Wellfield Management Plan

University of Connecticut

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1.0 INTRODUCTION

1.1 Background

The University of Connecticut (UConn) withdraws water from two stratified drift wellfields in the town of Mansfield, Connecticut. These are known as the Fenton River Wellfield located to the east of campus along the Fenton River, and the Willimantic River Wellfield located to the west of campus along the Willimantic River. The four Fenton River wells are registered with the Connecticut Department of Energy and Environmental Protection (DEEP) for a maximum withdrawal rate of 0.8443 million gallons per day (mgd). The four Willimantic River Wellfield wells are registered with the DEEP for a maximum withdrawal rate of 2.3077 mgd. Both wellfields are integral sources of supply for UConn.

As a result of ongoing concern about the environmental impacts of withdrawing water from the Fenton River Wellfield and in conjunction with the February 2001 Environmental Impact Evaluation (EIE) of the North Campus Master Plan, the Fenton River and its stratified drift aquifer have been extensively studied. UConn's "Fenton River Study" was published in March 2006 with the formal name *Long-Term Impact Analysis of the University of Connecticut's Fenton River Water Supply Wells on the Habitat of the Fenton River*. The study was conducted to determine whether and how water withdrawals from the Fenton River Wellfield affect the fisheries habitat of the Fenton River adjacent to the wellfield, and the maximum expected impact to instream flows under continuously sustained pumping conditions.

The Fenton River Study found that fisheries habitat became perceptibly reduced when the upstream flow in the Fenton River was flowing at less than 7.0 cubic feet per second (cfs) and the Fenton River Wellfield was operating. The amount of available habitat became significantly reduced by the pumping of the wellfield when the upstream flow was at 3.0 cfs. Thus, the primary recommendation of the Fenton River Study was to institute a series of successive reductions in the daily volume of pumping when the upstream flow in the Fenton River dropped from 6.0 cfs to 3.0 cfs, with the wellfield being shut down when upstream flows dropped below 3.0 cfs.

With a better understanding of the aquifer processes in the Fenton River and the impacts of ground water withdrawals, attention then turned to the Willimantic River aquifer and associated wellfield. UConn's "Willimantic River Study" was published in June 2010 with the formal name *Report of the Willimantic River Study: An Analysis of the Impact of the University of Connecticut Water Supply Wells on the Fisheries Habitat of the Willimantic River*. Similar to the Fenton River Study, the Willimantic River Study was conducted to determine whether and how water withdrawals from the Willimantic River Wellfield affect the fisheries habitat of the Willimantic River adjacent to the wellfield.

The Willimantic River Study found that the amount of available fisheries habitat in the Willimantic River is much greater than that in the Fenton River. For this reason, and the fact that the Willimantic River Wellfield was (at that time) UConn's only remaining source of supply after the Fenton River is shut off during low-flow periods, the Willimantic River Study recommended a progression of voluntary and mandatory water conservation measures as upstream flows in the Willimantic River dropped from approximately 19 cfs to approximately 8.0 cfs. The ability of UConn to enact these water conservation measures was tested immediately following the completion of the study, as dry conditions prevailed in summer 2010 and low river flows occurred.

One of the primary recommendations of the Willimantic River Study was to develop the subject comprehensive 2011 *Wellfield Management Plan* to conjunctively manage the water supplies at the Fenton River Wellfield and the Willimantic River Wellfield. Adoption and execution of this plan would then enable UConn to formally incorporate

the results of the Fenton River Study and the Willimantic River Study into its various plans and procedures for operating the UConn water system.

1.2 Purpose

This document is an update of UConn's initial *Wellfield Management Plan* published in May 2011. As discussed above, the primary purpose of this document is to allow UConn to formally incorporate the results of the Fenton River Study and the Willimantic River Study into the overall management of its water system. This document includes a review of both the Fenton River Study and the Willimantic River Study, a review of system operational history, and protocols for operating both wellfields throughout the year. As suggested by the Willimantic River Study, this document further includes:

- A determination for how UConn will monitor USGS-measured upstream discharges at each wellfield and correlate pumping rates to the habitat threshold triggers determined in both the Fenton River Study and the Willimantic River Study.
- A formal update to the 2008 draft Drought Response Plan, including response timing and recovery guidelines.
- Details for how Fenton Well D will be utilized when the Fenton River Wellfield would otherwise be shut down.
- Details for how the interconnection with The Connecticut Water Company (CWC) have been incorporated into overall wellfield management.

1.3 Relationship to Water and Wastewater Master Plan

On September 26, 2005, the Connecticut Department of Public Health issued a consent order to UConn to address what it characterized as deficiencies in the operation and management of its water supply system. As part of the consent order, UConn agreed to develop a *Water System Master Plan* to identify and evaluate viable options for meeting UConn's future drinking water needs. Additionally, UConn voluntarily expanded this charge to include evaluation of its wastewater collection and treatment needs as well.

The *Water and Wastewater Master Plan* was published in June 2007. The document was designed to convey an understanding of the extent and condition of water and wastewater infrastructure owned and operated by UConn; evaluate the capacity of the system to meet current and future water demands and wastewater treatment needs; estimate the value of water and wastewater assets owned by UConn; assess management and ownership options for the water and wastewater systems; and develop recommendations relative to future management and operation of the water and wastewater systems.

Most of the recommendations of the 2007 *Water and Wastewater Master Plan* are more directly applicable to UConn's water supply planning efforts than to this 2020 *Wellfield Management Plan*. With regard to the two wellfields, the 2007 *Water and Wastewater Master Plan* recommended the following:

- Perform the Willimantic River Study (completed in 2010);
- Continue to operate the Fenton River as outlined in the Fenton River Study (ongoing);

- Relocate Fenton Well A further from the river but within the distance available (250 feet) for a diversion permit exemption (unlikely to be pursued for the reasons in the 2020 *Water Supply Plan*); and

- Provide emergency power to Well #2 and Well #4 at the Willimantic River Wellfield (completed in 2011).

As this document recommends a monthly-based operating strategy derived from the current understanding of the characteristics of the two wellfields and the associated rivers, this 2020 *Wellfield Management Plan* supersedes the hypothetical operating scenarios presented in the previously published 2007 *Water and Wastewater Master Plan*.

1.4 Relationship to Other Water System Planning Documents

This 2020 *Wellfield Management Plan* presents a review of historical operational procedures as well as a review of the recent environmental studies that presented recommendations for reducing or curtailing withdrawals during periods of low streamflow. This is because the initial 2011 *Wellfield Management Plan* provided guidelines for the incorporation of wellfield management procedures from a variety of other UConn documents, including the 2011 *Water Supply Plan*, the 2008 draft Drought Response Plan, the 2011 *Emergency Contingency Plan*, and the 2011 *Water Conservation Plan*. As such, this 2020 *Wellfield Management Plan* provides background information above and beyond the scope of a typical operational reference document.

1.4.1 Relationship to the Individual Water Supply Plan

Whereas the 2020 *Water Supply Plan* is UConn's comprehensive water system planning document, this 2020 *Wellfield Management Plan* is intended to incorporate the operational recommendations of various environmental studies into a comprehensive operations document. As such, this document is designed to be associated with the 2020 *Water Supply Plan* but can also serve as a stand-alone document.

The monthly margin of safety projections prepared for the 2020 *Water Supply Plan* are influenced by the recommendations of this 2020 *Wellfield Management Plan*. It is envisioned that UConn will choose to continue updating or amending the 2020 *Wellfield Management Plan* concurrent with the 2020 *Water Supply Plan* in the future.

1.4.2 Relationship to the 2008 Draft Drought Response Plan

Several months prior to the extreme dry period in 2007, UConn prepared a draft "Drought Response Plan" to augment the pre-existing *Emergency Contingency Plan*. A copy of this plan (revised through August 22, 2008) is included in Appendix A. Designed to serve as a set of protocols rather than as a plan document, the 2008 draft Drought Response Plan established trigger levels, described responses, listed conservation measures, and described recovery from "emergency." The levels of response in the plan were denoted as follows:

- Stage IA – Water Supply/Conservation Alert
- Stage IB – Water Supply/Drought Advisory
- Stage II – Water Supply/Drought Watch
- Stage III – Water Supply/Drought Warning
- Stage IV – Water Supply/Drought Emergency

With the adoption of the 2018 Connecticut Drought Preparedness and Response Plan[1], there is no longer a need for UConn's drought response stages to be consistent with the State Plan. This is to prevent confusion between the State of Connecticut declaring a drought and a water supply system requesting conservation measures. However, the terms Advisory, Watch, Warning, and Emergency used by UConn are consistent with the previous 2003 Connecticut Drought Preparedness and Response Plan.

UConn's 2008 draft Drought Response Plan linked the projected available supply (including the available supply from the Fenton River Wellfield in accordance with the recommendations of the Fenton River Study) and High Head Reservoir levels to the trigger levels. An itemized list of response protocols was presented in the plan for each of the stages listed above to enable UConn to respond according to each particular trigger level.

The Connecticut DPH reviewed the 2008 draft Drought Response Plan and offered the following comments (in *italics*) by memorandum on September 9, 2008. Considerations related to these comments were incorporated, where appropriate, into the 2011 *Emergency Contingency Plan* and the 2011 *Wellfield Management Plan*, and carried forward and updated as appropriate in the 2020 *Emergency Contingency Plan* and this 2020 *Wellfield Management Plan*:

- Initial Trigger Level: *Issue Stage IA when the flow in the Fenton River reaches 4.0 or 5.0 cfs instead of 3.0 cfs to allow additional time to prepare for implementing conservation measures.* As it is expected that the Fenton River Wellfield will go offline each year, this recommendation was not incorporated.

- Source-Based Trigger Levels: *Base trigger levels for Stage IB, Stage II, Stage III, and Stage IV on groundwater levels rather than levels in the High Head storage facility.* A separation was performed between emergency situations in the 2020 *Emergency Contingency Plan* (where trigger levels were based on tank levels) and the drought procedures herein (based on instream flows). The availability of the CWC interconnection provides additional support to the use of tank levels over groundwater levels.

- Water Audits: *Water audits of the system's largest users should be performed when demand reductions are not met at each response stage.* Such water audits are currently performed when demand reductions are not met at each response stage. Furthermore, such audits are also part of the water system's normal business practice. The 2020 *Water Conservation Plan* discusses audits in more detail.

- System Recovery: *Recovery triggers should be based on groundwater levels and streamflows in addition to the High Head storage facility levels.* As noted above, emergency triggers are based on tank levels while drought triggers are based on instream flows.

- Term Clarification: *Clarification was recommended for what constitutes a projected available supply being "significantly less" than projected water usage, and what constitutes an "overall decrease in tank storage." These statements could be quantified in units or percentages.* This is discussed in the 2020 *Emergency Contingency Plan*.

- Emergency Sources: *The plan should identify all potential sources of water supply within a reasonable proximity to its distribution system that could potentially be tapped during a Stage IV emergency. This would necessitate an emergency order that is unlike the one outlined in prior stages and would require water boiling and possibly*

[1] https://www.ct.gov/waterstatus/lib/waterstatus/2018.11.06_state_drought_plan_adopted.pdf

other public health precautions contingent on the quality of the emergency source. These items are discussed in the 2020 *Emergency Contingency Plan*.

The 2008 draft Drought Response Plan was considered during the Willimantic River Study in 2008 and 2009 to correlate its protocols to those recommended when the Willimantic River falls below the threshold streamflow triggers outlined in its environmental study. The protocols suggested in the Willimantic River study report were then followed during the dry summer of 2010.

This 2020 *Wellfield Management Plan* (and where applicable, the 2020 *Emergency Contingency Plan*) fully incorporates the planning effort begun with UConn's 2008 draft Drought Response Plan. Because a dry spell or moderate drought is not necessarily a water supply emergency for UConn and therefore should not always be treated as such, this 2020 *Wellfield Management Plan* instead uses the guidelines from the two river studies to revise the five stages of water conservation triggers.

1.4.3 Relationship to the Emergency Contingency Plan

The purpose of the 2020 *Emergency Contingency Plan* is to outline protocols to follow when actual emergencies occur, such as failing wells, water main breaks, tank levels falling rapidly, contamination of water, or disasters. It is understood that such events can curtail UConn's ability to provide potable water, which may result in a threat to public health.

This 2020 *Wellfield Management Plan* does not consider the impact of such emergencies, but rather considers day-to-day operation of the wellfields under normal operating conditions and during periods of low river flows when wellfield operation could cause adverse environmental stress to the habitat of the rivers adjacent to each wellfield. Seasonal low stream flows are not considered an emergency situation for UConn, but instead a situation that advises conservation and results in the utilization of response protocols.

On the other hand, it is understood that a sustained drought such as the drought of record in the 1960s could result in low groundwater levels that could in turn cause wells to go dry. This situation would be considered an emergency and is considered under "Potential Emergency #1" in the 2020 *Emergency Contingency Plan*. These modifications were necessary to provide a clear, workable set of emergency response protocols for UConn and to differentiate emergency response from typical drought response for the majority of low-flow events.

