

**AQUARION WATER COMPANY OF CONNECTICUT
CANNONDALE WELL FIELD**

ATTACHMENT L

MITIGATION PLAN

INTRODUCTION

The Aquarion Water Company (AWC) is requesting authorization under the Individual Permit for Diversion of Water for Consumptive Use (IPDWCU) for their Cannondale Well Field. This individual permit application is a request to operate the Cannondale Well at a maximum withdrawal rate of 1.0 million gallons per day (mgd). However, data from aquifer tests conducted in 1984 and 2013 indicated that withdrawal from the proposed Cannondale Well impacted nearby surface-water bodies and potential shallow groundwater potable well supplies. To evaluate the potential long-term pumping related impact to Norwalk River flows and groundwater levels beneath the nearby CT DOT mitigation wetland and isolated vernal pools LandTech Inc. (LandTech) with assistance from WSP USA (figure 1) completed an ecological baseline survey of the well field and surrounding area between May and October 2017.

Data from the ecological baseline survey of nearby sensitive receptors specifically the Norwalk River, CT DOT mitigation wetland and vernal pools were used to develop the mitigation plan outlined below. The purpose of the mitigation plan is to address issues raised by CTDEEP during the October 13, 2011 and March 7, 2017 pre-application meetings and minimize potential impacts to the sensitive receptors that have been identified in and around the well field.

BACKGROUND

In 1984 Geraghty and Miller, Inc. (G&M) conducted a 90-day aquifer test on PW1 from June 19 through September 17, 1984. This test was performed to assess the pumping capability of the stratified-drift formation and identify potential impacts to nearby private potable supplies and the Norwalk River. The production well was pumped at a constant rate of 1,050 gpm or 1.5 mgd. Water levels in the production well, two potable supply wells, and 18 monitoring wells ranging in distance from 8 to 2,385 feet from the production well (PW1) were measured during the test. Flows in the Norwalk River were monitored at four locations adjacent to the well field from August 13 to September 14, 1984. The G&M analysis of the stream flow data collected during the aquifer test concluded that approximately 30 percent of water pumped during the test was derived from induced infiltration from the Norwalk River.

Additionally, during the 1984 test, two private potable supply wells completed in the overburden exhibited pumping-related impact. One domestic well, located approximately 530 feet from the production well (Hansen Well) had a drawdown of approximately 11.95 feet after 90 days of continuous pumping and a second private supply well located approximately 1,140 feet from the production well (415 Danbury Road) had a drawdown of approximately 11 feet. The Hansen well was able to operate during the test without incident and thus was not adversely impacted. However, the well at 415 Danbury Road was a shallow dug well that went dry after the 77th day of the 90-day pumping test.

A 6-day aquifer test was conducted at the well field by WSP from July 10 through July 16, 2013. Throughout the 6-day aquifer test the production well was pumped at a constant rate of 905 gpm or 1.3 mgd. This test was performed to assess the current pumping capability of the well and identify potential impacts to nearby wetlands, specifically the adjacent forested floodplain wetlands and CT DOT mitigation wetland that was constructed circa 2005. The 2013 results for the aquifer test documented that the well responded in a similar manner as the original 90-day aquifer test that was conducted by G&M in 1984 (at a constant rate of 1.5 MGD). In response to CTDEEP concerns raised during the October 2011 meeting, piezometers (with the input from LandTech prior to testing) were installed in the CTDOT mitigation wetland and were monitored during the 2013 test. The 2013 test results document impact to groundwater levels in the piezometers in the Norwalk River and nearby CTDOT mitigation wetland. No impact was observed in the forested wetland located south of the CTDOT mitigation wetland or Goetzen Pond (shallow pond and emergent marsh) located northwest of the well field.

ECOLOGICAL BASELINE SURVEY

An ecological baseline survey was conducted at the well field between March 13 and June 28, 2017. The purpose of the survey was to further characterize the sensitive receptors (ie Norwalk River, wetlands) impacted by the use of the well field during the above referenced aquifer tests. The ecological baseline survey was conducted to identify species associated with each receptor listed above, along with critical periods in each species life-cycle. This data allowed for the development of mitigation methods such as pumping restrictions and/or habitat modifications to minimize potential impacts associated with pumping the Cannondale Well. The location of the various sensitive receptors are shown on figure 1.

