# CHARLESTOWN STATE PARK WATER SUPPLY EXPANSION
## Investigation and Recommendations

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# EXECUTIVE SUMMARY

Due to the success of the River Ridge Development Authority (RRDA) in attracting new businesses to the River Ridge Commerce Center (RRCC), the demand for water in the RRCC is approaching the capacity of the Charlestown State Park water system ("Water System"). The State of Indiana (State) is committed to ensuring that the RRCC has adequate water supply to accommodate anticipated growth and attract new businesses, including those that may require large quantities of water. The Indiana Department of Natural Resources (IDNR) is currently working to design and build improvements to increase the capacity of the Water System to meet those needs. The State has also considered plans to develop the Charlestown State Park aquifer as a regional water supply for Southeastern Indiana.

This report presents our analysis and recommendations focused on 1) the expansion of the existing water supply components ("Supply System") of the Water System (*"supply system expansion"*), 2) improvements to the water distribution components ("Distribution System") of the Water System to facilitate the transition to operation of the IDNR Supply System and RRCC Distribution System as separate utilities (*"utility system separation"*), and 3) the future development of the regional water supply (*"regional water supply"*).

For the *supply system expansion*, specific recommendations are provided for the investigation, engineering design and permitting of near-term improvements to the IDNR water supply system. Additional recommendations are provided for *utility system separation* and the future development of the *regional water supply*.

The site survey, testing, and review of available data and previous reports completed for this report suggests that the *supply system expansion* can be addressed with the improvement and build-out of the existing water treatment plant (WTP), meeting the projected water demand of the RRCC through 2030.

### Immediately Increase Production and Treatment Capacity of the Existing WTP

Immediate action is recommended to design and construct improvements for the *supply system expansion* that will increase the total production capacity of the system from 2.0 million gallons per day (MGD) to approximately 6.0 MGD, with a minimum firm capacity of 4.0 MGD. Additional water can be produced from the existing wells by increasing the pump capacities and expanding and improving the existing treatment plant. The presence of low levels of unregulated per- and polyfluoroalkyl substances (PFAS) and other contaminants of emerging concern (CECs) were detected in the raw water. The existing water treatment plant is not designed for removal of these contaminants, and we recommend that the designed improvements consider the potential need to add supplemental treatment processes in the future.

### Separate Management of Water Supply and Distribution Systems

As part of an overall review, the State is in the process of formalizing control and management of the water supply and distribution components of the Water System associated with the Charlestown State Park aquifer. The State (IDNR) owns the Supply System and plans to operate it as a wholesale water utility, supplying RRCC and other future wholesale customers. Operation of the Supply System will continue to be performed by a qualified third-party contractor. The RRDA will manage the Distribution System within the RRCC, operating as a separate public water supply (PWS). IDNR will enter into a long-term wholesale water supply agreement with RRDA with terms that support continued economic development in the RRCC.

**Develop a Resilient Regional Water Supply**

The sustainable yield of this aquifer is estimated to be between 80 and 100 MGD, based on analysis of the existing horizontal collector wells formerly used by the Indiana Army Ammunition Plant (INAAP) (Layne, 2011). To meet future RRCC and regional demands beyond the capacity of the currently proposed *water supply expansion* it is recommended that a high-capacity (15 MGD) collector well be constructed, rather than multiple vertical wells.

A new treatment facility will be required after the expanded capacity of the existing plant is exceeded. Although the existing plant was built several feet above the 100-year flood level, the floodway and flood zone surround the plant. Future treatment capacity developed for the regional water supply should be located at a higher elevation to provide greater protection from extreme flooding events on the Ohio River, improving long-term water supply resiliency. The capacity of the existing transmission main supplying the RRCC will also be reached with the expansion of the existing plant. It is recommended that a separate transmission main route be chosen to provide flexibility for maintenance and greater resiliency in the event of major infrastructure failure. It is also recommended that additional treated water storage be added to provide flexibility for routine plant maintenance.

The locations of the collector wells, treatment plant and transmission and storage facilities should consider and be coordinated with the Charlestown State Park master plan, RRCC strategic plan, and regional economic development plans. Plans should also provide for efficient access to other utilities in the region that may become wholesale customers of the regional water supply for their customers’ use or to “wheel” water through their systems to other interconnected utilities.

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An in-depth evaluation of all components of the existing water supply and distribution facilities was beyond the scope of this work. As a result, design recommendations in this report are conceptual in nature and intended for scoping of independent engineering services for detailed investigation and design.

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# 1.0 INTRODUCTION

The Indiana Finance Authority (IFA) contracted INTERA to provide advisory services to the Indiana Department of Natural Resources (IDNR) related to the expansion and management of the Charlestown State Park Supply System, which supplies water to the River Ridge Commerce Center (RRCC). Charlestown State Park and the RRCC are shown in Figure 1. Water demand in the RRCC has increased to near the capacity of the existing supply system and the River Ridge Development Authority (RRDA), which manages the RRCC, has requested that IDNR construct improvements to increase capacity. The State of Indiana is committed to ensuring that RRCC has adequate water supply for all planned and future economic development activity within the RRCC, including that involving industries that may require very large quantities of water.

The State of Indiana intends to clarify and formalize, as necessary, the ownership and management of the infrastructure assets making up the supply and distribution components of the Water System. The State of Indiana will own the infrastructure constructed by IDNR, including the wells, treatment plan, transmission mains, storage tank and booster station, together referred to as the “Supply System” and shown in Figure 1. The Supply System will be operated as a wholesale provider of treated water. Operation of the Supply System will continue to be performed by a qualified third-party contractor under contract to the IDNR. Operating as a separate utility, RRDA will control the distribution infrastructure within the RRCC not owned by IDNR (“Distribution System”). IDNR will enter into a long-term wholesale water supply agreement with RRDA with terms that support continued economic development in the RRCC.

The primary purpose of this report is to provide a recommended design scope for soliciting proposals from qualified consultants for detailed engineering evaluation and design of near-term supply capacity improvements, and to make recommendations for evaluation and subsequent design of other improvements to facilities the transition to separate operation of the IDNR Supply and RRCC Distribution Systems. The report also provides recommendations for the long-term development of the system as a regional water supply for southeastern Indiana.

Section 2 of the report provides general background information about the RRCC and Charlestown State Park Water System. Section 3 summarizes analysis of the near-term and future demand for water in the RRCC and the region. Section 4 provides a summary of the existing Water System and the testing of the wells and water quality performed for this study. Section 5 describes the conceptual design recommendations for expansion and improvements to the Water System to meet demands projected through 2030 and Section 6 discusses future development of the regional water supply. Finally, Section 7 summarizes all recommendations for *supply system expansion*, *utility system separation*, and future *regional water supply* development.

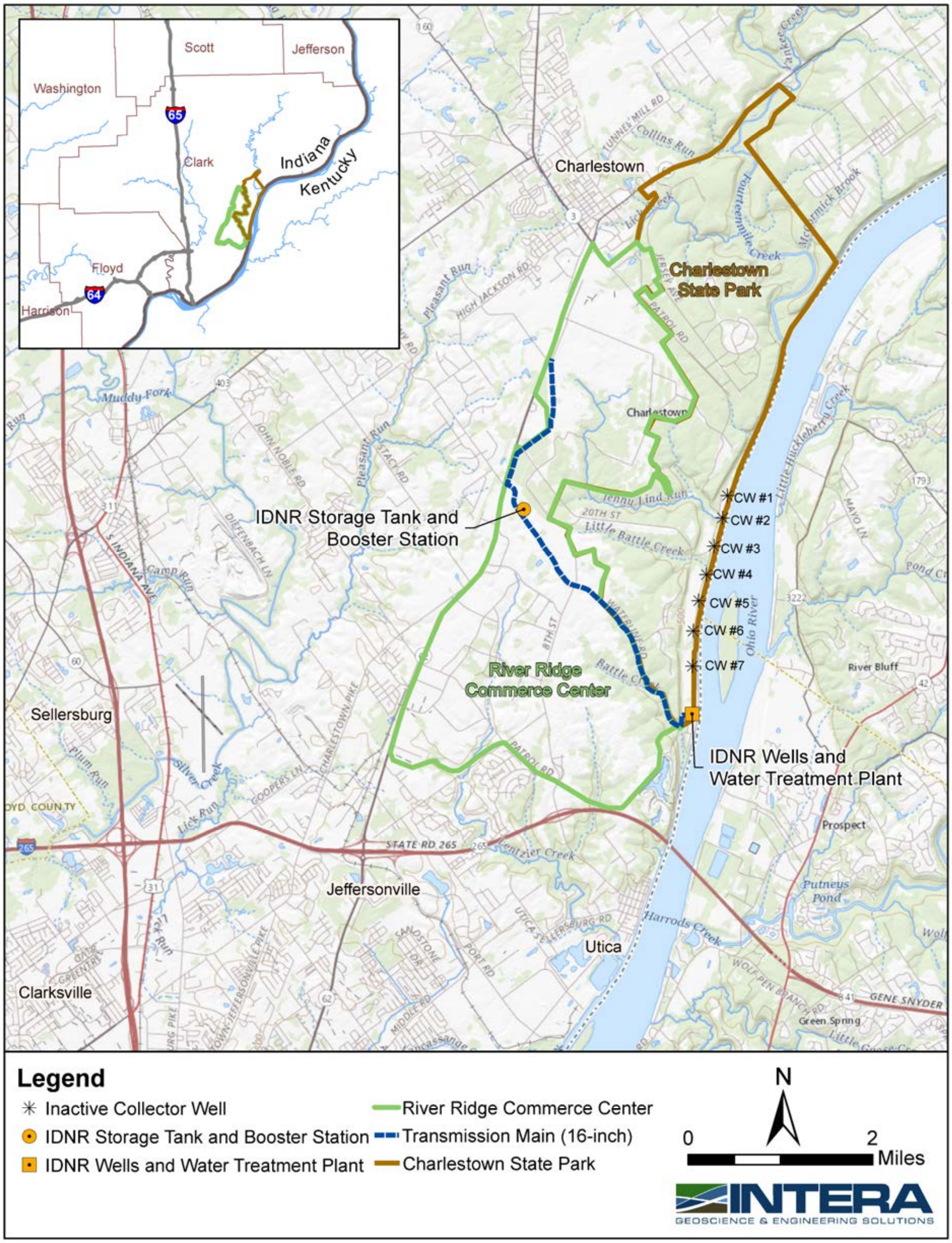


Figure 1. Location Map showing the IDNR Supply System

# 2.0 BACKGROUND

This section provides background information about the River Ridge Commerce Center (RRCC), the Charlestown State Park Water System, and the current arrangements between the Indiana Department of Natural Resources (IDNR) and River Ridge Development Authority (RRDA).