1.4.4 Relationship to the Water Conservation Plan

The purpose of the 2020 *Water Conservation Plan* is to more generally describe how to accomplish system-wide water conservation measures both in the long-term and in the short-term when triggered by the 2020 *Emergency Contingency Plan*, or this 2020 *Wellfield Management Plan*. The protocols for water conservation are similar between the three documents, although the timing of water conservation initiatives may need to be expedited during emergency situations.

2.0 REVIEW OF THE FENTON RIVER STUDY

2.1 Purpose

UConn's "Fenton River Study" was published in March 2006 with the formal name *Long-Term Impact Analysis of the University of Connecticut's Fenton River Water Supply Wells on the Habitat of the Fenton River*. The study was conducted to determine whether and how water withdrawals from the Fenton River Wellfield affect the fisheries habitat of the Fenton River adjacent to the wellfield. The Fenton River Study was conducted in conjunction with the EIE of the North Campus Master Plan due to ongoing concern about the environmental impacts of withdrawing water from the Fenton River Wellfield. The Fenton River Wellfield is depicted on Figure 2-1.

The specific objectives of the Fenton River Study were to:

- Develop relationships between instream flow and habitat in the Fenton River for selected fish species;
- Derive the relation between the magnitude and timing of groundwater withdrawals on the stage and flow of water in the Fenton River principally from Old Turnpike Road to Stone Mill Road using existing data, new data collection, and mathematical simulation modeling; and
- Mathematically model selected water-management scenarios to optimize water withdrawals while minimizing adverse impacts on stream flow and in-stream habitat.

2.2 Findings

The Fenton River Study demonstrated that the Fenton River is a complex system in the vicinity of the Fenton River Wellfield. There are several gaining and losing reaches throughout the study area which can vary in response to precipitation patterns. The study found that in general, during non-pumping conditions the Fenton River tends to gain flow in the downstream direction including during times of prolonged dry weather.

As no long-term USGS gauging station was available on the Fenton River, determination of the long-term frequency of low flows was accomplished by correlating the limited available gauging data of the Fenton River with the long-term gauging data from the nearby Mount Hope River. The frequency analysis was effective at predicting low flow values on the Fenton River and correlated well to observed flows during the 2005 drought. The frequency analysis found that the Fenton River can naturally reach flows during dry periods that approach the magnitude of the registration rate of the Fenton River Wellfield (0.8443 mgd, or 1.31 cfs). Recession curve analysis (based on one summer of data) indicated that the Fenton River takes about six days to drop from 20 cfs to 6.5 cfs and takes a little longer (about eight days) to drop from 6.5 cfs to 3.0 cfs.

Field data were measured and collected from 2003 through 2005. Hydrogeophysical investigations included soil borings, bedrock outcrop mapping, and the use of seismic and ground-penetrating radar techniques. Hydrologic data collection included rainfall data at the UConn Agronomy Farm and at the Fenton River Wellfield, groundwater monitoring in nearby monitoring wells using dataloggers, and streamflow measurements during a series of aquifer tests.

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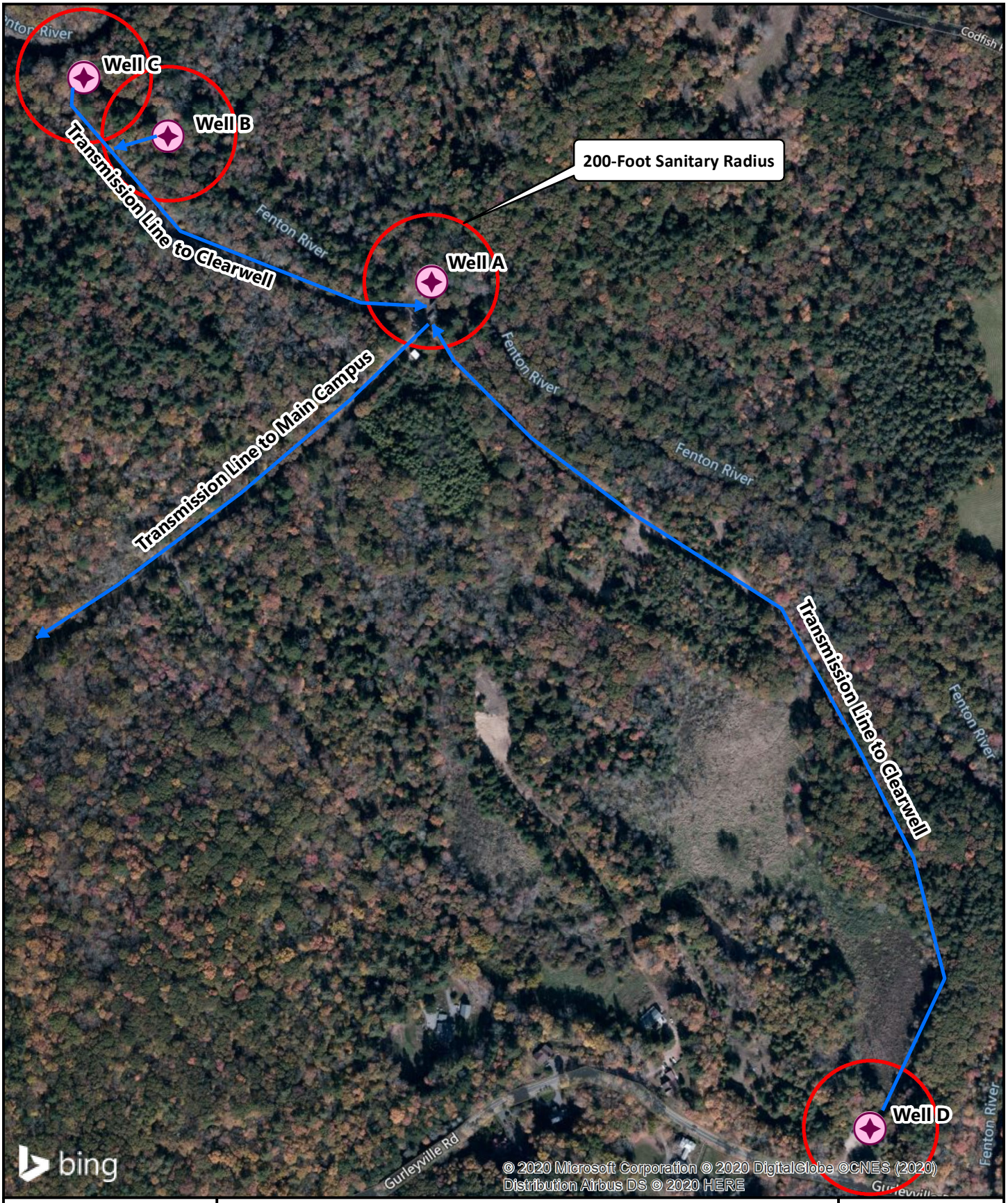

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FENTON RIVER WELLFIELD

WATER SUPPLY PLAN
UNIVERSITY OF CONNECTICUT
GURLEYVILLE ROAD
MANSFIELD, CT

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FIG. 2-1

Fisheries habitat investigations included field surveys to map mesohabitat reaches in the study area and to identify river segments most representative of major habitat conditions. Ten sub-reaches were identified for fish collections. Velocity, depth, substrate, cover, and water surface elevation were measured at transect points during three calibration flows (high, moderate, and low river flows) and bed elevations were surveyed. This information was used in the Physical Habitat Simulation (PHABSIM) system with the conceptual and analysis framework of the Instream Flow Incremental Methodology (IFIM) to model relationships between instream flow and fisheries habitat.

Target fish species included brown trout, brook trout, fallfish, and tessellated darter. Standard Weighted Usable Area (WUA) curves were produced for each species along with WUA curves by mesohabitat for each species. Uniform-Continuous Under Threshold (UCUT) curves were developed for each species to relate percentage of maximum WUA to the percentage of time that the Fenton River habitat for each species is below that percentage of maximum WUA. Results for the overall fish community are presented in Table 2-1.

TABLE 2-1
Percent of Maximum WUA, Discharge, and Persistent Duration of Common, Critical, and Rare Habitat Thresholds for Target Fish Community

Habitat Stressor Threshold	Parameter	Result
Common	Habitat (% Max WUA) Discharge (cfs) Persistent Duration (days)	35% 7.5 40
Critical	Habitat (% Max WUA) Discharge (cfs) Persistent Duration (days)	15% 2.5 15
Rare	Habitat (% Max WUA) Discharge (cfs) Persistent Duration (days)	10% 1.4 5

In modeling sub-reach 2 (the vicinity of Fenton Wells A and B), the Fenton River was found to be the most susceptible to the loss of fisheries habitat during low-flow periods. Results for the overall fish community in this sub-reach are presented in Table 2-2.

The Fenton River Study verified earlier suppositions that operation of the wellfield causes reduced groundwater discharge to the river and induced infiltration from the river. The magnitude of reduced instream flow was estimated through three independent means: thermistors in nested piezometers (infiltration rates of 0.17 to 0.58 ft/d), weir measurements (inconclusive), and streamflow loss observations (46% of the pumping rate). The field data found that the published results from the 1960s (0.22 ft/d) slightly underestimated the amount of induced infiltration. Analysis of 2004 data indicated that the ground water table near Well A can be as much as seven feet below the riverbed when the river is flowing and the wells are pumping.

TABLE 2-2
Percent of Maximum WUA, Discharge, and Persistent Duration of Common, Critical, and Rare Habitat Thresholds for Target Fish Community in Modeling Sub-Reach 2

Habitat Stressor Threshold	Parameter	Result
Common	Habitat (% Max WUA) Discharge (cfs) Persistent Duration (days)	35% 11 40
Critical	Habitat (% Max WUA) Discharge (cfs) Persistent Duration (days)	15% 6 15
Rare	Habitat (% Max WUA) Discharge (cfs) Persistent Duration (days)	10% 5 5

The field data were used to develop and calibrate a numerical model of groundwater flow using MODFLOW 2000. The model was subsequently validated with previous investigations that occurred in the 1960s. The numerical model was used to simulate the effect of the Fenton River Wellfield on the stage and discharge in the Fenton River with several infrastructure improvements and under several management scenarios.

The four primary improvements and management options considered included: (1) increasing the capacity of Well D; (2) increasing the capacity of Well A and moving it farther from the Fenton River to a location with a greater thickness of stratified drift; (3) increasing the capacity of Well D and turn off Well A during periods of low river flow; and (4) reducing overall pumping from the wellfield as flows fall below 6.0 cfs. The model results indicate that a linear rate of daily streamflow loss exists as a function of total daily pumping. Additionally, pumping only Wells C and D (the two wells farthest apart at the Fenton River Wellfield) will mitigate drawdown impacts (and therefore habitat impacts) in the vicinity of Well A and Sub-Reach 2.

The best management scenarios with multiple wells pumping during periods of low streamflows suggested that the relocation of Well A to halfway between its existing location and Well D (an action requiring an individual diversion permit from the Connecticut DEEP) or up to 250 feet to the south (no individual diversion permit required) could have moderate benefits to instream flow. However, relocating this well was not concluded to be cost-effective, as the reduction in streamflow loss was fairly minimal.

2.3 Conclusions

The Fenton River Study concluded that the timing and the rates of ground water withdrawals, with respect to: (1) periods of ground water recharge; and (2) periods that are critical for fish populations, can be managed to minimize impacts. The study notes that diminution of streamflow displays a delayed response to ground water withdrawals, and also notes that there is very little difference between scenarios that spread the same total pumping over longer durations during the day.

The habitat studies indicated that fisheries habitat impacts due to the operation of the Fenton River Wellfield were not discernable at upstream flows exceeding 10 cfs. Habitat begins to become perceptibly reduced when the

wellfield is pumping and upstream flows drop below 7.0 cfs, and available habitat is significantly reduced by pumping when upstream flows fall below 3.0 cfs. The key conclusion was that during low-flow conditions with an approximate five-year recurrence interval, pumping the Fenton River Wellfield reduced flow in the Fenton River by approximately 0.8 cfs in the vicinity of Well A, with the potential to cause adverse impacts to fish.

Modeling Sub-Reach 2 in the vicinity of Wells A and B required the highest flows, on the order of 6.0 cfs, to maintain at least 15% of maximum WUA for brook trout and fallfish. As such, the UCUT results from this modeling sub-reach were utilized to set guidelines for the cessation of pumping at the Fenton River Wellfield.

Given the fact that the Fenton River can naturally reach flows lower than the registration rate of the Fenton River Wellfield, the Fenton River Study concluded that there will be times when no management scenario will mitigate an adverse pumping impact to fish habitat. As such, the Fenton River Study suggested a management scenario that institutes successive pumping limitations when the flow in the Fenton River upstream of the wellfield is between 6.0 cfs and 3.0 cfs, with the wellfield completely shut down when upstream flow falls below 3.0 cfs.