Floodplain/CT DOT Mitigation Wetland

Between March 13, 2017 and June 28, 2017, the wetland system adjacent to the well field was inspected by LandTech. Based on the inspections, the following was identified:

- Forested floodplain wetland abuts the Norwalk River south of the production well (figure 1). The wetland is underlain by poorly drained loamy soils over sand and gravel outwash. It is characterized by a stand of second growth hardwood trees dominated by red maple and white ash, and a well-developed shrub understory.
- Connecticut Department of Transportation (DOT) mitigation wetland lies southwest of the production well (figure 1). The mitigation wetland was designed to complement the existing abutting wetlands, maximize edge habitat, and enhance wildlife usage through the use of native plantings. Small pools were incorporated into the design, near the interface of the existing wetlands to the east to create opportunities for vernal pools to develop. Portions of the floodplain wetland and DOT mitigation wetland contain areas of seasonal shallow water (potential vernal pools).

The forested floodplain wetland and DOT mitigation wetland contains an assemblage of trees, shrubs, and herbaceous plants adapted to wet conditions ranging from permanent inundation to seasonal soil saturation. These hydrologic conditions produce a reducing environment characterized by the absence of free oxygen in the soil profile. The wetland plants (hydrophytes) are adapted to these reducing conditions. These adaptations may include air and pore spaces in roots and stems (aerenchyma), shallow roots and buttressed tree trunks. Species without these special adaptations (upland plants) are intolerant of the absence of soil oxygen and usually do not survive in these environments.

Groundwater drawdown resulting from well water withdrawals has the potential to change the soils reducing conditions by introducing more soil oxygen. This could result in the impacted areas becoming more suitable for non-hydrophytic (upland) plants. Colonization of impacted areas by upland plants could result in vegetation community changes including loss of plants typically associated with wetland environments.

The hydrologic conditions of the forested floodplain wetland vary seasonally relating to changes in temperature and precipitation. In Connecticut, precipitation is fairly evenly distributed throughout the year. Seasonal temperature changes, however, result in increases in evaporation and plant transpiration during the warmer months. These seasonal changes result in wetter (reducing) soil conditions from late fall through spring and drier soil conditions during the summer and early fall months. In order to mitigate impacts associated with potential groundwater drawdowns, maintenance of reducing soil conditions during the early growing season (spring) is more critical than during typically drier summer months.

Vernal Pool Evaluation

Vernal pools are identified as specialized habitats that contain an unique assemblage of species adapted to breeding in seasonally flooded wetlands. An often-used definition of a vernal pool as included in *Best Development Practices: Conserving Pool Breeding Amphibians in Residential and Commercial Developments in the Northeastern United States* (Calhoun & Klemens, 2002) is:

*Vernal pools are seasonal bodies of water that attain maximum depths in spring or fall, and lack permanent surface water connections with other wetlands or water bodies. Pools fill with snowmelt or runoff in the spring, although some may be fed primarily by groundwater sources. The duration of surface flooding, known as hydroperiod, varies depending upon the pool and the year; vernal pool hydroperiods range along a continuum from less than 30 days to more than one year (Semlitsch 2000). Pools are generally small in size (< 2 acres), with the extent of vegetation varying widely. They lack established fish populations, usually as a result of periodic drying, and support communities dominated by animals adapted to living in temporary, fishless pools. In the Region, they provide essential breeding habitat for one or more wildlife species including Ambystomatid salamanders (*Ambystoma* spp., called "mole salamanders" because they live in burrows), wood frogs (*Rana sylvatica*), and fairy shrimp (*Eubranchipus* spp.).*

Several surveys of the seasonally flooded wetland areas (vernal pools identified on figure 1) were conducted during the 2017 spring amphibian breeding season to look for obligate vernal pool species including amphibian egg masses and larvae. These surveys included water depth and water clarity observations and visual searches for amphibian egg masses including dip netting for larvae and fairy shrimp. A bathymetric survey of the pools was also conducted in November 2017. Results of these surveys are discussed below.

- **Vernal Pool #1** is a seasonally flooded woodland pool with no inlet or outlet. Spring water depths ranged from about 6” to 24”. One wood frog egg mass and abundant fairy shrimp were found in the ponded area. No other amphibian egg masses or larvae were found in Vernal Pool #1.
- **Vernal Pool #1A** is a constructed pool on the east side of the DOT Mitigation Wetland. It has a direct surface water connection to Vernal Pool #1. This pool contains spring water depths up to 28”. Twelve wood frog egg masses and abundant fairy shrimp were observed in Vernal Pool #1A. No other amphibian egg masses or larvae were found.
- **Vernal Pool #2** is a seasonally flooded woodland pool with no inlet or outlet to the north of Vernal Pool #1. While these two pools are in close proximity, they do not have a surface water connection and are separated by a narrow berm. Spring water depths ranged from about 6” to 12”. No amphibian egg masses or larvae were found but the pool did contain fairy shrimp. Even though no evidence of amphibian breeding was found in Vernal Pool 2, it contains suitable habitat and appears capable of supporting breeding amphibians.
- The seasonally flooded woodland area south of the DOT Mitigation Wetland contained no evidence of obligate vernal pool species and was found to lack sufficient depths, extent and period of ponding to support breeding amphibians and was thus determined not to be a vernal pool habitat.