In 1998, the US Army designated the former Indiana Army Ammunition Plant (INAAP) in Charlestown, Indiana as surplus and began the process of transferring the property to the State of Indiana and the River Ridge Development Authority (RRDA) for reuse. The land transferred to the State of Indiana was added to the Charlestown State Park operated by the Indiana Department of Natural Resources (IDNR). The RRDA was formed as a multi-jurisdictional authority by the Clark County Commissioners for the purpose of transforming the site into a modern commerce center to replace the lost economic revenue previously generated by the INAAP. A successful partnership between the State of Indiana and the RRDA has resulted in strong economic development in the region. Under RRDA management, the River Ridge Commerce Center (RRCC) has established itself as a successful master planned industrial, research, and commercial business park contributing approximately $40 million in annual local and state income and sales taxes (Policy Analytics, 2019).

## 2.1 River Ridge Commerce Center

The RRDA sold its first property in the RRCC in 2005 (RRDA, 2019) and has developed it to its current population of more than 50 businesses employing 10,000 people (Policy Analytics, 2019). Figure 2 shows parcels already sold and land area open for future development in the southeastern and northern portions of the RRCC. The largest water user in the RRCC is Niagara, currently accounting for approximately 75% of the average annual water use. Niagara established operations in 2018 with its first water bottling line, requiring a water supply of 650,000 gallons per day. In January 2020, the facility began operation of a second bottling line. The facility was built with space for the addition of a third bottling line, which would require a similar supply of water. RRDA has recently begun development of a 300-acre office park adjacent to the new Lewis and Clark Bridge and SR-265 interchange. Prospects for continued growth within the RRCC are strong. The additional water demand accompanying that growth is highly dependent on the type of commercial or industrial development brought to the RRCC.

The water distribution infrastructure within the RRCC is believed to be owned by RRDA, except for the water supply transmission mains, storage tank and booster station constructed by the IDNR as part of the new supply system. The original INAAP distribution infrastructure within the RRCC was in poor condition and suffering from high levels of leakage. Water distribution and storage infrastructure within the RRCC has been rehabilitated or constructed by the RRDA, successfully reducing water loss to manageable levels. Since 2011, RRDA and its contractors have operated and maintained the Water System under contract with IDNR. RRDA operates and maintains the distribution system and manages billing and customer service within the RRCC.

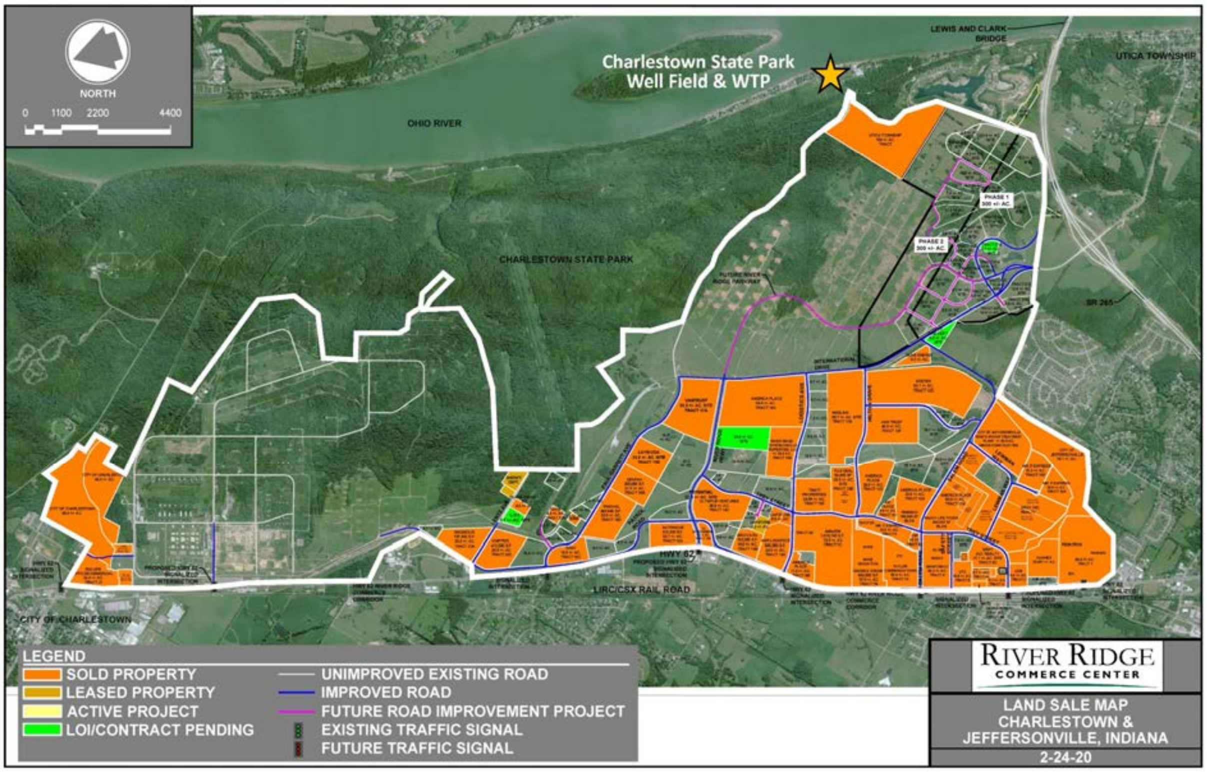


Figure 2. River Ridge Commerce Center

## 2.2 Charlestown State Park Water Supply

The water supply for the former Indiana Army Ammunition Plant (INAAP) was built during World War II to support the manufacture of smokeless gunpowder and rocket propellant. The original water supply system consisted of a series of seven high-capacity Ranney horizontal collector wells constructed in the prolific alluvial aquifer along the Ohio River. The collector wells and transmission mains used by INAAP are no longer in service but when in operation produce over 50 million gallons per day (MGD) (Layne, 2011).

The INAAP remained in operation until 1992. Approximately 4,000 acres of INAAP land was transferred to the State of Indiana to expand Charlestown State Park, which included the land along the Ohio River with the collector wells and pipelines. In 2007, IDNR acquired the rights to the water infrastructure from Water One. By the time of its transfer, the original infrastructure was in poor condition. Between 2009 and 2011, the State of Indiana invested in the construction of a new water supply system for the Charlestown State Park and the RRCC. The Supply System consists of a wellfield, treatment plant, transmission pipelines, storage tank and booster pump station with a capacity of approximately 2.0 MGD. The system is described in more detail in Section 4. The Supply System is operated by RRDA under contract with IDNR.

The alluvial aquifer has the potential for sustainable production of over 75 MGD for use as a regional water supply in Southeastern Indiana (Layne, 2011). The 2018 study *Southeastern Indiana Regional Water Supply* evaluated the potential demand for a regional water supply alternative, considering source vulnerability, regulatory compliance, and affordability (IFA, 2018). Regional economic development plans have also recommended the development of the well field as a regional water supply (Structurepoint, 2019).

A recent study by the Kentucky Department for Environmental Protection (KYDEP) reported the occurrence of per- and polyfluoroalkyl substances (PFAS) in community drinking water supplies using groundwater produced from the Ohio River Alluvium Aquifer, including the Louisville Water Company's (LWC) Payne Water Treatment Plant (WTP) (KYDEP, 2019). One source of PFAS in the alluvial aquifer is believed to be infiltration from the Ohio River. The Ohio River Valley Water Sanitation Commission (ORSANCO) is currently conducting a study of PFAS occurrence in the Ohio River (ORSANCO, 2020). Because the LWC Payne WTP is relatively close to the Charlestown State Park well field and produces groundwater from the same aquifer, it was considered prudent for the IDNR to evaluate whether PFAS or other potential contaminants of emerging concern (CECs) are present in the Charlestown State Park wells and to determine if the design of the current improvements and expansion should consider the possibility that additional treatment processes may be required in the future to remove these substances. Although drinking water standards have not yet been established for PFAS by the federal government or the State of Indiana, the USEPA is evaluating potential MCL's for perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). Several states have already established MCL's for PFOS, PFOA, and other PFAS.

## 2.3 Water Supply Agreements Between IDNR and RRDA

RRDA has operated the Supply System under contract with IDNR since April 2011. The current operations agreement expired in April 2019 and has since been extended month to month. RRDA provides customer service, billing, and operations and maintenance for the Distribution System. As a contract partner of RRDA, LWC provides operations and maintenance of the Supply System, and reporting for regulatory compliance. Since 2011, the Water System has been professionally operated and maintained by RRDA and its partners. Notably, water loss has been steadily reduced to the extent that in the first several years of operation water production declined even as water sales increased.