2.4 Recommendations

The Fenton River Study offered the following recommendations (in *italics*) to protect fisheries habitat in the vicinity of the Fenton River Wellfield:

1. *Install a continuously operating, telemetric streamflow gauging station on the Fenton River at Old Turnpike Road to manage pumping of the Fenton River Wellfield on a daily basis*; this was completed.
2. *Repair or replace Well D so that it can run continuously and pump at its maximum capacity*; this was completed.
3. *Replace Well A with a well of similar capacity farther from the river and in a deeper part of the stratified drift aquifer, such as halfway between existing Well A and Well D*. This replacement is not believed to be cost-effective and therefore not yet completed; given the current status of Well A as an emergency well, and the fact that a replacement Well A would not increase available supply (only system redundancy), it is unlikely that Well A will be replaced in the foreseeable future.
4. *Install modern electronic speed controls or duty-cycle controllers on all well motors*; this was completed.
5. *Upgrade motor controls to enable more flexible operation of each well and the entire wellfield*; this was completed.
6. *Calibrate and maintain flow meters on the discharge line of each well*; this was completed.
7. *Install a chemical disinfection system that follows best established practices to maintain the correct quantity of disinfectant over a wide range of pump flow rates from individual wells in order to add flexibility in pumping rates from each well and combination of wells*; this was completed.
8. *Reduce the daily volume of pumping to 0.633 mgd if the flow in the Fenton River as measured at Old Turnpike Road is less than 6.0 cfs*.
9. *Reduce the daily volume of pumping to 0.422 mgd if the flow in the Fenton River as measured at Old Turnpike Road is less than 5.0 cfs*.
10. *Reduce the daily volume of pumping to 0.211 mgd if the flow in the Fenton River as measured at Old Turnpike Road is less than 4.0 cfs*.
11. *Do not pump the Fenton River Wellfield if the flow in the Fenton River is less than 3.0 cfs*.
12. *Do not pump the Fenton River Wellfield if flow in the river is below 6.0 cfs for more than 15 consecutive days, or below 5.0 cfs for more than five consecutive days, regardless of the other thresholds. This will help to avoid increasing the frequency of occurrence of fish habitat reduction due to pumping*.

Recommendations 8 through 12 were incorporated into the Fenton River Wellfield operating protocols. The Fenton River Study suggested that the decision for restarting pumping when flow increases above 6.0 cfs should be based on the amount of flow and the expected time of recession back to 6.0 cfs. A series of equations were provided on Page 83 of the Fenton River Study for the operator to use in assisting with this judgment.

UConn has been following recommendations number 8 through 12 since completing the study. However, in practice, the operating rules are very close to one another requiring necessary operational changes as flows shift between 6.0 and 3.0 cfs. Thus, from 2006 to 2011 UConn tended to shut down the wellfield when the upstream flow falls below 6.0 cfs in late spring or summer. Following the issuance of the 2011 *Wellfield Management Plan*, treatment improvements and well pump upgrades have increased operator flexibility related to operating the wellfield through the triggers. Thus, UConn may now reasonably meet the withdrawal limitations while moving through the triggers from 6.0 cfs to 3.0 cfs.

2.5 Supplemental Studies

The adoption of the recommendations of the Fenton River Study by UConn has caused UConn to operate the Fenton River Wellfield based on environmental considerations instead of in response to system demand or operational constraints. Although it is generally understood that UConn could legally reactivate the Fenton River Wellfield during a low-flow period, UConn has elected to instead reserve this action for response to a public health emergency.

Notably, the results of the Fenton River Study were focused on Modeling Sub-Reach 2, namely the stretch of river from the vicinity of Well B to a point some 500 feet downstream of Well A. This was the stretch of river found to be at the highest risk of environmental impact due to operation of the Fenton River Wellfield. In addition, the Fenton River Study noted that flow in the Fenton River decreased between Old Turnpike Road and Well A, and thus pumping of the Fenton Wellfield would tend to exacerbate the loss of instream flow in this area. Operating protocols were likewise based on the findings from Modeling Sub-Reach 2.

Alternatively, the flow in the Fenton River was found to increase from Well A to Gurleyville Road (just downstream of Well D). This implied that the operation of Well D during low-flow periods could be managed "within" the natural amount of streamflow gain while avoiding the exacerbation of any loss of instream flow upstream near Well A.

Although it was beyond the scope of the Fenton River Study to focus on Well D in a more detailed manner, it was understood by UConn that the potential use of Well D with certain restrictions may be feasible while mitigating impacts to the river. In response to the dry conditions that persisted from mid-2007 to the end of the year resulting in the shutdown of the wellfield, UConn commissioned a simulation study to characterize the impacts of pumping Well D on the Fenton River in more detail. The results of the modeling effort (discussed in the 2011 *Wellfield Management Plan*) were sufficiently favorable that the prospect of utilizing Well D during prolonged dry periods was included as early as Stage IB in the 2008 draft Drought Response Plan.

Milone & MacBroom, Inc. (MMI), with the assistance of NEWUS and UConn, conducted a pumping test of Well D and study of streamflows in the Fenton River in September 2010 as discussed in the previous 2011 *Wellfield Management Plan*. The primary objective of the field study was to provide additional support for the use of Well D during periods of low flow in the river. Secondary objectives were to modify the recommendations of the Well D modeling study where possible relative to the pumping rates, duration of pumping, and ability to pump Well D when streamflow drops below 1.0 cfs.

Based on the result of this pumping test, UConn recognized that Well D was not sufficient for restoring the full capacity of the Fenton River Wellfield. Furthermore, use of Well D throughout the late spring and summer leading up to the typical driest month (September) was not a prudent use of water resources. Therefore, UConn proposed to use Well D only in September and October as presented in the previous 2011 *Wellfield Management Plan*.

Subsequent discussions with the DEEP revealed that the use of Well D in September and October of each year may be acceptable provided the withdrawal volumes were maintained within the natural streamflow gain within the river reach. Additional field studies were completed by MMI in 2014 and 2015 to further evaluate the effect of pumping Well D on the instream flow of the Fenton River. These studies culminated in the report *Low Flow Study of Fenton Well D* dated February 26, 2016.

The aforementioned report was submitted to the DEEP in 2017. DEEP ultimately approved Well D for use "at up to 0.213 million gallons per day as a back-up well as needed, in accordance with the referenced request" by letter dated August 25, 2017. A copy of this letter is provided in Appendix B. Because the referenced request was related to the use of Well D when the other wells at the Fenton River Wellfield would have otherwise been offline, UConn has interpreted this letter to mean that Well D is available as a back-up well in September and October of each year provided one or more of the Willimantic River Wellfield wells is offline. Refer to the available water discussion in the 2020 *Water Supply Plan* for more details.

3.0 REVIEW OF THE WILLIMANTIC RIVER STUDY

3.1 Purpose

UConn's "Willimantic River Study" was published in June 2010 with the formal name *Report of the Willimantic River Study: An Analysis of the Impact of the University of Connecticut Water Supply Wells on the Fisheries Habitat of the Willimantic River*. Similar to the Fenton River Study, the Willimantic River Study was conducted to determine whether and, if so, how water withdrawals from the Willimantic River Wellfield affect the fisheries habitat of the Willimantic River in the vicinity of the wellfield. The Willimantic River Study was triggered by the November 6, 2006 *Memorandum of Agreement* with the Connecticut Water Planning Council in which UConn agreed conduct a study for the Willimantic River Wellfield similar to that conducted for the Fenton River Wellfield. The Willimantic River Wellfield is depicted on Figure 3-1.

The specific objectives of the Willimantic River Study were to:

- Develop relationships between instream flow and habitat in the Willimantic River for selected fish species;
- Derive the relation between the magnitude and timing of groundwater withdrawals on the stage and flow of water in the Willimantic River from Merrow Road to Mansfield Depot using existing data, new data collection, and mathematical simulation modeling; and
- Numerically model selected water-management scenarios to optimize water withdrawals while minimizing adverse impacts on stream flow and instream habitat.

3.2 Findings

The Willimantic River is a complex system in the vicinity of the Willimantic River Wellfield. There are several gaining and losing reaches throughout the study area that can vary in response to precipitation patterns and timing. In general, during non-pumping conditions the Willimantic River tends to gain flow in the downstream direction including during times of prolonged dry weather.

The IFIM was used to evaluate the potential effects of reductions in river flow associated with withdrawal of water at the Willimantic River Wellfield on the habitats of representative fish species in the Willimantic River. Target fish species included brook trout, brown trout, fallfish, and common shiner.

Simulation of river hydraulics and aquatic habitat was performed using computer models collectively known as PHABSIM. The hydraulic simulation models of PHABSIM are used to predict changes in depth, velocity, and wetted area at various river flows. The aquatic habitat simulation models generate a composite suitability function collectively referred to as Habitat Suitability Criteria (HSC) derived from curves representing the depth, velocity, and substrate preferences of selected target species/life stages. The aquatic habitat simulation models integrate the output of the hydraulic simulation models with the HSC to yield an estimate of WUA.

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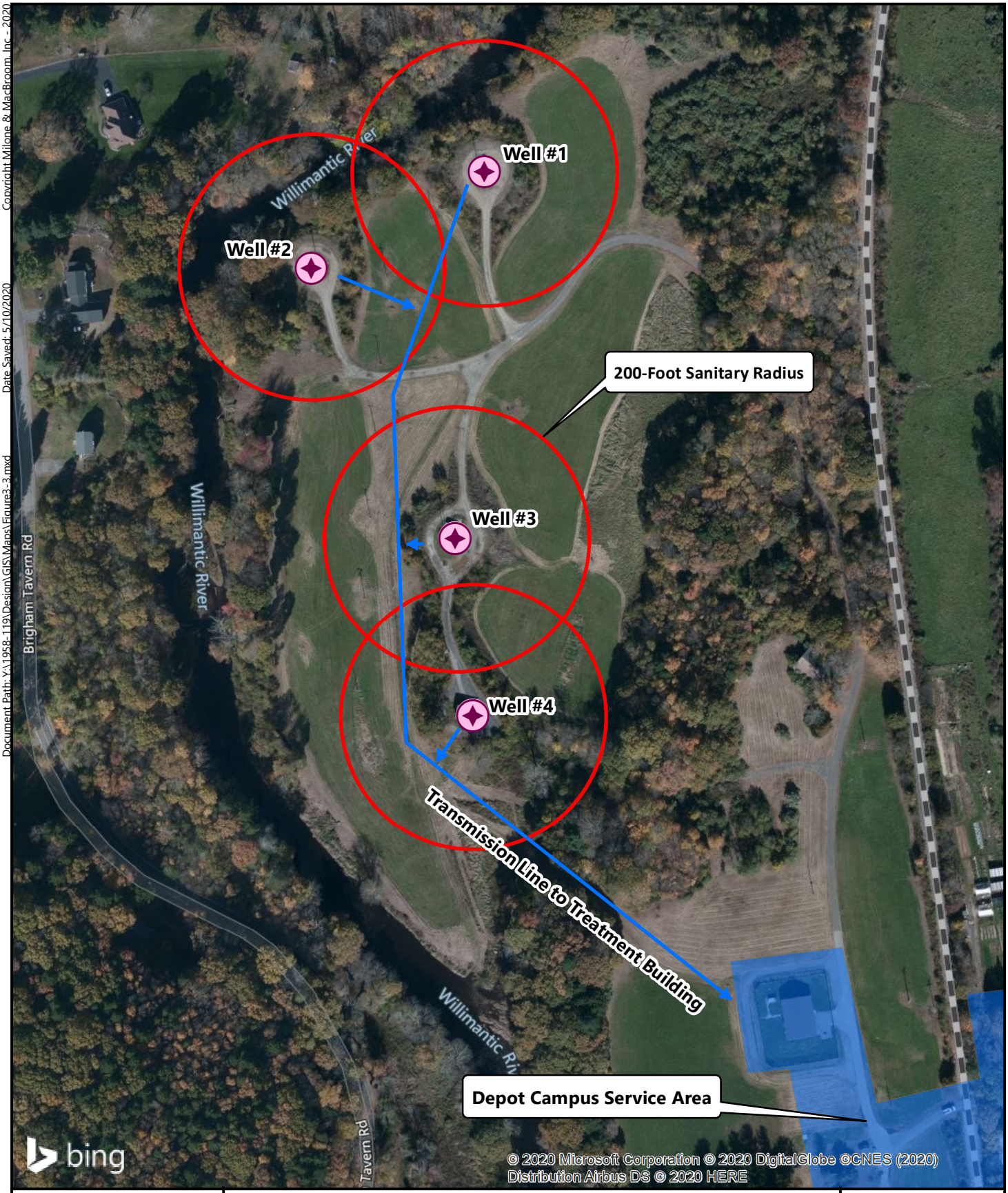

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WILLIMANTIC RIVER WELLFIELD

WATER SUPPLY PLAN
UNIVERSITY OF CONNECTICUT
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MANSFIELD, CT

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FIG. 3-1

Field data collection for the IFIM spanned 2008 and 2009. Aquatic habitats were mapped to determine the percentage of all significant mesohabitat types in the study area. Nine representative reaches of the significant mesohabitats were selected based on the aquatic habitat mapping, with representative transects selected within those reaches. Velocity, depth, substrate, cover, bed elevations, and water surface elevations were surveyed at each transect during five calibration discharges.