In order to mitigate potential water drawdown impacts on vernal pools from groundwater withdrawals, it is necessary to maintain a sufficient pool hydroperiod to support obligate vernal pool species breeding, egg development, larvae development and metamorphosis to the adult form, typically from March through June.

Norwalk River

An evaluation of the Norwalk River (figure 1) included an assessment of river characteristics, review of available fisheries data, river cross sections and a wetted perimeter analyses.

- The Norwalk River in the vicinity of the well field is a Class 3 Wild Trout Management Area. Existing populations of wild trout are enhanced through stocking of adults 9” in length or larger. There is a 9” minimum length harvest restriction. The large trout require deeper habitat to survive. Brown trout fry are also stocked between the Cannondale dam to the north and Wolfpit Road to the south.

- The river contains a typical assemblage of riffle, run and pool habitats.
- Five pools were identified between the dam above Cannon Rd and the Wilton YMCA.

River Cross Sections/Wetted Perimeter Analyses

- Two river cross-sections were surveyed and a wetted perimeter evaluation was prepared at the suggestion of DEEP Fisheries staff. Methodology and results are included in WSP's Summary of Flow Reduction Analyses included as Appendix I.
- Update Flow Duration and 7Q10
 - As requested by DEEP, the flow duration and 7Q10 was updated to include current information. This update is included as Appendix II.

The baseline survey identified the Norwalk River as an important fisheries, including habitat for trout and a valuable sport fishing resource. Mitigation of potential river impacts from well water withdrawals include pumping restrictions to maintain habitat for trout throughout the drier summer months. In order to protect trout habitat in the vicinity of the well field, stream base flow must be maintained during low flow periods. It is necessary to maintain some deep-water pools for adults, and riffle habitats for juveniles during low flow periods.

MITIGATION PLAN

Based on the data obtained from the ecological baseline survey and the 1984 aquifer test, a mitigation plan has been developed to address the species and critical conditions required, as discussed above. This plan is intended for the first five years after issuance of the permit. Following the five-year monitoring period the data would be re-evaluated and modified/discontinued unless significant impact is noted. The proposed mitigation plan is presented below.

Norwalk River Fisheries July – September (low flow period)

The Norwalk River flow must be maintained to provide habitat for trout. The critical period for the trout is between July and September, when river flows are typically lowest. Goals of the mitigation plan are to maintain deep-water pools for adults and riffle habitats for juveniles during low flow periods typically between July and September. The plan to ensure that there is adequate flow/stage during this period includes:

- a. Installing and Monitoring a Permanent Stream Gage Station (with telemetry) in the Norwalk River upstream of the well field (likely along Cannon Road).
- b. Calculating the seven-day average flow (based on the previous 7 day flow) of the Norwalk River daily, once the gaging station has been established.

- c. Updating the stream depletion ratio (30%) derived from the 90-day aquifer test completed in 1984. Using data from the proposed gaging station and periodic gaging downstream of the well field along with streambed permeability testing in the Norwalk River near the proposed well field.
- d. Limiting pumping-related impact from the Cannondale Well Field to 10-percent of the calculated seven-day average (based on the previous 7 day flow) Norwalk River flow.

Upon permit approval, Aquarion would establish a permanent stream gage (with telemetry) located upstream of the proposed Cannondale Well Field. This gaging station, along with information from periodic downstream gaging and streambed permeability tests, will provide the data necessary to ensure that pumping related impact to the Norwalk River is limited to 10-percent of the seven-day average Norwalk River flow.

The table below shows what the compliance withdrawal rate at the well field would have been from September 1 through 17, 2016 had the proposed mitigation been in effect. The table shows the calculated average daily flows for the Norwalk River at Cannon Road, the seven-day average flow at Cannon Road, the maximum allowable induced infiltration (10-percent of seven-day average) from the Norwalk River and the resulting allowable withdrawal or compliance rate. Note, the Norwalk River flows at Cannon Road was calculated based on statistical analysis, by correlating the flows measured at Cannon Road in 2013 and 2017 to the flows at the USGS Gaging station located in South Wilton (01209700). The allowable Cannondale Well Field compliance rate was calculated utilizing a stream depletion of 30-percent (estimated by G&M).