The Water System is currently regulated by the Indiana Department of Environmental Management (IDEM) as a non-transient non-community (NTNC) public water supply, with Public Water Supply ID Number IN2100018 (IDEM, 2020). Per Indiana Code IC 36-7-30-30, the water utility is not subject to regulation by the Indiana Utility Regulatory Commission (IURC) "for purposes of rate making, regulation, service delivery, or issuance of bonds or other forms of indebtedness" as long as utility service is produced and provided solely within the boundaries of the former INAAP.

# 3.0 PROJECTED DEMANDS

This section describes analysis of the near-term (2030) and build-out (estimated 2040) demands projected for the RRCC. It also summarizes recent estimates of potential long-term demand for a regional water supply system.

## 3.1 Water demand in the near term

Near-term demands for the RRCC are estimated to the year 2030. Improvements to the water supply system will be designed and constructed to establish adequate capacity to reliably meet near-term demands.

### 3.1.1 Historical water production

Figure 3 shows the water treatment plant daily production from 2016 through the third quarter of 2019. Until Niagara began bottling operations, it had not been necessary to operate the plant every day to supply RRCC. As a result, there is a great deal of variability in the historical daily production rates. The 10-day moving average of production is also shown to more clearly illustrate the growth trend. The figure shows the summer peaks when there is significant water use for irrigation. The large increase in water production in 2019 is due to the beginning of

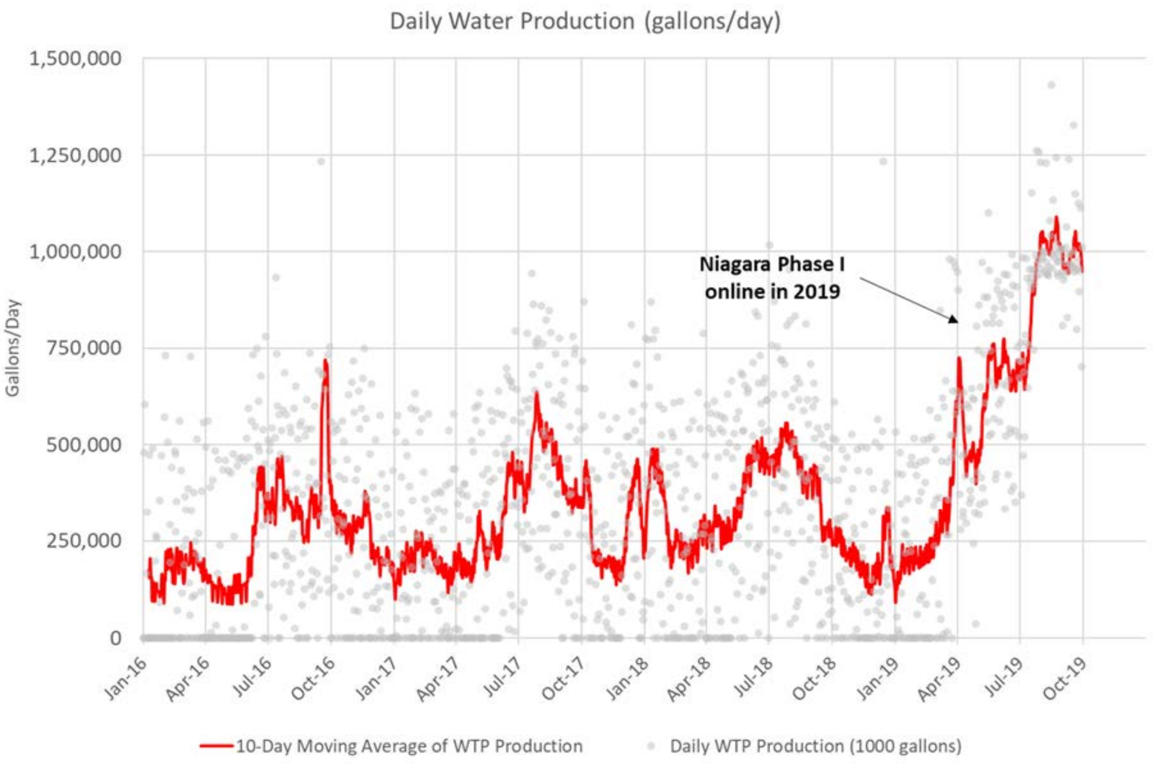


Figure 3. Daily water production of the Charlestown State Park treatment plant, 2016-2019

operations of the first production line of the Niagara water bottling plant. Additional historical water use data for RRCC is provided in Appendix C.

### 3.1.2 Historical water loss

When utility operations began in the RRCC, the rate of water loss was very high due to the poor condition of the aging distribution infrastructure. Since 2011, RRDA has made substantial progress in reducing water loss. Water loss refers to the difference between water production and authorized consumption. For the purpose of this analysis, authorized consumption is assumed to be equal to reported water sales.

Figure 4 shows the volume of water sales and water loss, as well as water loss expressed as a percentage of water production. In the figure, the steady reduction in volume of water loss is apparent. Percentage of water loss has also maintained a declining trend on an annual basis. However, percentage of water loss is a less useful metric for evaluating progress in water loss control because it is affected not only by changes in the volume of water lost, but also the volume of water produced. As water production and sales increase, the water loss percentage will decline even when no additional progress has been made in reducing leakage. This explains why percentage of water loss is highest in winter months when production is lowest. From 2012 to 2018, the annual volume of water loss was reduced by over 70%, saving over 60 million gallons of water per year. Water loss appears to have leveled off, and with the startup of the first Niagara bottling line in 2019, annual water loss is approximately 10% of production. It is

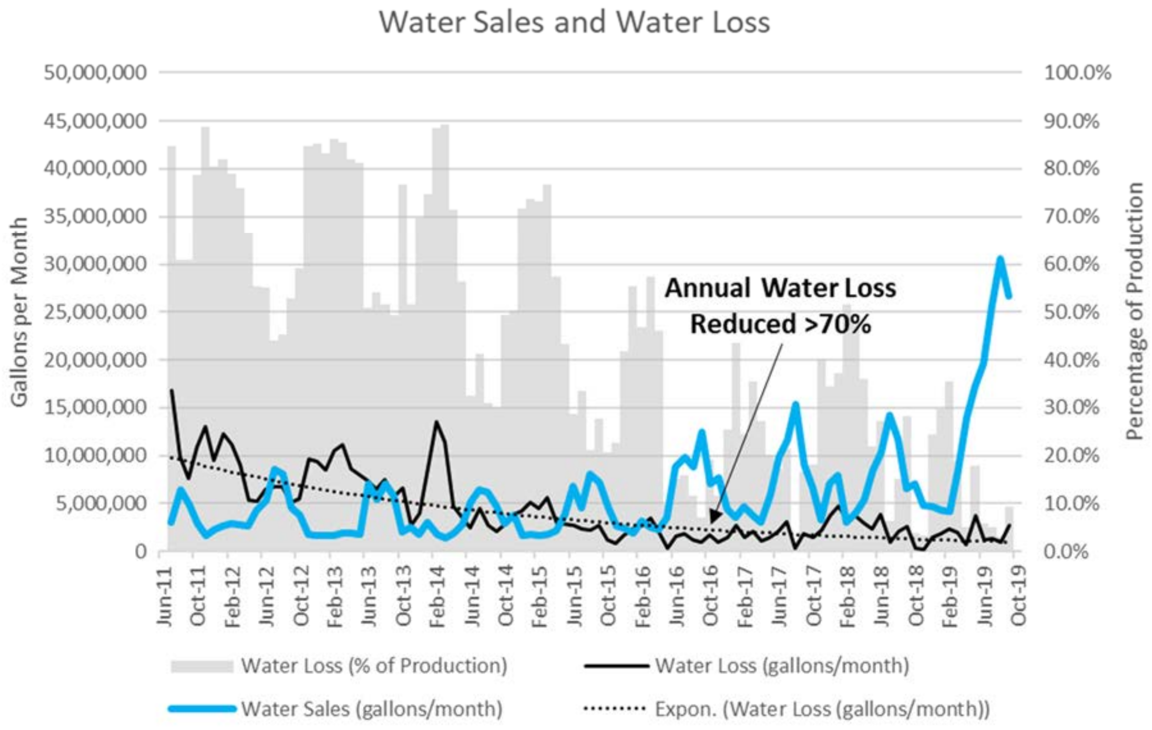


Figure 4. Monthly water sales and water loss, 2011-2019

conservatively assumed for planning purposes that through continued maintenance annual water loss will remain 10% or less of production.

### 3.1.3 Projected near-term demand

The RRDA provided demand projections to the year 2030 based on two possible future RRCC growth scenarios (Appendix C). The assumptions used for these scenarios were utilized for this study with two exceptions. First, one of the scenarios included the City of Charlestown as a large potential wholesale customer. The City of Charlestown water utility was acquired by Indiana-American Water (INAW) in 2018 and they have indicated that they are evaluating options for supplying water to the City of Charlestown from their own Southern Indiana Operation. As a result, the potential wholesale customer included in the RRDA projections was removed from the assumptions. The second exception is related to the use of a peaking factor of 1.5 times average day demand for maximum day projections. The Niagara bottling lines use very large volumes of water at a steady demand with a low peaking factor. Because the two bottling lines in current operation account for most of the water demand in the RRCC, and future demand projections include similar large-user water demands, the peaking factor is assumed to drop from 1.5 to 1.3 times average day demand beginning in 2022.