The USGS has operated a long-term real-time gauging station on the Willimantic River (the "Coventry" gauge) since 1931. Flow statistics from this site have been published by the USGS. The 99% duration discharge of the Willimantic River (approximately equivalent to the 7Q10 discharge) is estimated to be 11 cfs. The published mean daily discharge values were modified to represent discharge at the Willimantic River Wellfield by correcting for water supply withdrawals, wastewater discharges, and drainage basin area. The lowest recorded mean daily discharge at the wellfield since 1958 is believed to be approximately 6.0 cfs in August 1999 during a prolonged dry period.

The PHABSIM output provided relationships between WUA and discharge for each target fish species. The mean daily streamflow dataset calculated for the wellfield and the WUA to discharge relationships for each target species were then used to perform habitat time-series and UCUT analyses. These analyses evaluated the magnitude, frequency, and duration of various discharge-related habitat events for the target species. The results of the UCUT analysis are summarized in Table 3-1.

A hydrogeologic study was performed to evaluate the effects of sustained pumping on the aquifer under various river discharges. The objective was to collect data during three different combinations of river flow regime (low to moderate for the first event, low to moderate for the second event, and low for the final event) and wellfield operation (low for the first event, moderate for the second event, and high for the final event). Each monitoring event consisted of a 72-hour constant-rate pumping test.

Data collection included water levels measured at existing monitoring wells and at 12 piezometers installed for the study as well as temperature monitoring at each piezometer and along the thalweg of the river. In addition, river flow was measured consistent with USGS methods at locations upstream of, downstream of, and at the USGS gauging station at the wellfield in order to determine if direct impacts to river discharge could be detected. Automatic dataloggers were used to assist with data collection and were installed in one monitoring well and in four of the piezometers.

The drawdown due to pumping of the Willimantic River wells can cause the groundwater table in the vicinity of the river to fall below the river water surface and, in some locations, below the riverbed elevation. In these cases, water will infiltrate from the riverbed into the ground water system (i.e., induced infiltration). The piezometer and temperature data provided an estimate of the area of influence of the wellfield, which is believed to extend from slightly south of the wellfield and along the stratified drift aquifer to the northwest into Coventry.

A numerical model was originally constructed using the USGS program MODFLOW-2000 for the vicinity of the Willimantic River Wellfield during the Level A Aquifer Protection Area study. The Level A model was updated in this study to further characterize the Willimantic River and its interactions with the underlying aquifer. A pumping test conducted in 1999 and the three monitoring events performed during the 2008 hydrogeologic study were used to calibrate and verify the updated model.

TABLE 3-1
Percent of Maximum WUA, Discharge, and Persistent Duration of Common, Critical, Rare, and Extreme Habitat Thresholds for Target Fish Community

Habitat Stressor Threshold	Parameter	Result
Common (Upper Subregion)	Habitat (% Max WUA) Discharge (cfs) Persistent Duration (days)	44% 27 19
Common (Lower Subregion)	Habitat (% Max WUA) Discharge (cfs) Persistent Duration (days)	34% to 49% 19 19
Critical	Habitat (% Max WUA) Discharge (cfs) Persistent Duration (days)	28% 15 13
Rare	Habitat (% Max WUA) Discharge (cfs) Persistent Duration (days)	24% 12 12
Extreme	Habitat (% Max WUA) Discharge (cfs) Persistent Duration (days)	19% 7.8 7

The updated numerical model was used to simulate the timing and magnitude of pumping on the stage and discharge in the Willimantic River under various management scenarios. First, the four existing production wells and eight theoretical production well locations within the model area were simulated to determine the timing of pumping impacts. The model output suggests that the Willimantic River will have a slightly delayed response to pumping with reductions of discharge in the Willimantic River occurring as soon as nine hours after pumping begins for wells close to the river.

The existing wells and several of the theoretical wells were then simulated under 11 pumping management scenarios to determine if withdrawals can be managed to minimize adverse habitat impacts while meeting water supply demands. The model output for the management scenarios suggested that while there are combinations of wellfield withdrawals that will provide lower impact overall to instream flow through the model area, the difference in river flow reduction between the existing wellfield operation and the best modeled condition has a delta of only 0.31 cfs. It is believed that water conservation measures are more cost effective than constructing and permitting new water supply wells to achieve this very small incremental benefit.

3.3 Conclusions

The Willimantic River consistently conveys more water at the Willimantic River Wellfield than the Fenton River conveys at the Fenton River Wellfield. For this reason, it has historically been considered the more appropriate river for supporting public water supply withdrawals. The instream flow study portion of the Willimantic River Study resulted in some distinctive findings, especially when compared to the Fenton River Study:

- It is extremely unlikely that the Willimantic River Wellfield would be capable of running the Willimantic River dry, as the maximum legal withdrawal of 2.3077 mgd is equivalent to 3.6 cfs, and 3.6 cfs is approximately 60% of the value of the lowest instream flows believed to have occurred in the river near the wellfield.

- From the perspective of fish habitats, a very low flow may be "rare" on the Willimantic River but not especially rare on the Fenton River. As a result, the UCUT curves for the Willimantic River are shifted in comparison to the UCUT curves for the Fenton River, and differentiation of the common, critical, extreme, and rare thresholds is more challenging.

- The critical threshold for the Fenton River occurs around 15% of maximum WUA whereas the critical threshold for the Willimantic River occurs around 30% of maximum WUA.

- Fish species in the Willimantic River routinely experience a relatively lower loss of habitat than fish species in the Fenton River. In other words, fish "enjoy" a relatively greater amount of habitat in the Willimantic River.

- Nevertheless, a strict interpretation of the UCUT curves for the Willimantic River would tend to call for protection to a higher standard (maintaining a greater percent of maximum WUA for each species) than the interpretation of the UCUT curves for the Fenton River.

- If cutbacks in wellfield withdrawals were linked with the common, critical, extreme, and rare thresholds, the Willimantic River would be asked to protect a proportionally greater quantity of habitat than the Fenton River (nearly double for the critical flow) largely because it conveys more water.

- However, unlike the Fenton River where the common, critical, rare, and extreme habitat stress thresholds can be met in a matter of hours from one to the next, the Willimantic River may require several days to pass through these thresholds. This will allow for a more methodical response from UConn.

The hydrogeologic study portion of the Willimantic River Study has resulted in an updated numerical model that works well under a variety of wellfield pumping scenarios. Some distinctive findings include the following:

- Effects of wellfield withdrawals are manifested in reduced ground water discharge and induced infiltration within nine to 16 hours for each existing well. In addition, the ratio of ground water withdrawals to reduced instream flow is nearly one-to-one in the short term and equal to one-to-one under continuous steady pumping conditions. Therefore, the relationship between wellfield withdrawals and reduced ground water discharge/induced infiltration is relatively immediate and direct.

- Only a minimal overall benefit can be gained by relocating wells. The time lag between pumping and impact to the river is difficult to increase by moving wells further away because the aquifer is narrow.

- A very minor (0.31 cfs) benefit to proximal riffle habitats can be gained by shifting some of the ground water withdrawals downstream, but the net effect will be the same at the downstream end of the study area over the long term.

- This low benefit to streamflow suggests that an investment in moving or replacing infrastructure to reduce the effect on instream flow will not be as cost effective as additional water conservation measures or development of new sources of supply.

3.4 Recommendations

The recommendations of the Willimantic River Study were aimed at reducing demand through the use of conservation measures rather than setting specific production cutbacks. The results of the UCUT analyses were correlated to the 2008 draft Drought Response Plan and the *Emergency Contingency Plan* in place at that time as shown in Table 3-2. The time lapse between each trigger level was found historically to be approximately four to six days.

TABLE 3-2
Recommended Willimantic River Drought Trigger Levels and Corresponding Management Response

Response Stage	Willimantic River at Wellfield Trigger Discharge	Examples of Conservation Measures
Prepare for implementation of Stage IA	Discharge ≤ 27 cfs	None / Preparation for Stage IA
Stage IA (Two potential triggers)	Discharge < 27 cfs for 19 or more days	Voluntary: Shorter showers, condensed washing loads, elimination of nonessential consumption, raise thermostats on centrally chilled buildings
	Discharge < 19 cfs	
Stage IB	Discharge < 15 cfs	
Stage II (Two potential triggers)	Discharge < 15 cfs for 13 or more days	Voluntary items above become mandatory and include (but are not limited to) the following mandatory items: No flushing of hydrants, pipes, or sewer lines; no vehicle fleet washing; no use of water for street sweeping; reduce irrigation by 50%; reduce operation of research equipment cooled with domestic water; import water needed for construction dust control; no pool filling; raise thermostats of centrally chilled buildings
	Discharge < 12 cfs	
Stage III (Two potential triggers)	Discharge < 12 cfs for 12 or more days	
	Discharge < 7.8 cfs	
Stage IV	Discharge < 7.8 cfs for 7 or more days	

The formal recommendations of this study were divided into Demand-Based Water Conservation recommendations and Supply Management recommendations. Recommendations (in *italics*) for Demand-Based Water Conservation included:

1. *Incorporate the trigger discharges into the (2008 draft) Drought Response Plan*. Discharges measured by the USGS at the Merrow Road gauging station are used to determine when triggers are met. The precise

methodology that UConn uses to activate and deactivate conservation measures and to formally link these trigger thresholds to appropriate response and recovery guidelines is discussed in Section 5.0 of this 2020 *Wellfield Management Plan*. These triggers will be revisited as appropriate when changes in supply occur.

2. *Incorporate mandatory conservation measures for both on- and off-campus users, including residential, municipal, and commercial customers*. This process will continue using the 2020 *Water Conservation Plan* as a guide.

Recommendations for Supply Management (in *italics*) included:

1. *Develop a combined Willimantic River Wellfield – Fenton River Wellfield Management Plan to manage UConn's water supplies, including a strategy of how UConn will correlate upstream discharges to the discharge triggers for protection of fisheries habitat, a formal update to the Drought Response Plan, and authorization for limited but occasional use of the Fenton River Wellfield when it would otherwise be shut down*. The subject document fulfills this recommendation.

2. *Complete the design and construction of the Reclaimed Water Facility*; operational since 2013.

3. *After the Reclaimed Water Facility is operational, UConn should ensure that the increment of water freed from non-potable usage (e.g. Central Utility Plant) will be partially allocated to instream needs as well as new potable demands that may arise in the future in an equitable manner*. As noted in the 2020 *Water Conservation Plan*, expansion of the campus greywater system would reduce future potable water demands. Furthermore, completion of the CWC interconnection has greatly reduced withdrawals from the wellfields by transferring off-campus customer demands to CWC. A specific allocation for future demands is not believed necessary at this time.

4. *Consider future ground water supplies downstream of the Willimantic River Wellfield in a location where instream flows would be higher than they are at the existing wellfield, and/or fish habitats would be less sensitive to flow reductions*. Such locations were more fully evaluated in the Potential New Sources of Water Supply EIE completed in 2012. These sites were found to be able to individually contribute only a small increment of additional supply and are not believed to be cost-effective at this time.

5. *Pursue interconnections with the Connecticut Water Company's Northern Region/Western System and Windham Water Works, which UConn could utilize for supply during drought periods*. Connection to the CWC Western system was completed in late 2016.

6. *Consider provision of short-term or pulsed releases from the Staffordville Reservoir, Crystal Lake, and/or State Line Pond. Other waterbodies may also be available to make such releases. This will require cooperation with the dam owners and the parties that control the impoundments and the dam outlet works*. No plans are in place to move forward with this recommendation at the present time. It may be the next logical step if UConn were eventually able to withdraw the full registered capacity of the Willimantic River Wellfield (2.3077 mgd) using the existing wells, because it would enable greater protection of the adjacent section of the river while UConn utilized the wellfield to its full legal potential.

4.0 SYSTEM OPERATIONAL HISTORY

Operation of UConn's water system can be divided into six distinct operational periods based on source availability:

- Pre-Fenton River Wellfield (prior to 1926);
- Fenton River Wellfield as sole source of supply (1926 to 1972);
- Fenton River Wellfield and Willimantic River Wellfield (1969 to 2006);
- Subsequent to Fenton River Study (2006 to 2010);
- Subsequent to Willimantic River Study (after 2010) and the initial 2011 *Wellfield Management Plan* (2011 to 2016); and
- Subsequent to the CWC interconnection (2017 to present).

