SHEET

A. For each aquifer (formation, alluvium, colluvium, saprolite, etc.) in the groundwater flow system, provide the following information:

☐ Consolidated:________________________________; ________________________________
(Geologic Formation) (Rock Type)

☐ Unconsolidated:______________________________; ________________________________
(Topographic Position) (Type of Deposit)

B. For each aquifer having a water-bearing zone in the well bore (open rock or screened), provide the following additional information:

☐ Mineralogy/Lithology/Texture:____

☐ Principal Permeability Type(s); rank them in importance (1 being the most important):

Permeability Type	**Rank**	**Orientation(s)**	**Check One (✓)**		
			Outcrop	**Air Photo**	**Topo**
Joints					
Bedding Partings					
Fracture Trace					
Schistosity					
Void(s)					
Intergranular					
Stress Relief Fractures					
Others:					