Niagara is by far the largest water customer in the RRCC. Their facility was constructed with space for the addition of a third bottling line, which would increase water demand by an additional 0.65 MGD. Niagara could decide at any time to install the third line and would require less than a year for it to be operational.

In summary, assumptions used in this study for the evaluation of near-term future demand are as follows:

- Base growth in demand of 5% per year
- Additional large customer demand
    - Niagara 2nd phase – 0.65 MGD, began operation in 2020
    - Niagara 3rd phase plus another large user – 1.3 MGD, in operation in 2022.
- Reduction in maximum day demand peaking factor from 1.5 to 1.3 times average demand beginning in 2022 to reflect the dominant influence of large water users on the demand profile.

Figure 5 shows the projected average and maximum day demands for the years 2020 to 2030. Also shown is the current and projected total and firm capacity of the Supply System needed to meet projected demands. Firm capacity is equal to total capacity with the largest unit removed from service. The existing filtration units can be operated with half of the unit out of service, which results in a current firm capacity of 1.0 MGD. It is noted that until the capacity of the treatment plant is expanded, projected demands are less than the total capacity but greater than the firm capacity of the supply system. As a result, it may be necessary to temporarily utilize alternative supplemental sources if demand exceeds available supply capacity.

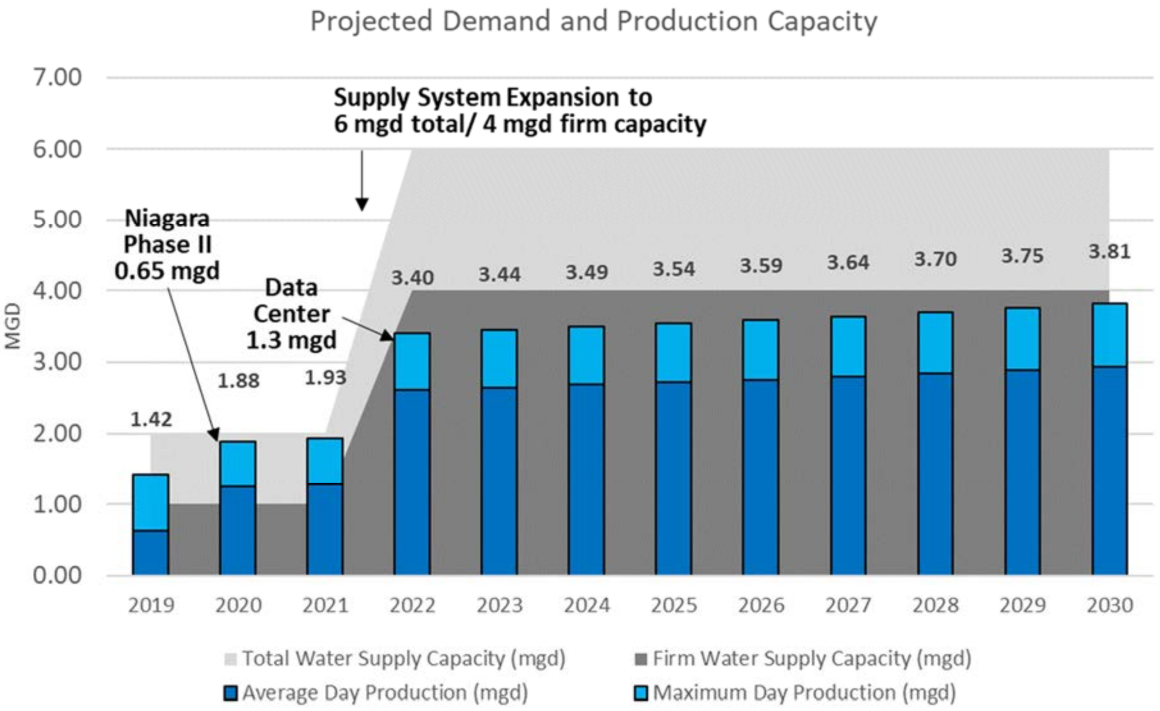


Figure 5. Projected RRCC demand and water production capacity to 2030

## 3.2 Water demand at RRCC build-out

Consideration of the water demand at full build-out of the RRCC is important to inform planning. These projections are used to consider options for further expansion of the water supply system beyond the current project. As appropriate, planning for future expansion and regional water supply development may inform decisions related to the near-term expansion.

The 2018 RRCC master plan describes two development concepts, with and without the development of RRCC's certified mega-site, which is suitable for a major industrial facility. Figure 6 shows the full build-out and phasing of RRCC Concept 1, which includes the mega-site. Build out of the RRCC is projected to occur in 20 years. For Concept 1, the average daily water demand of the RRCC at full build-out is estimated to be 5.7 MGD (Structurepoint, 2018). Assuming a peaking factor of 1.3 to 1.5, the maximum daily demand for water at full build out is estimated to be 7.4 to 8.6 MGD. Representatives from RRDA noted that the actual water demand will entirely depend on the types of industries and other businesses that are established as RRCC builds out, and that maximum demand could be as high as 10 to 15 MGD (Vittitow, 2020). As the RRCC is built out, new water use will shift from the currently developed south end north towards the City of Charlestown.

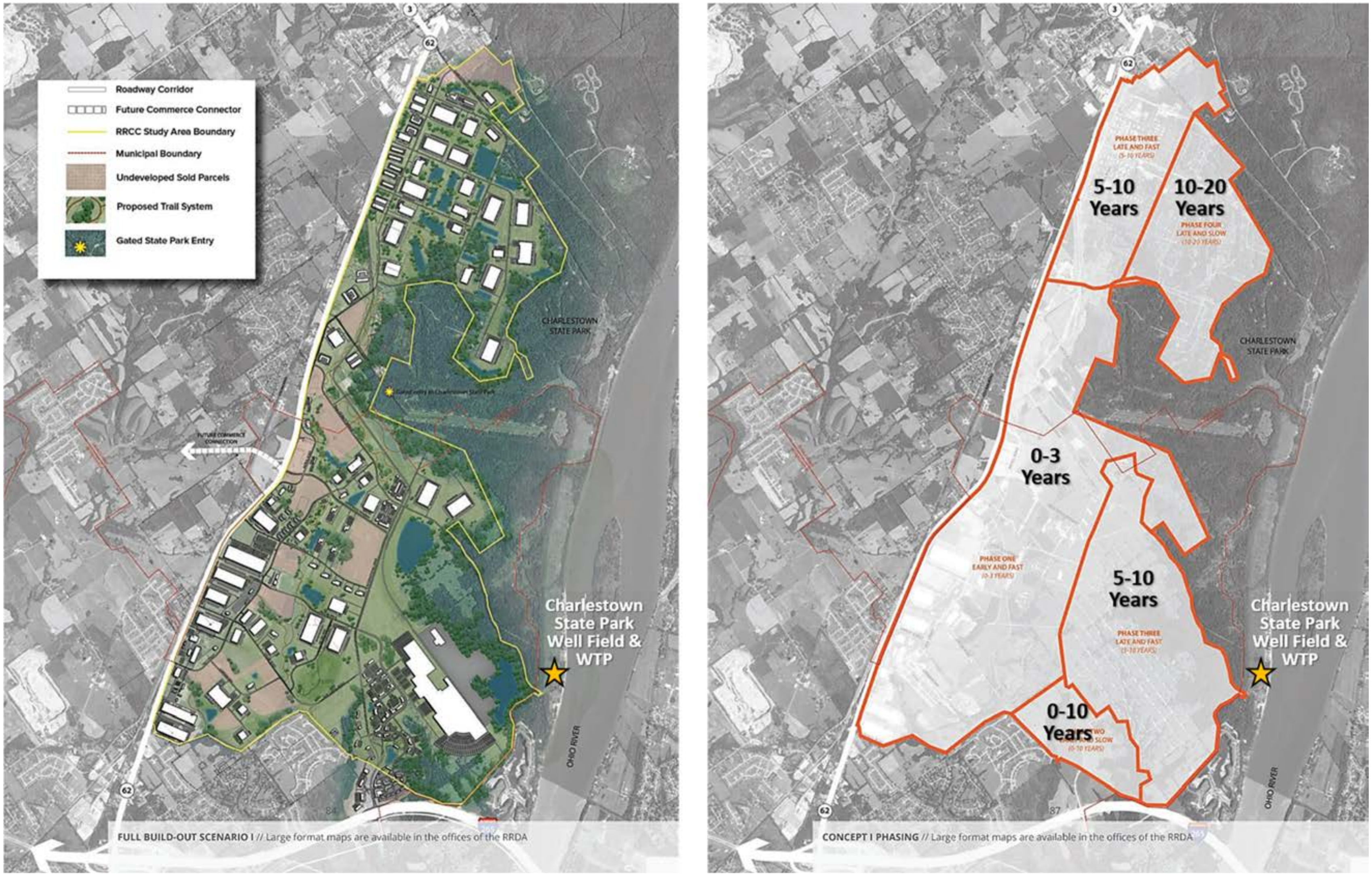


Figure 6. River Ridge Commerce Center Build-Out Scenario 1

*Source: Structurepoint, 2018*

## 3.3 Regional demands

The Charlestown State Park and former INAAP wellfield has been considered as a potential regional water supply since transfer of the property to the State of Indiana. In 2018, INTERA completed a study for the Indiana Finance Authority (IFA) that evaluated the potential demand in southeastern Indiana for a regional water supply and the estimated cost to develop a system at the Charlestown State Park well field. Figure 7 shows the projected growth in public supply water demand through 2060 for counties in southeastern Indiana.