The Fenton River Wellfield provided 100% of the water to the UConn Main Campus system from 1926 until 1972, at which point a 16-inch transmission line was installed from the Willimantic River Wellfield to the Main Campus. After that time, the Willimantic River Wellfield began to provide an increasing percentage of the overall supply. The operational periods subsequent to 1969 are therefore of most interest to this *Wellfield Management Plan* because both wellfields were available. These four periods are discussed in detail below.

4.1 System Operation Prior to 2006

4.1.1 Pre-1990s

Limited records exist detailing the day-to-day operation of the Fenton River Wellfield in relation to the Willimantic River Wellfield prior to the 1990s. It is believed that neither of the two wellfields was shut down for more than a few days at the time. Anecdotal data collected during the Willimantic River Study suggested that during the 1970s UConn would operate the Fenton River Wellfield and the Willimantic River Wellfield on alternate days during low-flow periods. However, it is more likely that the Fenton River Wellfield was pumped intermittently whereas the Willimantic River Wellfield pumped continually (albeit at a potentially lower rate on intermittent days) because UConn still needed to provide Mansfield Training School with water, and only the Willimantic River Wellfield could provide that water.

Water demand increased throughout the 1980s and peaked in 1989, corresponding to the peak on-campus enrollment during that decade. The Willimantic River Wellfield provided approximately 70% of the water (an average of 1.65 mgd) used by UConn and Mansfield Training School in 1989.

4.1.2 1990s-2006

The period 1989 through 1997 corresponded to a decline in overall water usage at UConn. Mansfield Training School closed in 1993 and was transferred to UConn, becoming the Depot Campus. Total annual water usage was at its lowest during this period in 1997 at 412 million gallons. Enrollment increased again in 1997 and 1998, and off-campus uses such as E.O. Smith High School increased enrollment, while during the same time period the Bergin Correctional Facility opened near the Depot Campus. The increase in the number of users at the end of the decade was counteracted by water conservation measures instituted by the UConn 2000 projects. In 1998, UConn used an average of 1.15 mgd, with 83% of the water coming from the Willimantic River Wellfield; however, the Fenton River Wellfield remained an important supply.

As the UConn 2000 project and the 21st Century UConn initiative continued, UConn expanded and water demands began to increase, though at a rate mitigated by continued water conservation efforts. Total water usage was approximately 469 million gallons in 2003, an average rate of 1.29 mgd. The Willimantic River Wellfield continued to provide the majority (approximately 82%) of water produced, but the Fenton River Wellfield was still used year-round.

4.2 System Operation Subsequent to Fenton River Study

The findings and recommendations of the Fenton River Study placed restrictions on the amount of water production that could be contributed by the Fenton River Wellfield. Daily withdrawals at the wellfield were reduced during low-flow periods based on recommendations 8 through 12 listed in Section 2.4 of that previous study. From 2006 to 2011, UConn typically shut down the Fenton River Wellfield completely after flow in the Fenton River reached 6.0 cfs if a prolonged dry period was predicted in order to avoid navigating through the operational requirements associated with pumping reductions. UConn occasionally operated the Fenton River Wellfield wells for testing and maintenance purposes during the low-flow periods, but typically such actions did not produce more than 25,000 gpd from any well. More recently, well and treatment system improvements have allowed UConn to operate the wellfield in accordance with the protocols as flows fall from 6.0 to 3.0 cfs.

A second operational change that occurred following the Fenton River Study was the hiring of UConn's first contract operator of its water system, New England Water Utility Services (NEWUS), in August 2006. Prior to that time, the UConn water system had been operated by certified UConn personnel. NEWUS has helped to modernize many of the systems at the two wellfields.

4.2.1 Case Study: 2007 Low-Flow Period

The Fenton River Wellfield was shut down on July 26, 2007 in response to seasonal low flows in the Fenton River. The wellfield had been minimally used prior to that date due to system improvements (i.e., installation of a new booster pump with variable frequency drive and a rebuild of Well D). The dry period persisted through the end of the year, and the wellfield remained offline through January 2008. During this time, the Willimantic River Wellfield provided 100% of the system water needs, and UConn implemented conservation measures to try and minimize the stress to the Willimantic River wells.

A "Stage IA Water Conservation Alert" was issued on August 6, 2007 by UConn in accordance with the *Emergency Contingency Plan* in effect at that time. System users were asked to voluntarily conserve water. The request for voluntary conservation was the first stage of UConn's five-step emergency triggers. The triggers for subsequent steps were based on a combination of operational factors including projected available supply, projected water usage, and tank storage levels.

As a result of the start of the fall semester on August 27, 2007, the water demand on the system increased from approximately 1.2 mgd to 1.7 mgd. System demand peaked at over 1.8 mgd for three consecutive days leading up to August 31. UConn entered Stage IB of its emergency triggers on September 4 and entered Stage II Watch on September 5, 2007.

The activation of the Stage II Watch caused UConn to immediately initiate mandatory conservation measures, supplementing the voluntary conservation measures already in place. In addition to the mandatory conservation measures identified in the *Emergency Contingency Plan*, UConn raised room temperatures by four degrees Fahrenheit and began serving breakfast and lunch on paper plates at dining halls. In mid-September, the control

settings for the Bone Mill tank at the Depot Campus were changed to allow for the tank to refill on a daily basis (as opposed to every third day) to even out spikes in demand associated with the diversion of water to the Depot Campus system.

Following a period of sporadic precipitation and cooler temperatures that served to moderate the impact of the drought on the surface and ground water levels and further lessen demand, UConn was able to lift its Stage II Watch on October 29, 2007. A "Water Conservation Alert" (voluntary conservation) remained in effect into November.

The Willimantic River Study estimated that these conservation measures reduced production by 10% (as compared with 2006 production data) over the five-month period that the Fenton River Wellfield was offline. However, the decline in production may have also been influenced by other less tangible factors.

If the Willimantic River Study recommendations had been in place, UConn would have entered the following stages of water conservation throughout the prolonged dry period in 2007:

- Stage IA/IB in mid-August;
- Stage II in late August;
- Stage III and Stage IV in early September; and
- Stage II for the remainder of September.

Note that the Willimantic River protocols would have caused an earlier onset of Stage IB and Stage II. Furthermore, Stage III and Stage IV would have occurred, whereas they were not triggered in 2007.

4.3 System Operation Subsequent to Willimantic River Study

The Willimantic River Study was published in June 2010. The operational recommendations were aimed at reducing demand through the use of conservation measures rather than setting specific production cutbacks. The streamflow response triggers were correlated to the five stages of the 2008 draft Drought Response Plan in terms of the voluntary or mandatory conservation measures to be enacted.

4.3.1 Case Study: 2010 Low-Flow Period

The operational recommendations of the Willimantic River Study were quickly put into effect in the dry summer of 2010. The Fenton River Wellfield was taken offline on June 28, 2010 in response to low flows in the Fenton River, leaving the Willimantic River Wellfield as UConn's sole source of supply. As the 2008 draft Drought Response Plan was originally written to provide operational recommendations based on the amount of stored water available, and UConn had no problems with storage or with wellfield hydraulics in 2010, it became apparent that environmental triggers would tend to override the operational triggers listed in the plan.

UConn notified customers by letter dated July 6, 2010 of the need to conserve water (Stage IA) and requested that system users voluntarily limit their water use. This action, triggered by the onset of seasonally low surface water flows in both the Fenton and Willimantic Rivers, was consistent with UConn *Emergency Contingency Plan* in place at that time and the Willimantic River Study. The following water conservation measures were suggested:

- Take short showers and turn off the water flow when soaping and shampooing.
- Use the appropriate water level or load size selection on the washing machine.

- Use water only as needed when washing dishes, shaving, and brushing teeth. Do not let the faucet run unnecessarily.
- Run dishwashers only when completely full.
- Use of public water to wash building exteriors, driveways, sidewalks, or a vehicle is discouraged.
- Reconsider pouring water down the drain when there may be another use for it.
- Immediately report any leaky fixtures in UConn buildings to Facilities Operations.

On August 13, 2010, UConn issued a Stage II Watch when flows in the Willimantic River hit triggers established in the Willimantic River Study. In addition to continuing the voluntary conservation measures requested beginning on July 6, UConn implemented certain mandatory conservation restrictions including:

- Lawn watering for all users was limited to four hours or less per day and only between the hours of 5 A.M. and 9 A.M. and 7 P.M. to 9 P.M. Athletic fields were allowed up to two hours of water per day during the same hours.
- Filling of public or private pools was only provided via water from a non-UConn source.
- Washing of motor vehicles was banned. UConn's wash bay was closed.
- The use of ornamental or display fountains was banned.
- The use of water for washing and wetting down streets, sidewalks, driveways, or parking areas was banned unless required by the local health authority.
- The use of UConn water for dust control at construction sites was banned. Contractors were required to provide water for dust control from an outside source.
- The use of hydrant sprinkler caps was banned.
- Water main flushing was only allowed to be used to address acute water quality issues.

On September 13, 2010, UConn issued a Stage III Warning as flows in the Willimantic River continued to recede and hit persistent low-flow triggers established in the Willimantic River Study. The Stage III request reinforced the need to conserve water and reiterated those restrictions identified during the prior advisory communication. In an effort to conserve additional water resources, on September 27, 2010 the Department of Dining Services began using paper plates and cups and plastic silverware in all eight residential dining halls. This activity was believed to save an additional 30,000 to 40,000 gallons of water per day.

System production during the first three weeks of September 2010 was 1.64 mgd, slightly higher than the production realized during 2008 and 2009 when system production in September was 1.58 mgd and 1.59 mgd, respectively. In spite of this slight increase, the 2010 figures compare favorably with these prior years when demands (especially those of the Central Utility Plant for cooling purposes) were depressed due to the relatively milder weather. While it is difficult to quantify the impact conservation measures had on water usage in 2010, the data suggest that UConn's conservation efforts reduced water consumption below what would otherwise be expected for similar conditions.

The mandatory water conservation measures were lifted on October 25, 2010 due to rainfall increasing the amount of flow in the Willimantic River. UConn remained on a Stage IA conservation notice until the Fenton River flow was deemed sustainable above 3.0 cfs on November 11, 2010.

As outlined by the procedures in the initial 2011 *Wellfield Management Plan*, UConn is now in a unique position of gearing up for water conservation in any given year, and then requiring mandatory conservation during any year that is drier than normal. Adjustments to wellfield operating protocols and drought responses were therefore clearly necessary as performed in the initial 2011 *Wellfield Management Plan*.

4.3.2 Case Study: 2016 Low-Flow Period

The operational recommendations of the Willimantic River Study were again put into effect in the late summer of 2016, when drought conditions were again experienced at the Storrs Campus. The Fenton River Wellfield was taken offline on June 23, 2016 in response to low flows in the Fenton River, leaving the Willimantic River Wellfield as UConn's sole source of supply. Similar to 2010, UConn had no problems with storage or with wellfield hydraulics in 2016, and again environmental triggers overrode the operational triggers.

UConn notified customers of a Stage IA - Water Conservation Alert by letter dated June 28, 2016 and requested that system users voluntarily limit their water use. This action, triggered by the onset of seasonally low surface water flows in both the Fenton and Willimantic Rivers, was consistent with the 2011 *Emergency Contingency Plan* and the Willimantic River Study. The following water conservation measures were suggested:

- Taking short showers.
- Running dishwashers and clothes washing machines with full loads.
- Shutting off water while washing dishes, shaving, brushing teeth, and lathering up to wash hands, rather than running the water continuously.
- Avoiding vehicle washing or power-washing homes and other buildings.
- Not using water to clean sidewalks, driveways, and roads.
- Reducing, to the extent possible, the water of lawns, recreational and athletic fields, gardens, or other landscaped areas (if watering is essential, late-evening hours are best).
- Not using public water to fill residential swimming pools.

On August 29, 2016, UConn issued a Stage IB - Water Supply Advisory, reminding users of the need to conserve water and repeated the request that system users voluntarily limit their water use using the same methods described in the Stage IA letter.

On September 1, 2016, UConn issued a Stage II - Water Supply Watch that included mandatory and voluntary water conservation measures. The Stage II notification was issued when flows in the Willimantic River hit triggers established in the Willimantic River Study. Voluntary conservation measures that were requested included:

- Take shorter showers.
- Run dishwashers and washing machines with full loads.
- Use water only as needed when washing dishes, shaving, and brushing teeth.
- Avoid power washing buildings and washing vehicles with public water.
- Raise the thermostat in UConn buildings, particularly when leaving at night.
- Immediately report leaky fixtures in UConn buildings to Facilities Operations (486-3113)

Also, UConn implemented certain mandatory conservation restrictions including:

- Lawn watering for all users is limited to four hours or less per day and only between the hours of 5 a.m. to 9 a.m. and 7 p.m. to 9 p.m. Athletic fields will be allowed up two hours of water per day during the same hours.
- Filling of public or private pools must be provided via water delivered from another source.
- Washing of motor vehicles is banned. The UConn's wash bay will be closed until further notice.
- The use of ornamental or display fountains is banned.

