PROJECT BACKGROUND
The Hall Road Well Station is located in Abington, Pennsylvania approximately 12 miles (20 kilometers) north of Philadelphia. The site is designed to extract and treat 1.5 million gallons per day (MGD) of water from the Piedmont and Blue Ridge crystalline-rock aquifers. It is also part of a network of groundwater extraction wells owned and operated by Aqua-America Pennsylvania (Aqua PA) which delivers over 22 MGD of treated groundwater to end users in South-East Pennsylvania.

In 2009, the Pennsylvania Department of Environmental Protection (PADEP) introduced legislation requiring mandatory 4-log virus disinfection for all groundwater extraction and treatment sites in the state. This legislation is similar to federal legislations such as the United States Environmental Protection Agency’s (USEPA) Groundwater Rule (GWR) introduced in 2006 which requires groundwater systems to achieve 4-log virus inactivation in the event that the source water contains or is exposed to pathogens including *Escherichia coli*, enterococci or coliphages. However, the PADEP requirement is different in that it mandates 4-log inactivation of viruses regardless of whether or not a contamination event has occurred.

In response, many groundwater providers have made efforts to improve chlorine-based disinfection. This is primarily accomplished by expanding existing contact tanks and/or installing new tanks or installing oversized pipes or pipe loops to increase chlorine contact time. However, solutions such as these would have been difficult for the space-constrained Hall Road Well Station which would have required approximately 430 feet of additional 36-inch diameter pipe. Aqua PA decided that a solution with a smaller footprint was required.

THE TROJANUV SOLUTION
TrojanUV recognized the contribution UV technology could potentially make to virus treatment. UV disinfection is instantaneous and does not require extended contact times unlike chlorine and other chemical-based disinfection alternatives. As a result, UV can accomplish similar levels of disinfection to chlorine but within smaller space constraints.

Until recently, UV was considered unfavorable for virus disinfection due to the high resistance of certain species of virus (namely adenovirus) to UV. To overcome this, TrojanUV and its validation partner utilized a validation protocol that incorporated a surrogate organism, which like adenovirus, is highly resistant to UV disinfection. The results were four TrojanUVSwift™SC (Small Community) systems capable of achieving USEPA Ultraviolet Disinfection Guidance Manual (UVDGM) mandated doses for inactivating 4-log virus, including adenovirus (186 mJ/cm²) at flow rates of over 700 gpm through a single reactor. In addition to virus, these four systems were also validated for the inactivation of chlorine-resistant pathogenic microorganisms such as *Cryptosporidium* and *Giardia*. 
Aqua PA determined that UV technology was the best approach for meeting the PADEP regulations for 4-log virus treatment of groundwater without a significant increase in footprint. TrojanUV recommended that two TrojanUVSwiftSC D12 UV reactors be installed at the Hall Road Well Station each equipped with twelve low-pressure high-output (LPHO) lamps. The installation itself required less than 100 ft³ (<3 m³) of space, far less demanding than the over 400 feet of pipe required for enhanced chlorine treatment.

In addition to providing a smaller footprint, UV disinfection was also advantageous as it provided a chemical-free solution, limiting the possible generation of regulated disinfection by-products including trihalomethanes (THMs) and haloacetic acids (HAAs).

**SYSTEM PERFORMANCE**

The TrojanUVSwiftSC systems installed at the Hall Road Well Station have been in operation since July of 2012 and performance was assessed by way of a performance test conducted from September to December, 2012. The system itself was found to be highly reliable and operated continuously throughout this performance assessment period with no unintended disruptions in service. This reliability was significant considering the installation provides a critical source of potable water for the area.

In addition, the validated dose during system operation was maintained at a level above the minimum UVDGM-required validated dose for 4-log virus treatment of 186 mJ/cm² (Figure 1).

The dose-pacing feature of the system allowed for the automatic adjustment of power output to compensate for increases or decreases in flow rate or water quality in order to maintain the minimum validated dose using as little energy as possible. This feature maintains the system’s operational integrity while minimizing operational costs and adds a measure of environmental sustainability to the system by conserving energy.

**TROJANUV VIRUS VALIDATION**

The UVDGM mandates that a validated UV dose of 186 mJ/cm² is required for achieving 4-log inactivation of virus. This dose is substantially higher than the dose required for equivalent reductions of other pathogens such as *Cryptosporidium* and *Giardia* (22 mJ/cm²). The reason for this discrepancy is the disproportionately high resistance of adenovirus to UV light. Other viruses including noroviruses and rotaviruses are much less resistant.

The TrojanUVSwiftSC reactors were certified for virus treatment by validation using *Aspergillus brasiliensis* as a surrogate organism. *A. brasiliensis* was selected as a surrogate because like adenovirus, it is highly resistant to UV and fits the USEPA criteria for surrogates used in UV reactor validation including being a stable and easily managed non-pathogenic surrogate.

This one-of-a-kind validation was third-party witnessed and allows water providers to implement a fully EPA-compliant solution for 4-log virus treatment with a single UV unit.