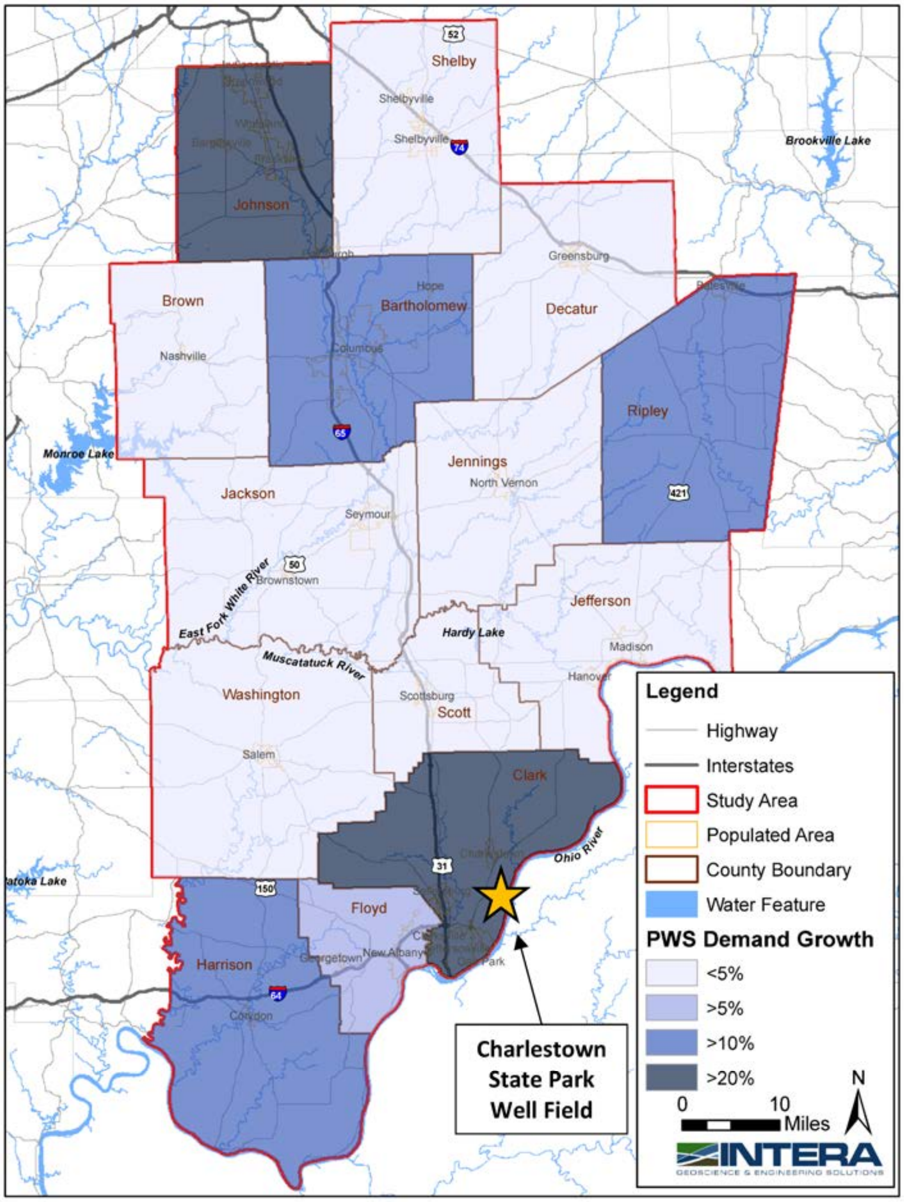


Figure 7. County-level public water supply demand growth through 2060

*Source: IFA, 2018*

In the study, the potential demand for a regional water supply was estimated based on known challenges that may compel utilities to search for alternatives to their existing supplies. Many water utilities face multiple challenges to provide reliable and affordable water service to their customers. Some in Southeastern Indiana rely on sources of water that are vulnerable to drought or contamination. Others struggle to maintain continuous regulatory compliance due to source water quality. Surveys conducted by IFA found that many utilities in the study area and throughout Indiana confront rapidly increasing costs and are concerned over how to make necessary investments and repairs while maintaining affordable rates for their customers (IFA, 2015, 2016, 2018). As shown in Figure 8, it was estimated that these challenges would result in demand for a regional water supply alternative. It should be noted that since these estimates were developed, more has been learned about the general extent of occurrence of CECs such as per- and polyfluoroalkyl substances (PFAS) and actions to establish regulations have gained additional urgency. As a result, the potential demand for a regional alternative water supply option may be greater than originally estimated.

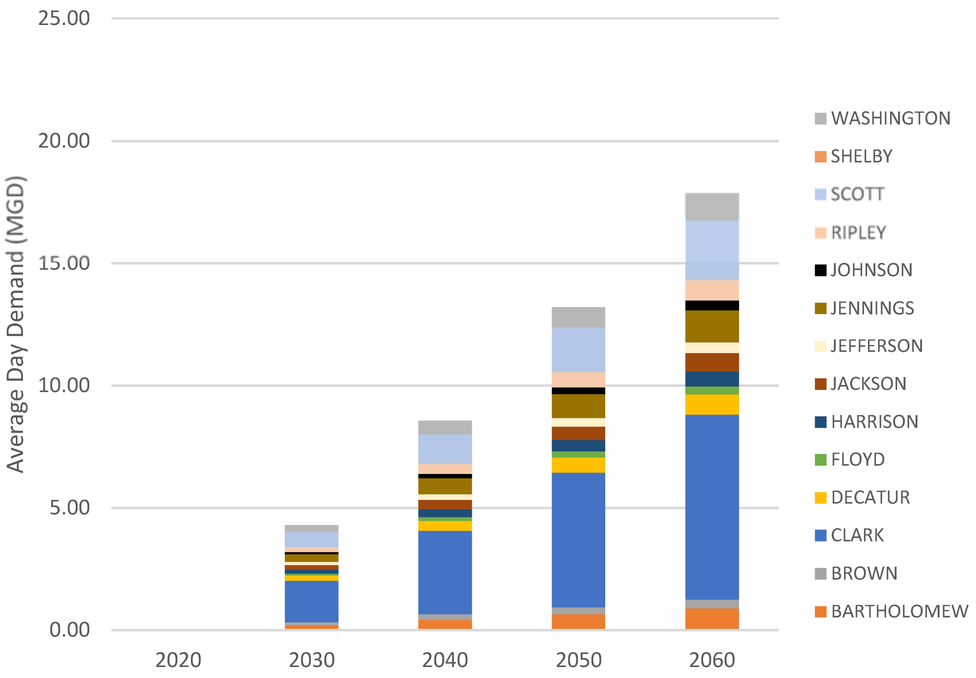


Figure 8. Potential demand for regional water supply, 2020-2060

*Source: IFA, 2018*

Previous studies of the aquifer have estimated that more than 75 MGD could be reliably produced from a redeveloped well field (Layne, 2011). Utilities in southeastern Indiana are highly interconnected, offering an economical strategy for delivering regional water supplies via existing infrastructure with pumping and capacity improvements as required to allow for wheeling of water through distribution systems to adjacent utilities. Additional discussion and recommendations related to the development of the regional water supply are presented in Section 6 of this report.

# 4.0 CURRENT SYSTEM

The current Supply System consists of a well field, treatment plant, transmission mains and storage tank and booster pump station (Figure 9). The well field and treatment plant are operated to fill the ground storage tank, and the booster pump station delivers water from the Supply System ground storage tank to the RRCC Distribution System. IDNR owns the Supply System and contracts with RRDA for its operation. The original construction plans for the water supply system are included in Appendix D.

The RRCC Distribution System consists of pipeline networks, additional storage tanks, service lines and meters, and hydrants. RRDA has invested in improvements to the Distribution System and has planned for the construction of additional facilities to support further development of the RRCC. The Distribution System is operated by RRDA.