- The use of water for washing and wetting down streets, sidewalks, driveways, or parking areas is banned unless required by the local public health authority.
- The use of UConn water for dust control at construction sites is banned. Contractors are required to provide water for dust control from off-site.
- The use of hydrant sprinkler caps is banned.
- Water main flushing will only be used to address water quality issues.

On September 7, 2016, UConn issued a Stage III - Water Supply Watch as flows in the Willimantic River continued to recede and hit persistent low-flow triggers established in the Willimantic River Study. The Stage III request reinforced the need to conserve water and reiterated those voluntary and mandatory restrictions identified during the prior Phase II advisory communication.

On September 15, 2016 UConn issued a Stage IV - Water Supply Emergency due to continued decrease in flows at the Willimantic River. The mandatory and voluntary water conservation measures outlined in the Stage III notification were repeated in the Stage IV notification.

The Stage IV - Water Supply Emergency restrictions were lifted in November 2016, but a letter issued November 17, 2016 indicated Stage III mandatory and voluntary conservation measures would remain in effect. On December 21, 2016, a letter was issued rescinding Stage III and II restrictions but noting that the Storrs Campus remained in a Stage IA condition and voluntary water conservation measures were still necessary. Residents and businesses in the community were requested to continue to conserve water by reducing demand by 15%. Finally, on March 3, 2017, flows in the Willimantic River were such that the Stage IA alert was rescinded, but UConn noted Tolland County was still under a Drought Watch issued by the State of Connecticut, and residents and businesses were asked to continue water conservation measures that would reduce their use by some 15%.

System production in August 2016, up to August 29, was 0.92 mgd, which was slightly higher than the production in July 2016 (0.86 mgd), and consistent with production levels in 2015 (0.96 mgd) and 2014 (1.05 mgd). In spite of this slight increase, the 2016 figures compare favorably with prior years. While it is difficult to quantify the impact conservation measures had on water usage in 2016, the data suggest that UConn's conservation efforts reduced water consumption below what would otherwise be expected for similar conditions.

4.4 System Operation Subsequent to CWC Interconnection

Based on the contractual agreements between UConn, CWC, and the Town of Mansfield completed in 2013 and 2014, nearly all of UConn's former off-campus customers were transferred to being customers of CWC once the CWC interconnection was completed in late 2016. This greatly reduced demands on the UConn water system, as water for those customers was now offset by water entering the UConn system from CWC. The completion of the Reclaimed Water Facility in 2013 also greatly reduced demands by allowing the use of non-potable water to meet certain needs such as at the Central Utility Plant.

With the completion of the CWC interconnection, the Fenton River Wellfield is now considered to be a supplemental source of supply for UConn from an available water standpoint. The CWC interconnection is now the secondary source of supply. As such (and as explained in the 2020 *Emergency Contingency Plan*), the expected seasonal shutdown of the Fenton River Wellfield is no longer considered a potential emergency situation and does not necessarily trigger water conservation measures.

4.4.1 Case Study: 2017 Low-Flow Period

In the fall of 2017, drought conditions were again experienced at the Storrs Campus. The Fenton River Wellfield was taken offline on September 21, 2017 in response to low flows in the Fenton River, leaving the Willimantic River Wellfield as UConn's primary source of supply. Similar to 2010 and 2016, UConn had no problems with storage or with wellfield hydraulics in 2017, and again environmental triggers overrode the operational triggers.

UConn notified customers of a Stage IA - Water Conservation Alert by letter dated September 25, 2017 and requested that system users voluntarily limit their water use. A copy of this letter is included in Appendix C.

Flows in the Willimantic River were consistently at or near Stage IA conditions for most of the fall of 2017, but river flows never decreased to the point where additional triggers were reached. On December 4, 2017, precipitation had restored flows in the Willimantic River to pre-drought conditions and the Stage IA alert was rescinded. As a precautionary measure, UConn's notification letter still requested residents and businesses to continue water conservation measures noted in the Stage IA Alert issued in September.

System production during the early part of September 2017 was averaging 1.22 mgd, which was lower than historical demand patterns, and likely influenced by the transfer of off-campus users to CWC which supplied those users through the new interconnection. It is difficult to quantify the impact conservation measures had on water usage in the fall of 2017, because production data has been exhibiting continuous downward trends based on several factors, including the transfer of former off-campus users to CWC, reduced demands on potable water system due to the use of the reclaimed water facility, leak detection efforts, continued UConn water system upgrades that reduced leaks, construction/renovation projects that have increased water efficiency, and the short duration of the 2017 drought condition. These are all in addition to the water conservation measures requested of water users.

Note that drought conditions were never realized in 2018 and 2019 which were very wet years. Despite the abundant availability of water in 2018 and 2019 and continued new construction of buildings per the UConn 2015 Campus Master Plan, water production continued to decrease during these two years for all of the reasons described above.

5.0 PROTOCOLS FOR CONJUNCTIVE USE OF SUPPLIES

The following protocols are the guidelines by which UConn shall manage its water system during normal and low-flow periods. Emergency situations are not considered – such situations and the appropriate response protocols are outlined in the 2020 *Emergency Contingency Plan*.

5.1 Interpretation of USGS Gauging Station Discharge

The Fenton River Study and the Willimantic River Study both recommended utilizing an upstream USGS-maintained gauging station to determine the discharge that is approaching each wellfield. These two gauging stations are real-time USGS stations that can be monitored on the internet at the following world-wide web addresses:

- Fenton River gauge: http://waterdata.usgs.gov/nwis/uv?01121330
- Willimantic River gauge: http://waterdata.usgs.gov/nwis/uv?01119382

The Fenton River Study recommended using a direct reading of the Old Turnpike Road gauge to determine the amount of discharge in the Fenton River. This reading would allow the wellfield to be managed through the reductions and eventual cessation of withdrawals as upstream discharge fell from six cfs to three cfs and below.

The Willimantic River Study was different in that demand management (voluntary and mandatory conservation) was recommended as opposed to supply management (reductions or cessations in withdrawals). The environmental triggers are based on levels of flow downstream of the Willimantic River Wellfield in the study reach. Since the daily withdrawal typically varies in response to system demand, an adjustment to the direct reading from the Merrow Road gauge is recommended based on the average pumping rate for the previous seven days, as shown by the following equation:

- USGS discharge – [Previous seven day average withdrawal rate from Willimantic River Wellfield (gallons) x 0.13368 / 24 / 60 / 60] = Discharge Downstream of the Wellfield

UConn may utilize the above equation to correct the USGS discharge at Merrow Road to a representative discharge downstream of the Willimantic River Wellfield. It is this adjusted discharge that would be compared to the Willimantic River streamflow triggers discussed in Section 5.3.

5.2 Normal Operation Procedures

Under normal environmental conditions, UConn has sufficient available supplies to meet the current and future committed demands on its water system with minimal environmental impact. According to Section 3.9 of the 2020 *Water Supply Plan,* available supply from the Fenton River Wellfield is limited to 0.844 mgd (diversion registration), and available supply from the Willimantic River Wellfield is limited to 2.15 mgd based on either well pump capacity or safe yield. Note that UConn also has up to 1.5 mgd contractually available through the CWC interconnection.

Assuming a long-term one-to-one ratio between aquifer pumping and streamflow loss, these values equate to a maximum loss of streamflow of 1.31 cfs downstream of the Fenton River Wellfield and 3.32 cfs downstream of the Willimantic River Wellfield. According to the Fenton River Study, when flows in the Fenton River (as measured at Old Turnpike Road) are greater than 10 cfs, there is no discernable environmental impact on the habitat of the

Fenton River. Similarly, the Willimantic River Study indicated that there is no discernable environmental impact when the Willimantic River is flowing above 27 cfs. Thus, when flows in either river are above their respective values, UConn is considered to be operating under "normal" conditions and UConn has operational flexibility to pump one or both wellfields or a combination of wells at each wellfield to meet system demands.

During a typical year, UConn withdraws approximately 50 to 80% of its water from the Willimantic River Wellfield. This proportion approaches 100% during the summer and autumn months during most years when the Fenton River Wellfield is offline based on the in-stream flow recommendations of the Fenton River Study. It is understood that the Willimantic River Wellfield cannot be shut down entirely as it is the sole source of supply for the Depot Campus and CWC's off-campus customers connected to that portion of the UConn water system. However, UConn strives to utilize the Fenton River Wellfield during the winter and spring months as much as possible to give the Willimantic River aquifer the ability to recharge and the wells a respite from pumping.

When the discharge in the Fenton River drops below 10 cfs as measured by the USGS at Old Turnpike Road, or the discharge in the Willimantic River drops below 27 cfs as measured by the USGS at Merrow Road (as modified for pumping rate as shown in Section 6.3), UConn activates its "Low-Flow Operation Procedures" described below.

5.3 Low-Flow Operation Procedures

UConn utilizes its Low-Flow Operation Procedures when discharges in the Fenton River drop below 10 cfs, and/or when discharges in the Willimantic River downstream of the Willimantic River Wellfield drop below 27cfs. In general, the Fenton River drops below 10 cfs nearly every year, while the Willimantic River drops below 27 cfs approximately every third year. Thus, UConn must remain prepared to activate at least a portion of these Low-Flow Operation Procedures every single year.

The Fenton River Wellfield typically drops below 10 cfs before the Willimantic River drops below 27 cfs. As such, since 2006 UConn has managed its water supply without the Fenton River Wellfield during the summer months, except that in certain non-drought years[2] the Fenton River Wellfield may continue to be pumped. Thus, the discharge triggers for the Fenton River Wellfield presented in Table 5-1 are primarily related to supply management (consistent with the Fenton River Study recommendations), while the discharge triggers for the Willimantic River Wellfield are primarily related to demand management (consistent with the Willimantic River Study recommendations).

The Fenton River Wellfield management procedures call for supply management as the discharge in the Fenton River falls from 6 cfs to below 3 cfs and include operating only certain wells based on the discussion in Section 2.0 of this plan. In previous years, UConn has simply shut the Fenton River Wellfield down when the upstream discharge falls below 6 cfs in order to avoid manually setting the reduced pumping rates. As noted previously, recent upgrades now allow UConn to operate the wells through the triggers.

The five Water Conservation triggers in Table 5-1 are based on the trigger names in the 2008 draft Drought Response Plan. Note that this plan supports and recommends that the word "drought" be removed from the name for each stage, as they are correlated to streamflows and not a drought declaration:

[2] For example, during 2018 and 2019 flows in the Fenton River were sufficient such that the Low Flow Operation Procedures were not necessary. The availability of the Fenton River Wellfield during these two years facilitated the recent well redevelopments and pump maintenance at the Willimantic River Wellfield.

TABLE 5-1
Low-Flow Operation Procedures

River / Wellfield	Discharge (Q)	Management Procedure
Fenton	Q < 10 cfs	Prepare for Stage IA
Willimantic	Q < 27 cfs	
Fenton River Wellfield Management – Upstream Discharge		
Fenton	5 cfs ≤ Q < 6 cfs	Reduce wellfield withdrawals to a maximum of 0.633 mgd, minimize withdrawals from Well A
Fenton	4 cfs ≤ Q < 5 cfs	Reduce wellfield withdrawals to a maximum of 0.422 mgd, minimize withdrawals from Wells A and B
Fenton	3 cfs ≤ Q < 4 cfs	Reduce wellfield withdrawals upstream of Well A to a maximum of 0.211 mgd, utilize Well C or D only
Fenton	Q < 6 cfs for more than 15 consecutive days; or Q < 5 cfs for more than 5 consecutive days; or Q < 3 cfs	Cease wellfield withdrawals. **Activate Stage IA**. **Exception:** During September and October, withdrawals are allowed from Well D (maximum of 0.213 mgd) when one or more wells at the Willimantic River Wellfield are offline.
Willimantic River Wellfield Management – Downstream (Adjusted) Discharge		
Willimantic	Q < 27 cfs for 19+ days, or Q < 19 cfs	**Activate Stage IA**[1]
Willimantic	Q < 15 cfs	**Activate Stage IB**
Willimantic	Q < 15 cfs for 13+ days, or Q < 12 cfs	**Activate Stage II**
Willimantic	Q < 12 cfs for 12+ days, or Q < 7.8 cfs	**Activate Stage III**
Willimantic	Q < 7.8 cfs for 7+ days	**Activate Stage IV**

[1] It is possible that localized dry conditions could occur in the Willimantic River watershed that could cause UConn to enact various conservation measures while the Fenton River Wellfield remained fully operational. Under this rare circumstance, UConn should utilize the Fenton River Wellfield as much as possible to "rest" the Willimantic River Wellfield during the drought period, since it is likely that water levels in the Fenton River will soon recede as the localized drought regionalizes.