Date	River Flow at Cannon Road (cfs)	7-day Average Flow at Cannon Road (cfs)	Maximum Allowable Flow Loss (cfs)	Compliance Withdrawal Rate (cfs)	Compliance Withdrawal Rate (gpm)
9/1/2016	6.09	3.59	0.36	1.20	537
9/2/2016	2.81	3.18	0.32	1.06	476
9/3/2016	1.95	2.87	0.29	0.96	430
9/4/2016	1.60	2.66	0.27	0.89	398
9/5/2016	1.34	2.51	0.25	0.84	376
9/6/2016	1.17	2.40	0.24	0.80	359
9/7/2016	1.51	2.35	0.24	0.78	352
9/8/2016	1.26	1.66	0.17	0.55	249
9/9/2016	1.17	1.43	0.14	0.48	214
9/10/2016	1.00	1.29	0.13	0.43	193
9/11/2016	1.95	1.34	0.13	0.45	201
9/12/2016	1.43	1.35	0.14	0.45	203
9/13/2016	1.00	1.33	0.13	0.44	199
9/14/2016	1.08	1.27	0.13	0.42	190
9/15/2016	0.74	1.19	0.12	0.40	179
9/16/2016	0.48	1.10	0.11	0.37	164
9/17/2016	0.31	1.00	0.10	0.33	149

The table above illustrates that the proposed mitigation would decrease withdrawal from the well field from the requested 1.0 mgd (or 694 gpm) to 0.214 mgd (or 149 gpm), thus decreasing the impact to the Norwalk River. Furthermore, the results from the wetted perimeter analysis (Appendix I) at cross-sections locations selected by LandTech (with guidance from CTDEEP) show that at 7Q10 flows predicted pumping related impact to river stage would be less than 0.3 foot. This analysis provide confidence that the proposed mitigation method is reasonable.

Vernal Pool March – June

The baseline survey shows evidence of Vernal Pools and associated species which require ponded conditions during the spring breeding season which generally spans from March through June. The mitigation plan to prevent the Vernal Pools from drying out during the spawning period includes:

- a. No pumping from March through June
- b. Verify existing piezometer locations and install additional piezometers in the vernal pools
- c. Conduct monthly monitoring of surface water and groundwater levels of the vernal pools

Upon permit approval, Aquarion would establish piezometers in the vernal pools and equip each with pressure transducers to monitor surface water and shallow groundwater stage in each vernal pool. For the first year that the well field is operating, Aquarion will monitor the piezometers in the vernal pools manually on a monthly basis and in subsequent years on a quarterly basis to ensure that the equipment is functioning properly. Data from the manual measurements and pressure transducers will also be used to better assess pumping-related drawdown effects on the surface and groundwater in and beneath each of the vernal pools. As part of the mitigation plan, the Cannondale well field would not be operated during the critical spawning period (March through June). The monitoring plan would also require Aquarion to review the surface water and groundwater level data from each vernal pool prior to the critical period (January and February) of each year to determine if further pumping restrictions, in addition to the restrictions associated for the Norwalk River flows, river flow cutbacks, are necessary. Reduction in the pumping rate may be needed to ensure that the vernal pools are wet prior to the spawning season. Aquarion will also conduct annual spring vernal pool breeding surveys within the identified vernal pools to evaluate breeding success.

This proposed mitigation is reasonable because eliminating pumping during the critical vernal pool breeding period will maintain pool water levels and allow obligate vernal pools species to complete their annual breeding cycle.

Floodplain/CT DOT Mitigation Wetlands

The historic aquifer testing has shown that groundwater under the CT DOT mitigation wetland is impacted by pumping the Cannondale well field. The mitigation plan to avoid impacts to wetland plant communities from pumping induced groundwater drawdown includes:

- a. Establish permanent vegetation monitoring transects/plots to evaluate changes in vegetation.
- b. Monthly monitoring of an existing piezometer in the DOT mitigation wetland to evaluate seasonal and pumping-related changes in groundwater levels.

Aquarion would perform a vegetation survey along two transects, one through the DOT wetland and one through the floodplain wetland, each transect consisting of three or more vegetation plots. Dominant vegetation will be identified using standard sampling protocols and facultative status (wetland vs. upland) of dominant vegetation will be recorded. The vegetation would be evaluated annually in order to identify short term and long term impacts to the vegetation associated with pumping the Cannondale Well including plant health and changes in plant community structure. Based on the evaluation, seasonal modification of pumping rates may be needed.

Shallow Private Potable Wells

Based on the 1984 test results, one shallow well located at 415 Danbury Road would need to be monitored during periods of long-term pumping of the Cannondale well field. If additional shallow wells are identified within 1,500 feet of the Cannondale production well, they would also need to be further evaluated. Based on the evaluation, the shallow well(s) may require mitigation measures. Mitigation of any confirmed interference with a private shallow overburden well and the well field could include:

- a. Deepening the well.
- b. Lowering the well pump.
- c. Connecting the residence to the public water system.

This proposed mitigation ensures individual wells are protected from the potential impacts of the proposed public water supply well.