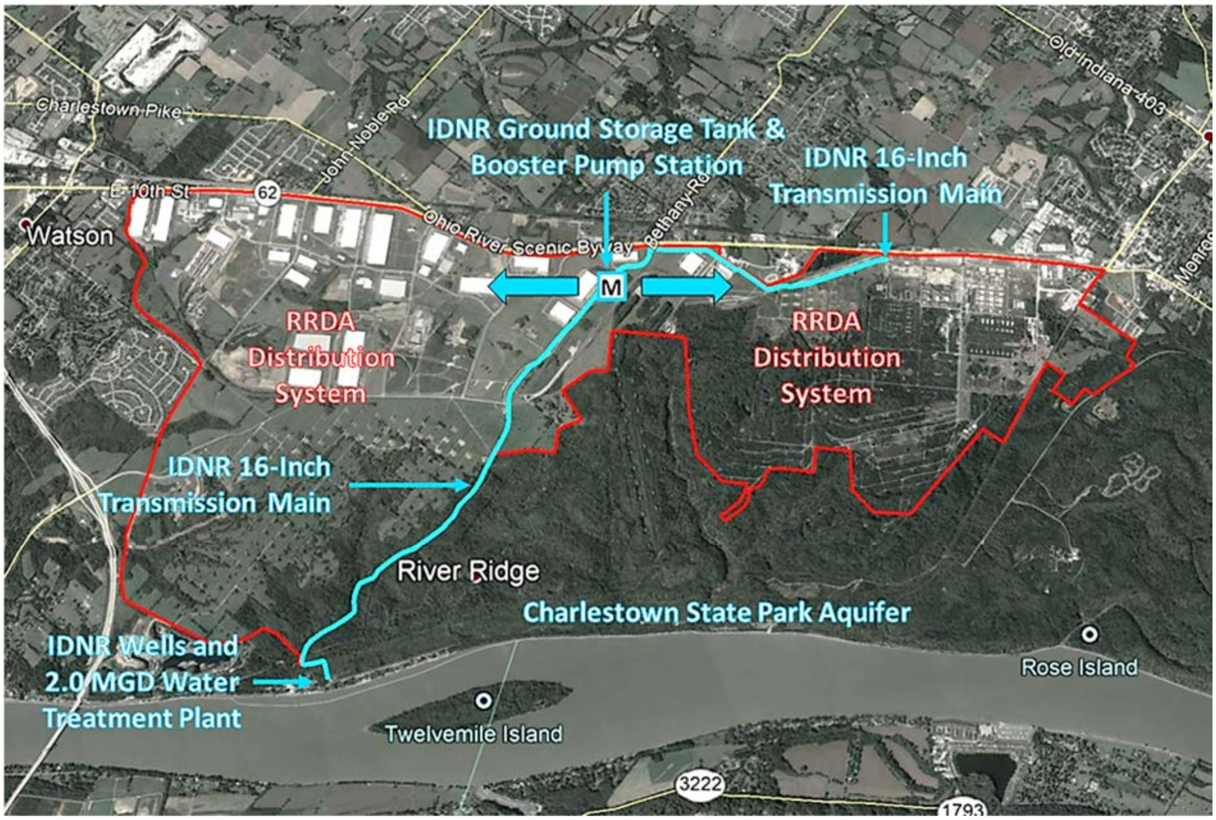


Figure 9. IDNR Supply System and RRDA Distribution System

To assess options for expansion of the Supply System, a visual inspection of the facilities was conducted, and the well field was tested to determine well performance and evaluate raw water quality. Original design documents (Appendix D) were reviewed and Supply System operators from RRDA and LWC were interviewed to identify operational challenges and needed improvements. The general resiliency and reliability of the Supply System was also evaluated.

This section describes the existing Supply System and the results and conclusions of well field testing and engineering review. The WWII-era Ranney collector wells, associated transmission mains and other infrastructure used by the former INAAP are not discussed here in detail.

## 4.1 Source of Supply

The current source of supply is the Charlestown State Park Well Field, with three production wells located near the treatment plant in a line parallel to the Ohio River (Figure 10). To assess current conditions, we conducted field tests at the well field, including hydraulic testing and water-quality sampling.

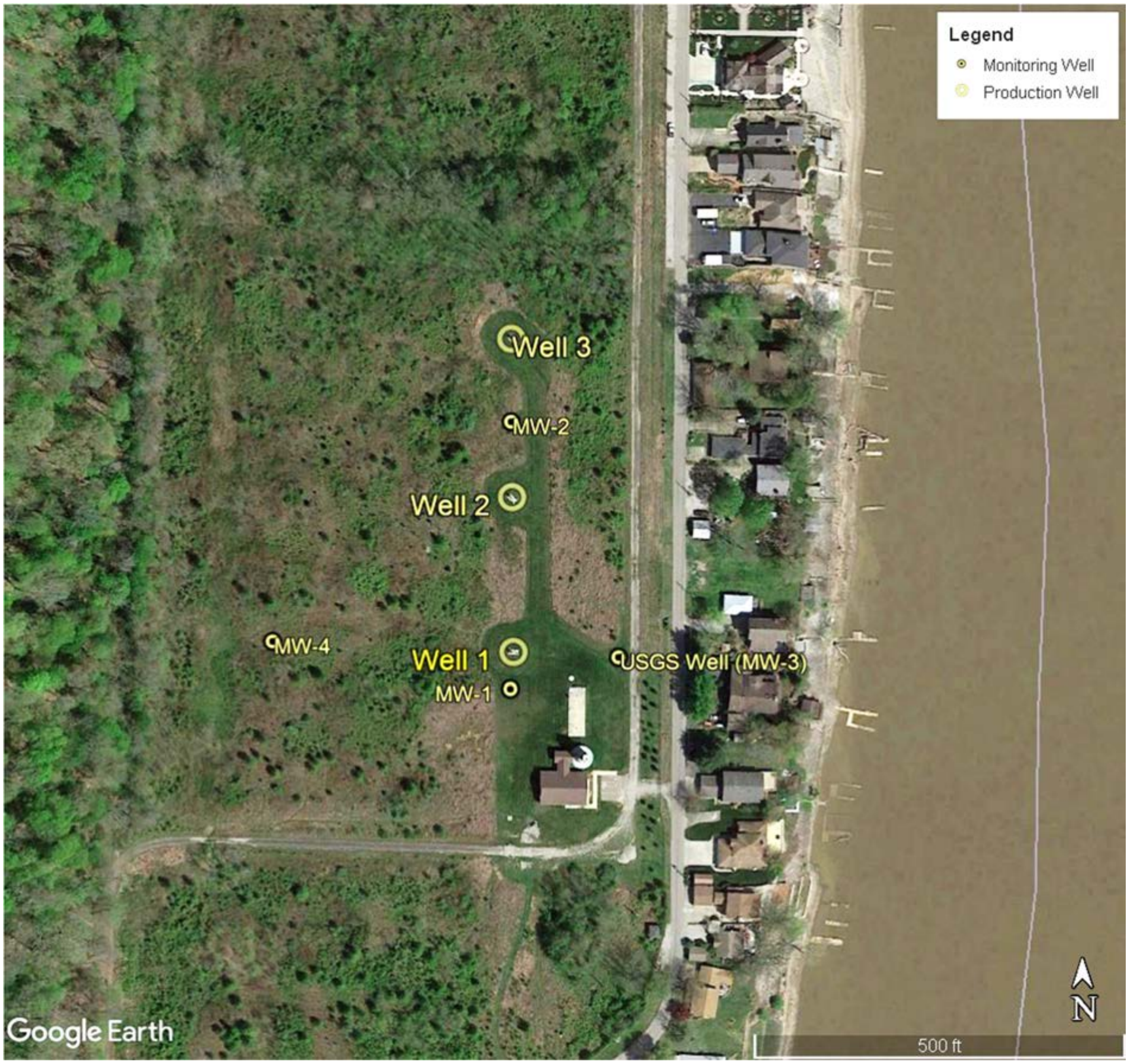


Figure 10. Charlestown State Park Well Field

### 4.1.1 Aquifer

The wells produce groundwater from the Ohio River Alluvium, a highly productive glacial outwash aquifer (the Aquifer) composed of permeable sand and gravel deposits. The deposits fill a pre-glacial bedrock valley along the Ohio River.

The Aquifer is limited in extent, with a saturated thickness of less than 100 feet. Perpendicular to the river, the Aquifer pinches out where the bedrock crops out along a line of bluffs ranging from 400 to 1,000 feet from the river. The Ohio River is incised into the Aquifer and is connected through a layer of silt and organic material lying along the riverbed. The hydraulic connection to the Ohio River supports high yields from the Aquifer and is the primary control on groundwater levels. Static water levels in the Aquifer are determined by river stage, which is controlled downstream of the well field by the McAlpine Locks and Dam in Louisville. Analysis of daily data from a USGS monitoring well at the well field indicates that the minimum, median, and 90th percentile groundwater levels are 419, 420, and 425 ft. The ground elevation in the wellfield is approximately 449 ft. Data and analysis are included in Appendix A.

### 4.1.2 Wells and Pumps

The existing well field was designed with three production wells constructed and equipped to produce 700 GPM (~1 MGD) each. However, the wells were constructed to produce significantly higher yields. Due to the high transmissivity of the aquifer and minimal pumping interference, the wells are closely spaced, separated by distance of 200 feet between them. The existing wellhead protection area delineation is based on pumping of all three wells at 1,400 GPM.

Shown in Figure 11, Well 1 was constructed and tested in 2009, followed by construction of Well 2 and Well 3 in 2010. The wells are approximately 100 to 120 ft in total depth, with 16-inch casing and 30 ft of 16-inch screen. The total depth and screen setting of Well 1 is approximately 20 feet deeper than Wells 2 and 3. Each well is equipped with a 30 HP motor with soft-starter and vertical line shaft turbine pump rated for 700 GPM production. The pump intakes for all three wells are reportedly set at the same depth. Additional details of the well construction and pump curves and specifications are included in Appendix C.