- UConn issues a *Stage IA - Water Conservation Alert* when one of the following trigger conditions is met:
  - When flow in the Fenton River drops below 6 cfs for more than 15 consecutive days;
  - When flow in the Fenton River drops below 5 cfs for more than 5 consecutive days;
  - When flow in the Fenton River drops below 3 cfs;
  - When flow in the Willimantic River drops below 27 cfs for more than 19 consecutive days; or
  - When flow in the Willimantic River drops below 19 cfs.

- When flow in the Willimantic River drops below 15 cfs, UConn issues a *Stage IB - Water Supply Advisory*.

- When flow in the Willimantic River drops below 12 cfs (or below 15 cfs for more than 13 consecutive days), UConn issues a *Stage II - Water Supply Watch*.

- When flow in the Willimantic River drops below 7.8 cfs (or below 12 cfs for more than 12 consecutive days), UConn issues a *Stage III - Water Supply Warning*.

- When flow in the Willimantic River drops below 7.8 cfs for more than seven consecutive days, UConn issues a *Stage IV - Water Supply Emergency*.

The appropriate responses to each water conservation trigger are described below.

5.3.1 Stage IA – Water Conservation Alert

- Issue request for voluntary water conservation measures (Section 5.3.6).
- Contact the DPH, DEEP, and CWC concerning the activation of the Alert. It is expected that CWC will issue a similar request to its customers in Mansfield who are served through the CWC interconnection.
- Evaluate operative status of system components and availability of supply.
- Monitor daily production, storage, and consumption to quantify any demand reductions. The goal is to reduce demand by at least 5% from normal conditions. The success of meeting this goal should be checked by reviewing daily wellfield production records and tank levels for the preceding five days.

5.3.2 Stage IB – Water Supply Advisory

- Re-issue request for voluntary water conservation measures.
- Review mandatory conservation measures and update if necessary (Section 5.3.6).
- Contact the DPH, DEEP, and CWC concerning the activation of the Advisory. It is expected that CWC will issue a similar request to its customers in Mansfield who are served through the CWC interconnection.
- Evaluate operative status of system components and availability of supply. Evaluate and identify operating adjustments, emergency equipment, or other materials necessary to temporarily increase available supply. Ensure operating adjustments are in place to maximize available supplies.
- Monitor daily production, storage, and consumption to quantify any demand reductions. Investigate any deviance from normal patterns. The goal is to reduce demand by 10% from normal conditions. The success of meeting this goal should be checked by reviewing daily wellfield production records and tank levels for the preceding five days.
- Review the 2020 *Emergency Contingency Plan* and update contact information or other sections if necessary, in order to ensure redundant sources of supply are available.

5.3.3 Stage II – Water Supply Watch

- Re-issue request for voluntary water conservation measures.
- Issue mandatory conservation measures and water use restrictions.
- Contact the DPH, DEEP, and CWC concerning the activation of the Watch. It is expected that CWC will issue a similar request to its customers in Mansfield who are served through the CWC interconnection.
- Evaluate operative status of system components and availability of supply. As required, schedule necessary in-house emergency equipment; order additional equipment or services from outside vendors following UConn Purchasing Department procedures.
- Monitor daily production, storage, and consumption to quantify any demand reductions. Investigate any deviance from normal patterns. The goal is to reduce demand by 15% from normal conditions. The success

of meeting this goal should be checked by reviewing daily wellfield production records and tank levels for the preceding five days.

5.3.4 Stage III – Water Supply Warning

- Re-issue request for voluntary water conservation measures.
- Re-issue mandatory conservation measures and water use restrictions.
- Contact the DPH, DEEP, and CWC concerning the activation of the Warning. It is expected that CWC will issue a similar request to its customers in Mansfield who are served through the CWC interconnection.
- Evaluate operative status of system components, availability of supply, and effectiveness of demand reduction measures taken to date.
- Eliminate all unnecessary outdoor water usage and routinely monitor and enforce compliance with mandatory conservation measures.
- Schedule necessary purchase of supplemental water, either bottled or by tanker, for critical areas.
- Monitor daily production, storage, and consumption to quantify any demand reductions. Investigate any deviance from normal patterns. The goal is to reduce demand by 20% from normal conditions. The success of meeting this goal should be checked by reviewing daily wellfield production records and tank levels for the preceding five days.
- Monitor ground water levels at each production well at least once per day. Ensure that water levels in each well are more than five feet above each pump setting while operating. Refer to the 2020 *Emergency Contingency Plan* and activate emergency procedures if necessary.

5.3.5 Stage IV – Water Supply Emergency

- Re-issue request for voluntary water conservation measures.
- Re-issue mandatory conservation measures and water use restrictions.
- Contact the DPH, DEEP, and CWC concerning the activation of the Emergency. It is expected that CWC will issue a similar request to its customers in Mansfield who are served through the CWC interconnection.
- Evaluate operative status of system components, availability of supply, and effectiveness of demand reduction measures taken to date.
- Eliminate all unnecessary outdoor water usage and routinely monitor and enforce compliance with mandatory conservation measures.
- Make necessary adjustments and/or order supplemental water supplies to meet needs of high priority users.
- Monitor daily production, storage, and consumption to quantify any demand reductions. Investigate any deviance from normal patterns. The goal is to reduce demand by 25% from normal conditions. The success of meeting this goal should be checked by reviewing daily wellfield production records and tank levels for the preceding five days.
- Continue to monitor ground water levels at each production well at least once per day. Refer to the 2020 *Emergency Contingency Plan* and activate emergency procedures if a source of supply can no longer be used due to low groundwater levels.

5.3.6 Water Conservation Measures

The request for voluntary water conservation measures is announced to the public when any of the discharge triggers are reached in Table 5-1 as explained in Section 5.3.1 through 5.3.5. The UConn Facilities and Operations Department is responsible for monitoring instream flows and determining when a discharge trigger has been met and when public announcements are issued. The announcements include letters to students, faculty, staff, and

customers, as well as announcements on UConn's local radio station and cable TV channel. Several departments are in charge of handling the media request:

1. Facilities Operations / Contract Operator: Draft water conservation requests for voluntary conservation measures. Issue water conservation request to off-campus users; coordinate with CWC; respond to reported leaks as high priority repairs; report relevant water demand changes to UConn water conservation communications team (Administration & Operations, Office of Sustainability, University Communications).
2. University Communications: Review and approve draft water conservation request.
3. Director of Utility Operations & Energy Management within Facilities Operations (or, if desired, Vice President / Chief Operating Officer): Issue water conservation request as UConn Announcement.

The Director of Utility Operations & Energy Management within Facilities Operations and/or his/her designee is responsible for notifying outside state and local agencies of the status of UConn's water system at each trigger level. University Communications is responsible for notifying legislators and the governor of Connecticut, if needed.

Voluntary water conservation measures include:

- Reduce use by taking shorter showers and condensing washing of dishes and laundry into full loads;
- Be more conscious of use by not letting water run to warm up or cool down, and not letting faucets run while brushing teeth, shaving, etc.;
- Avoid power washing buildings and washing vehicles with public water;
- Eliminate non-essential consumption of water (lawn watering, garden watering at night only, car washing); and
- Raise air conditioning thermostats for centrally chilled buildings to 75 degrees, particularly when leaving at night.
- Immediately report leaky fixtures in UConn buildings to Facilities Operations.

In addition to voluntary water conservation measures, mandatory water conservation measures are enforced when UConn reaches the discharge triggers for Stage II, Stage III, or Stage IV (Section 5.3.3 through 5.3.5). Public announcements are made through the same protocols as the voluntary conservation measures, with the following additions:

1. Vice-President / Chief Operating Officer: Issue department-head directives applicable to UConn operations (Chief Operating Officer direct reports and Athletics).
2. Executive Vice President / Provost: Issue directives applicable to academic/research activities (Deans and Directors)
3. Facilities Operations / Contract Operator: Issue directives applicable to non-UConn and off-campus water system users; coordinate with CWC; provide updated list of Central Utility Plant and centrally cooled buildings; report relevant water production and demand changes to the UConn water conservation communications team.

Mandatory water conservation measures for *Stage II - Water Supply Watch* include:

- No routine maintenance flushing of hydrants, pipes and sewer lines allowed, and will only be performed to address water quality issues;
- No fleet vehicle washing allowed, and the vehicle wash bay is closed;

- Lawn watering is limited to four hours or less per day, and only between the hours of 5 am and 9 am and 7 pm to 9 pm. Athletic fields are allowed up to two hours of water per day during the same hours;
- Curtail running of lasers, autoclaves and other research lab devices that consume water for once-through cooling;
- No use of UConn water for construction site dust control or rinsing activities, with contractors required to provide dust control water from off-site;
- No use of UConn water for washing and wetting down streets, sidewalks, driveways, or parking areas unless requested by the local public health authority;
- No water use by ornamental or display fountains;
- The use of hydrant sprinkler caps is banned;
- No pool filling using UConn water; and
- Thermostats set to 78 degrees for centrally cooled buildings.

Additional measures enacted during a *Stage III - Water Supply Warning* include the use of paper plates and plastic silverware in any or all eight on-campus dining areas, depending on which dining areas provide the most conservation benefits. In general, the conservation methods employed Stage III and Stage IV are the same as those used during Stage II, with the expectation that the conservation goals of 20% and 25% from normal wellfield production would be met under Stage III and Stage IV, respectively.

5.3.7 Recovery from Conservation Measures

Defining a rigid regimen for recovering from the five water conservation stages is difficult due to the relatively rapid peaking and decline of river hydrographs from summer storms. Thus, Facilities Operations & the contract operator should exercise professional judgment in determining the exact timing of recovery. Potential recovery triggers are suggested as follows:

1. When flow in the Willimantic River rises above 7.8 cfs for seven consecutive days, and flow in the river appears to be stable or slowly increasing, UConn may return to a *Stage III - Water Supply Warning*.

2. When flow in the Willimantic River rises above 12 cfs for seven consecutive days, and flow in the river appears to be stable or slowly increasing, UConn may return to a *Stage II - Water Supply Watch*.

3. When flow in the Willimantic River rises above 15 cfs for seven consecutive days, and flow in the river appears to be stable or slowly increasing, UConn may return to a *Stage IB - Water Supply Advisory*.

4. When flow in the Willimantic River rises above 19 cfs and flow in the river appears to be stable or slowly increasing, UConn may return to a *Stage IA - Water Conservation Alert*.

5. When flow in the Willimantic River is stable or slowly increasing above 19 cfs, and flow in the Fenton River is generally sustainable above three cfs, UConn may lift the *Stage IA - Water Conservation Alert* and continue to operating according to the Low-Flow Operation Procedures in Table 6-1 regarding the Fenton River withdrawals.

UConn will re-issue appropriate water conservation notices as the water system recovers through the five water conservation stages in order to educate water users regarding system status and necessary conservation measures.

The goal for recovery is to ensure that UConn does not cause announcement fatigue related to a constant barrage of water conservation announcements, particularly with regard to repeatedly moving upwards and downwards between triggers. In general, it is better to remain at an activated trigger for a few more days while waiting for forecasts to materialize than to move to a lower trigger for a short period, only to return to the higher trigger a few days later.

APPENDIX A

2008 Draft Drought Response Plan

DROUGHT RESPONSE PLAN

DRAFT 08-22-08

UCONN
Water Supply Emergency Contingency Plan

1. TRIGGER LEVELS:

Stage IA – Water Conservation Alert:

- Projected Available Supply[1] is forecast to be greater than or equal to the Projected Water Usage[2] for an extended period yet flow in the Fenton River is at 3.0 cfs or less.

Stage IB – Water Supply / Drought Advisory:

- Projected Available Supply[1] is forecast to be equal to or less than Projected Water Usage[2], or
- Continuous pumping at maximum available supply results in an overall decrease in tank storage, as expressed by water levels in the High Head Reservoir.

Stage II – Water Supply / Drought Watch:

- Projected Available Supply[1] is forecast to be significantly less than Projected Water Usage[2] for an extended period, or
- Three consecutive days of continuous pumping at maximum available supply results in an overall decrease in tank storage, as expressed by water levels in the High Head Reservoir.

Stage III – Water Supply / Drought Warning:

- If the High Head Reservoir fails to recover to two-thirds full (10' level) for three consecutive days.

Stage IV – Water Supply / Drought Emergency:

- If the High Head Reservoir fails to recover to 40% full (6' level) for four consecutive days.

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[1] Projected Available Supply is the expected capacity of the system's sources operating concurrently, and adjusting for any losses due to well maintenance or repair; transmission or pumping limitations due to depressed groundwater levels at the Willimantic wells; anticipated reductions in Fenton well withdrawal based on flow recession equations developed in the Study Report; or other supply-reducing events.

[2] Projected Water Usage is the expected production for the particular time of year for which the assessment is made, and includes any reductions or increases in demand due to historical variation or known significant changes.