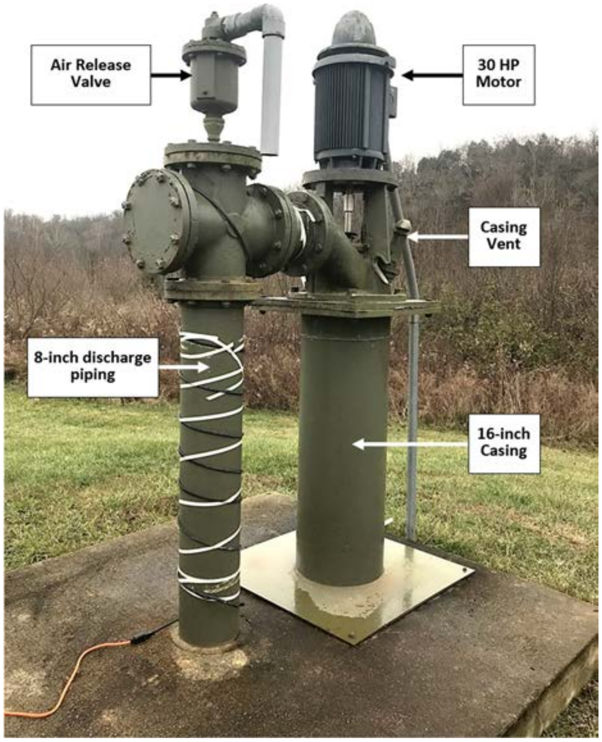


Figure 11. Well No. 1

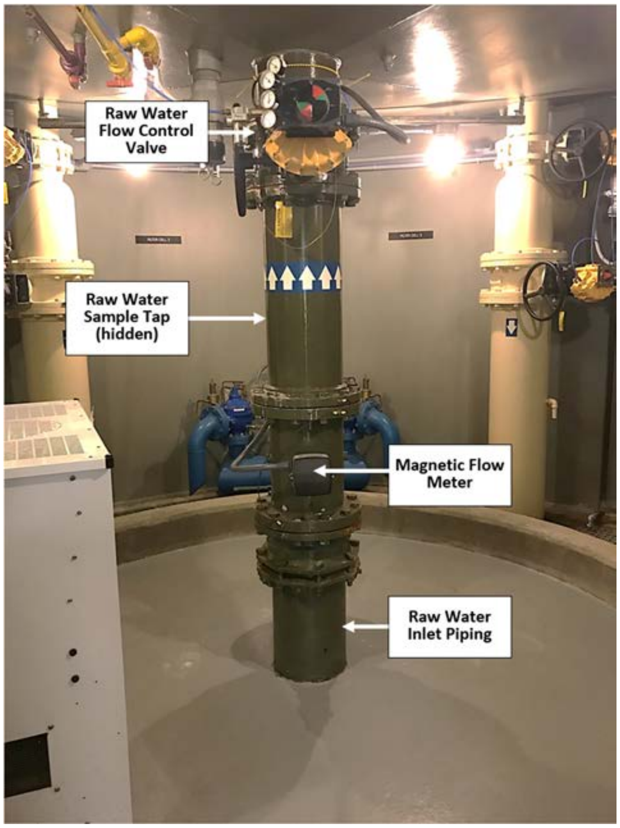


Figure 12. Raw water riser pipe with flow control valve and raw water meter

Wells are manually selected for operation on a regular rotation. Because there is no storage at the water treatment plant, well and high service pumping rates are matched to maintain a minimum water level in the detention tank. The flow rate from the wells is controlled by throttling flow with a pneumatically-actuated butterfly valve on the inlet line to the treatment unit (Figure 12). The valve is controlled based on the water level in the treatment unit's detention tank. Throttling results in energy loss and will cause the well pumps to operate out of their optimal efficiency range, reducing energy efficiency and increasing the cost of groundwater pumping.

The wells are not equipped with water level transducers for monitoring static and pumping water levels, nor are they equipped with individual flow meters. Combined flow from the well field is measured by the magnetic flow meter on the inlet riser pipe shown in Figure 12.

The transmitting capacities of the existing well screens are adequate to accommodate a significant increase in production rates. Well construction data indicates that the maximum flow capacities of the well screens are 1,980 GPM for Well 1 (WHPA, 2010) and 2,580 GPM each for Wells 2 and 3, based on a maximum inflow velocity of 0.1 FT/SEC.

The existing discharge piping is 8-inch, connecting to 12-inch piping outside of the vaults. At 700 GPM the flow velocity in the 8-inch ductile iron pipe is approximately 4.2 feet per second. Significantly increasing flow will require upsizing of the 8-inch diameter pipe and appurtenances.

### 4.1.3 Well field capacity testing

The well field was tested to evaluate the hydraulic properties of the aquifer and to evaluate the feasibility of increasing capacity of the existing wells.

Four monitoring wells were installed during construction of Well 1 (Figure 10). In 2013, one of the monitoring wells (MW-3) was converted to a US Geological Survey (USGS) gaging station that continuously measures, records, and reports water levels at the well field (USGS, 2020). We used this record to establish the range of static water levels in the well field and determine the available drawdown. All the monitoring wells were instrumented and used during the testing of the well field described in this report.

The existing wells were tested to determine whether there had been any changes in well efficiency and performance since they were first placed in service, and to verify the feasibility of installing higher capacity pumping equipment in them. To do this, we temporarily instrumented all the production wells with pressure transducers to record water level changes with the wells in operation. Pressure transducers were also installed in the three existing monitoring wells to evaluate mutual pumping interference within the well field. Pressure transducers were installed in mid-January and retrieved in early February. Additional details are provided in Appendix A.

During the testing period, the well field and plant were operated normally, with minimal adjustments. The backwash recycling system was turned off to ensure that only flow from the wells would be measured during testing. Also, operation of the wells was planned such that for the first 10 days of the test the wells were operated only in pairs and for the next 11 days the wells were operated individually. Water level data was collected from all instruments at the end of testing. LWC could not provide the continuous record of flow rates as planned, due to issues with data retrieval from the SCADA system. They provided flow rate data manually recorded in operating logs instead.

The continuous water level and available flow rate data were used to estimate drawdown in each well caused by pumping at different rates, specific capacity of each well, and the pumping interference between wells. Details of the analysis are included in Appendix A.

#### 4.1.3.1 Well efficiency

Based on the hydraulic testing conducted for this project, pumping interference between wells is very low. Observed interference at pumping rates of 700 GPM is less than one foot.

Since the wells were first constructed, periodic testing has been performed to evaluate well and pump efficiency. This historical data was reviewed and compared with the data collected from the hydraulic testing performed for this study. Reportedly, none of the wells have exhibited enough loss of capacity to require rehabilitation (Smith, 2020). Specific capacity is used as a measure of well efficiency defined as the production in gallons per minute per foot of drawdown (GPM/ft) at a specific production rate. Specific capacity data is available from the original well construction and testing in 2009-2010, overboard testing in 2016 and 2019, and estimates derived from the testing done for this report. The data is presented in Appendix A.

The original (2009-2010) specific capacities of Wells 1, 2 and 3 at pumping rates of 1,400 GPM were 165-170 GPM/ft, 460-465 GPM/ft, and 435-440 GPM/ft. The specific capacity of Well 1 has improved since the well was constructed in 2009, possibly due to incomplete development at the time of construction. The original specific capacities of Wells 2 and 3 were both more than twice that of Well 1. Current specific capacities For Wells 2 and 3 cannot be directly compared to the original 2010 results because the drawdowns were measured at different pumping rates. Using the available data, the current specific capacities at pumping rates of 1,400 GPM for Wells 1, 2, and 3 are estimated to be 192 GPM/FT, 459 GPM/FT, and 425 GPM/FT, respectively.

#### 4.1.3.2 Estimated available drawdown

To assess the potential for increasing capacity of the wells, we estimated available drawdown, defined as the distance that the water level can be lowered below the static water level (SWL) by the installed pumping equipment. The lowest achievable pumping water level (PWL) in these wells is above the pump inlet by a distance equal to the net positive suction head requirement (NPSHr) of the pumping equipment. Additional details related to the SWL's in the well field are presented in Appendix A. Figure 13 shows the available drawdown for the existing pumping equipment. The available drawdown of the wells at existing and proposed pumping rates equipment is noted in Table 1.

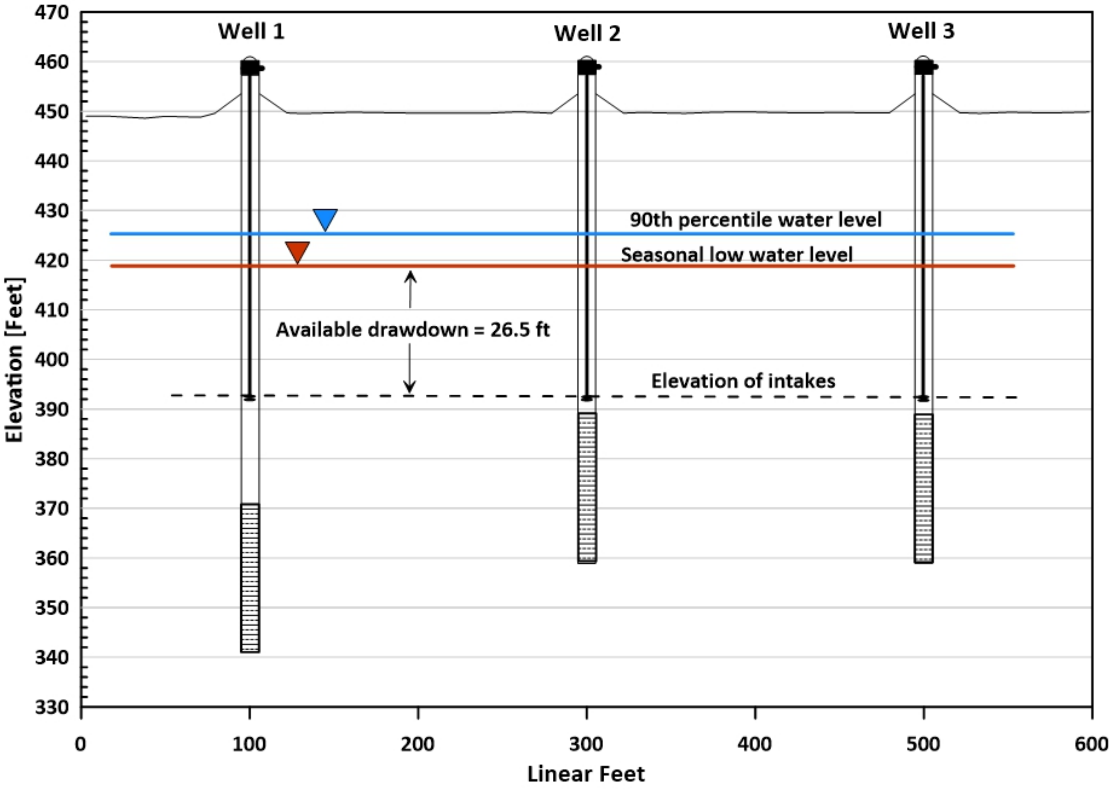


Figure 13. Well cross section showing range of static water levels, the pump intakes, and the depth available for NPSHr and pumping drawdown.