2. **RESPONSE:**

Stage IA – Water Conservation Alert:

- Implement Demand-Side Water Conservation Plan for voluntary conservation.
- Contact the Departments of Public Health and Environmental Protection and other state and local agencies, as outlined in the plan, concerning the initiation of an Alert.
- Maintain compliance with Fenton River Study flow management recommendations, including cessation of Fenton Well Field withdrawals when flow is less than 3 cfs, as measured at USGS gaging station 01121330.
- Evaluate the operative status of system components and availability of supply.
- Monitor daily production, storage and consumption to quantify any demand reductions.

Stage IB – Water Supply / Drought Advisory:

- Re-issue Demand-Side Water Conservation Plan for voluntary conservation.
- Contact the Departments of Public Health and Environmental Protection and other state and local agencies, as outlined in the plan, concerning the initiation of an Advisory.
- Maintain compliance with Fenton River Study flow management recommendations, including phased scaling back of Fenton Well Field withdrawals when flow is less than 6 cfs, as measured at USGS gaging station 01121330.
- Investigate any material deviation from normal consumption, production or storage patterns.
- Evaluate the operative status of system components and availability of supply. Evaluate and identify operating adjustments, emergency equipment, or other actions necessary to temporarily increase available supply.
- Contact DPH and DEP regarding the possible activation of Fenton Well D and/or issuance of temporary or emergency authorization allowing rebalancing of registered diversion rates to allow increased withdrawals from Willimantic Wells 1 and/or 3.
- Review Water Supply Plan Emergency Contingency Plan and update if necessary.
- Monitor daily on-campus, metered consumption, storage and metered production to ensure consumption and production reductions are met (10% from previous non-advisory average).
- Ensure all operating adjustments are made to increase available supply, with the exception of activating Fenton wells that are off-line or restricted due to low-flow conditions.

Stage II – Water Supply / Drought Watch:

- Re-issue Demand-Side Water Conservation request for voluntary conservation.
- Issue Demand-Side Water Conservation notice for water use restrictions.
- Contact the Departments of Public Health and Environmental Protection and other state and local agencies, as outlined in the plan, concerning the initiation of a Watch.
- Maintain compliance with Fenton River Study flow management recommendations, including phased scaling back of Fenton Well Field withdrawals when flow is less than 6 cfs, as measured at USGS gaging station 01121330.

Stage II – Water Supply / Drought Watch (continued):

- Continue investigation of any material deviation from normal production, consumption and storage patterns.
- Evaluate the operative status of system components and availability of supply. As required, schedule necessary in-house emergency equipment; order additional equipment or services from outside vendors following University purchasing procedures.
- Contact DPH/DEP regarding activation of Fenton Well D in accordance with recommended abbreviated pumping plan and/or issuance of temporary or emergency authorization allowing rebalancing of registered diversion rates to allow increased withdrawals from Willimantic Wells 1 and/or 3.
- Review Mandatory Conservation measures and update if necessary.
- Monitor daily on-campus, metered consumption and metered production to ensure consumption and production reductions are met (15% from previous non-advisory average).

Stage III – Water Supply / Drought Warning:

- Re-issue Demand-Side Water Conservation request for voluntary conservation.
- Re-issue Demand-Side Water Conservation Plan for mandatory conservation.
- Contact the Department of Public Health and other state and local agencies, as outlined in the plan, concerning the initiation of a Warning.
- Evaluate the operative status of system components, availability of supply, and the effect of demand reduction measures taken to date. Evaluate and prioritize reactivation of any Fenton wells off-line or throttled due to flow-imposed limits, including Fenton Well D.
- Eliminate all unnecessary outdoor water usage and routinely monitor and enforce compliance with mandatory conservation measures.
- Activate Fenton Well D in accordance with recommended abbreviated pumping plan, if feasible.
- During increasing severity of stage, and upon notification and consultation with appropriate state agencies, initiate limited Willimantic Well 1 and 3 well use to maintain level in the High Head Reservoir.
- Review High Priority User list and update if necessary.
- Schedule necessary purchase of supplemental water, either bottled or by tanker, for critical areas.
- Monitor daily on-campus, metered consumption, metered storage, and metered production to ensure consumption and production reductions are met (20% from previous non-advisory average).

Stage IV – Water Supply / Drought Emergency:

- Re-issue Demand-Side Water Conservation request for voluntary conservation.
- Re-issue Demand-Side Water Conservation notice for water use restrictions.
- Contact the Department of Public Health and other state and local agencies, as outlined in the plan, concerning the initiation of an Emergency.

Stage IV – Water Supply / Drought Emergency (continued):

- Eliminate all outside water usage, and enforce all mandatory conservation restrictions, as necessary.
- Evaluate the operative status of all system components, availability of supply, and the effect of demand reduction measures taken to date. Make necessary operating adjustments to meet needs of high priority users.
- During increasing severity of stage, and upon notification and consultation with appropriate state agencies, increase production at the Fenton Well Field to maintain level in the High Head Reservoir.
- Order supplemental water supplies for high priority users.
- Monitor daily on-campus, metered consumption and metered production to ensure consumption and production reductions are met (25% from previous non-advisory average).

3. CONSERVATION MEASURES:

Demand-Side Water Conservation Plan – Voluntary Measures

Water Conservation Measures	Departmental Responsibilities

Water Conservation Alert; Water Supply Advisory; Water Supply Watch: <u>Voluntary Measures</u>
• Reduce use
  o shorter showers
  o condense washing of loads (dishes and laundry)
• Be more conscious of use
  o Not letting water run to warm up or cool down
  o Not letting faucets run while brushing teeth, shaving, etc
• Eliminate non-essential consumption of water (lawn watering, garden watering at night only, car washing).
• Raise air conditioning thermostats for centrally-chilled buildings to 75 degrees
• Report leaks immediately
  o Facilities Operations (6-3113)
	OEP – draft WC request for voluntary conservation measures
	
	Univ Relations – review and approve draft WC request
	
	VP/COO – issue WC request as UConn Announcement
	
	FacOps/NEWUS – issue WC request to off-campus users
	
	FacOps/NEWUS – respond to reported leaks as high priority repairs
	
	FacOps/NEWUS – report relevant water demand changes to UConn WC communications team (A&O, OEP, Univ Relations, Town of Mansfield)
	
	The following communications responsibilities applicable to each step in this Plan:
	
	A&O - notify DPH, DEP, DOC, Town of Mansfield, and town members of Water/Sewer Advisory Board
	
	Univ Relations – notify legislators and governor, as needed

Demand-Side Water Conservation Plan – Mandatory Measures

Water Supply Warning; Water Supply Emergency: Mandatory Water <u>Conservation Measures</u> • No routine maintenance flushing of hydrants, pipes and sewer lines • No fleet vehicle washing • 50% reduction in irrigation of athletic fields, landscaping and research facilities, unless separate irrigation ponds or wells are used • Curtail running of lasers, autoclaves and other research lab devices that consume water for cooling (once-through cooling) • No use of UC water for construction site dust control or rinsing activities • No use of water for street sweeping • No pool filling • Thermostats set at 78 degrees for centrally-cooled buildings	*VP/COO – Issue department-head directives applicable to UConn operations (COO direct reports and Athletics) *EVP/Provost - Issue directives applicable to academic/research activities (Deans and Directors) *FacOps/NEWUS – Issue directives applicable to non-University and off-campus water system users FacOps provide updated list of CUP and centrally-cooled buildings FacOps – report relevant water production and demand changes to UConn Water Team --- *When warranted, these parties are also responsible for notifying same water system users about repeal of mandatory measures.

4. RECOVERY FROM EMERGENCY:

The method of recovery from a water emergency will vary according to the stage and responsible trigger. In general, once the emergency condition is rectified, the emergency can be considered over and normal system operating conditions can resume. Several non-drought emergencies may not result in formal activation of the stage response plan due to the short-term duration of the emergency. Therefore, the recovery can be quite rapid, compared to recovery from a drought.

The steps to be taken to step down from longer term and drought related emergencies are as follows:

Stage IV – Water Supply / Drought Emergency:

When the water level in the High Head Reservoir is maintained above 6 feet, 40% full, for three consecutive days with an overall trend showing an increase in tank storage, and continued recovery can be sustained without use of the Fenton wells, well use may be curtailed as flow management recommendations dictate. When water level in the High Head Reservoir can be maintained above 10 feet, two-thirds full, with an overall trend showing an increase in tank storage, Stage III can be re-implemented and mandatory restrictions eased.

Stage III – Water Supply / Drought Warning:

When response measures have resulted in the water level in the High Head Reservoir being maintained above 10 feet, two-thirds full, for three consecutive days with an overall trend showing an increase in tank storage, and continued recovery can be sustained without use of the Fenton wells, well use may be curtailed as flow management recommendations so dictate. Production from all sources is to be reviewed and if projected available supply is greater than the projected water usage, Stage II can be re-implemented and mandatory restrictions further eased.

Stage II – Water Supply / Drought Watch:

When response measures have resulted in the water level in the High Head Reservoir returning to normal, and when Projected Available Supply is greater than the Projected Water Usage, Stage I can be re-implemented and voluntary conservation maintained.

Stage IB – Water Supply / Drought Advisory:

When response measures have resulted in the water level in the High Head Reservoir returning to normal for five consecutive days, and when Projected Available Supply is greater than the Projected Water Usage, the advisory can be lifted.

Stage IA – Water Conservation Alert:

When response measures have resulted in the water level in the High Head Reservoir returning to normal for five consecutive days, and when Projected Available Supply is greater than the Projected Water Usage, and when the flow in the Fenton River is greater than 3.0 cfs, the Alert can be lifted.

APPENDIX B

DEEP Letter Authorizing Use of Well D as a Backup Well in September and October

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

79 Elm Street • Hartford, CT 06106-5127 www.ct.gov/deep Affirmative Action/Equal Opportunity Employer

August 25, 2017

Jason Coite, P.E.
Environmental Compliance Manager
Office of Environmental Policy
University of Connecticut
31 Ledoyt Road, Unit 3055
Storrs, CT 06269-3055

Re: University of Connecticut
Fenton Wellfield, Well D Usage

Dear Mr. Coite,

The Department of Energy and Environmental Protection (Department) has reviewed the University of Connecticut's request, dated August 10; 2017, to operate Fenton Well D during September and October as a back-up well. The University provided data supporting that this withdrawal volume is equal to or less than the natural gain in stream flow between the upper 3 wells in the Fenton Well Field (A, B and C) and Well D; and framed the circumstances under which Well D would be utilized. The Department concurs with the analyses provided.

The Department therefore approves the use of Fenton Well D each year under low flow conditions at up to 0.213 million gallons per day as a back-up well as needed, in accordance with the referenced request. If you have any questions, please do not hesitate to contact me or Corinne Fitting, of my staff, at (860) 424-3724.

Sincerely,

Betsey Wingfield
Bureau Chief
Bureau of Water Protection and Land Reuse

Cc: Lori Mathieu, Section Chief, DPH Drinking Water Section
Rich Miller, Director, UCONN Office of Environmental Policy (email only)
Stan Nolan, Director, UCONN Facilities Operations and Building Services (email only)
Scott Bighinatti, Milone & MacBroom, Inc. (email only)

APPENDIX C

Copy of September 25, 2017 Letter Announcing Stage IA - Water Conservation Alert

UCONN
UNIVERSITY OF CONNECTICUT

September 25, 2017

Dear UConn Water System Users:

UConn is issuing a Stage IA Water Conservation Alert because seasonally dry conditions have reduced area streamflows. We are enlisting your cooperation to conserve water until further notice.

The University's water supply remains adequate to meet current and forecasted system demands and any emergency needs such as firefighting. Per UConn's Water Supply Plan, we are committed to operating an environmentally sustainable water supply system. Given current streamflow conditions and rainfall forecast, we are asking our students, faculty, staff and our off campus municipal, commercial, and residential users to be conscientious of their daily water use and to conserve water voluntarily by:

- Taking shorter showers
- Running dishwashers and clothes w ashing machines with full loads
- Shutting off water while washing dishes, shaving, brushing teeth, and lathering up to wash hands, rather than running the water continuously
- Avoiding vehicle washing or power-washing homes and other buildings
- Not using water to clean sidewalks, driveways and roads
- Reducing, to the extent possible, the watering of lawns, recreational and athletic fields, gardens, or other landscaped areas (if watering is essential, late-evening hours are best)
- Not using public water to fill residential swimming pools

By issuing the Stage IA Water Conservation Alert, we encourage you to reduce how much water you use. Thank you for your help. We appreciate your cooperation. UConn is actively monitoring conditions and will continue to provide updates as conditions change.

Sincerely,

Stanley L. Nolan
Director of Utility Operations and Energy Management

Office of the Executive Vice President for
Administration and Chief Financial Officer
Facilities Operations & Building Services
25 LEDOYT ROAD, UNIT 3252
STORRS, CT 06269-3252
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