Table 1. Available drawdown for existing wells

| Well | SWL (elev,ft) | Pump Intake (elev,ft) | Depth from SWL to Pump Intake (ft) | Available drawdown @ Pumping Rate of 700 GPM (ft) | Available drawdown @ Pumping Rate of 1400 GPM (ft) |
|---|---|---|---|---|---|
| 1, 2, and 3 | 419-425 | 389.5 | 29.5-35.5 | 23.5-29.5 | 13.5-19.5 |

*Notes: SWL = static water level, NPSHr is estimated to be 6 ft @ 700 GPM and 16 ft @ 1400 GPM*

### 4.1.4 Well field water quality

The existing treatment facility was designed for iron and manganese removal. With respect to iron and manganese, the raw water quality has improved since the wells were originally constructed. The treatment facility performs very well for removal of those constituents.

A recent study by the Kentucky Department for Environmental Protection reported per- and polyfluoroalkyl substances (PFAS) in treated water produced by several water utilities using groundwater from the Ohio River Alluvium (KYDEP, 2019). PFAS are not currently regulated for drinking water by the federal government or State of Indiana, but future regulations are anticipated. The Charlestown State Park treatment plant is not designed to remove PFAS and would need to be modified if PFAS removal were necessary. Sampling of each well was done to determine whether PFAS or other potential contaminants of emerging concern (CECs) are present in the source water in order to plan for the potential future need for treatment.

We evaluated prior water quality data and regulatory reporting, then collected additional water quality samples from each well to identify issues that should be addressed with the expansion.

#### 4.1.4.1 Review of prior water quality data

Several sources of water quality data were reviewed. RRDA provided a summary of general water quality for the wells and LWC performed additional water quality sampling on December 11, 2019. Historical water quality data from the original well construction and testing was also reviewed, as were IDEM monthly operating reports (MORs).

Revisions to the Lead and Copper Rule (LCR) have been proposed recently by the USEPA (USEPA, 2019). Among other proposed changes, the action level for lead may be reduced. Review of recent LCR compliance reporting suggests that there are no significant issues and the plant does not currently treat for corrosion control. A more thorough review of the water chemistry and corrosion control is warranted considering the pending revision to the LCR.

Review of recent Disinfection By-Product Rule compliance reporting suggests that total trihalomethane (TTHM) and Haloacetic Acid (HAA) are well within regulatory limits.

The December 11, 2019 water quality analysis provided by LWC was for a mix of raw water from Wells 1 and 3, which were operating together at the time of sample collection. Several contaminants of concern were detected, including perfluorooctanoic acid (PFOA), perchlorate, and hexavalent chromium.

#### 4.1.4.2 Water-quality sampling and analysis

Water-quality samples were collected from each production well during the hydraulic testing of the well field. Samples were collected from a raw-water sample port located within the treatment plant, upstream of any treatment (Figure 12). Prior to sample collection, each well was pumped individually for at least 30 minutes to ensure that the water in the pipeline was representative of the well being tested. The samples were analyzed for a comprehensive set of drinking-water constituents, including metals, pesticides, semi-volatile organic compounds (SVOCs), and volatile organic compounds (VOCs). In addition, the samples were analyzed for selected contaminants on the Unregulated Contaminant Monitoring Rule (UCMR) 3 and 4 lists, including 1,4-Dioxane, selected PFAS, and other CECs. Results are summarized below, and full laboratory results are presented as Appendix B.

#### 4.1.4.3 Summary of water quality observations

**Inorganics**

Generally, more metals were detected and at higher concentrations in Well 1 than in Wells 2 and 3 (Table 2). Secondary maximum contaminant levels (SMCL) were exceeded in raw water for iron (Well 1) and manganese (Wells 1 and 2). Iron and manganese concentrations in the Aquifer vary by location and commonly exceed the SMCL's of 300 ug/L and 50 ug/L, respectively (WHPA, 2010). A comparison of iron and manganese concentrations measured at the time of well construction (WHPA, 2010) with the current results suggests that iron and manganese concentrations have stabilized or decreased over time in each of the three production wells (Table 3).

Table 2. Summary of metals detected in 1/23/20 samples.

| Analyte | Units | Reg Limit | Well 1 | Well 2 | Well 3 |
|---|---|---|---|---|---|
| Iron | [ug/L] | 300^ | **400** | 43 | 32 |
| Arsenic | [ug/L] | 10* | 1.5 | < 1.0 | < 1.0 |
| Barium | [ug/L] | 2000* | 87 | 45 | 49 |
| Copper | [ug/L] | 1300! | 18 | 5.0 | 2.1 |
| Lead | [ug/L] | 15! | 5.8 | 1.6 | < 1.0 |
| Manganese | [ug/L] | 50^ | **240** | **150** | 48 |
| Nickel | [ug/L] | -- | 6.7 | 1.5 | < 1.0 |

*Notes: detections above reg limit in bold. ug/L; microgram per liter*

**USEPA Maximum Contaminant Level*

*^USEPA Secondary Maximum Contaminant Level*

*! USEPA Action Level or Maximum Contaminant Level Goal*

Table 3. Comparison of original iron and manganese concentrations with current results.

| Analyte | Units | SMCL | Well 1<br>9/20/09 | Well 1<br>1/23/20 | Well 2<br>4/28/10 | Well 2<br>1/23/20 | Well 3<br>6/3/10 | Well 3<br>1/23/20 |
|---|---|---|---|---|---|---|---|---|
| Iron | ug/L | 300 | 908 | 400 | 197 | 43 | 60 | 32 |
| Manganese | ug/L | 50 | 246 | 240 | 187 | 150 | 108 | 48 |

*ug/L; micrograms per liter*

Hexavalent chromium was detected at a concentration of 0.04 ug/l in the combined Well 1 and 3 sample collected by LWC on December 11, 2019. Hexavalent chromium comes from natural and industrial sources. Total chromium is regulated with a federal MCL of 100 ug/l, but there is no separate federal or State of Indiana MCL for hexavalent chromium. Some states have proposed or established MCL's for hexavalent chromium. New Jersey has proposed an MCL of 0.07 ug/l for hexavalent chromium which is only slightly above the levels detected in the combined sample. Appropriate technologies for the removal of hexavalent chromium include ion exchange (IX) and reverse osmosis (RO) (SWRCB, 2017).

Perchlorate was detected at a concentration of 0.27 ug/l in the combined sample collected by LWC. Perchlorate may come from natural sources in arid regions but is most associated with the manufacture of propellants and munitions, as was performed at INAAP. There is no federal or State of Indiana MCL for perchlorate. The USEPA has established a lifetime drinking water health advisory level of 15 ug/l. Some states have established MCL's for perchlorate, including California which currently has an MCL of 6 ug/l and is currently evaluating revision to a lower MCL of 1 ug/l, and Massachusetts, which has an MCL of 2 ug/l. Though the detected level is significantly lower than the USEPA health advisory level, considering the historical activities of the INAAP, water quality should be monitored, and future wells tested. If treatment were required in the future, appropriate technologies for removal of perchlorate include ion exchange (IX) and reverse osmosis (RO) (USEPA, 2017).

**Organic compounds**

No pesticides, SVOCs, or VOCs were detected in any of the samples collected for this study. However, several UCMR compounds including 1,4-dioxane (dioxane) and three PFAS compounds were detected. Dioxane and PFOA were detected in all three wells and PFOS and PFHxA were detected in two of the three wells (Table 4).

Dioxane is a synthetic industrial chemical. It was detected in all three production wells at concentrations ranging from 0.08 to 0.26 ug/L (Table 4). There are currently no federal or State of Indiana MCL's for Dioxane and the observed concentrations are below the USEPA drinking water lifetime health advisory (HA) of 200 ug/L (USEPA, 2018). Some states have established limits for Dioxane, including an MCL of 0.4 ug/l in New Jersey and a notification level of 1 ug/l in California. The levels detected in the wells are close to the MCL established by New Jersey. If treatment were required in the future for Dioxane, appropriate technologies include advanced oxidation processes (AOP) (USEPA, 2017).

Table 4. Summary of organic compounds detected in 1/23/20 samples.

| Analyte | Units | USEPA Lifetime HA | Michigan Draft Rule | New Jersey MCL | California Response Levels | Well 1 | Well 2 | Well 3 |
|---|---|---|---|---|---|---|---|---|
| 1,4 - Dioxane | [ug/L] | 200 | -- | 0.4 | | **0.18** | **0.26** | **0.08** |
| PFOA | [ng/L] | 70 | 8 | 14 | 10 | **4.7** | **4.4** | **6.9** |
| PFOS | [ng/L] | | 16 | 13 | 40 | < 2.0 | **2.1** | **2.0** |
| PFHxA | [ng/L] | -- | 400,000 | -- | | **2.3** | < 2.0 | **2.1** |

*Notes: detections in bold. ug/L - micrograms per liter, ng/L - nanograms per liter. HA; Health Advisory*

In the water quality sampling completed for this study, PFOA was detected in all three wells and PFOS and PFHxA were each detected in two of the three wells. In the sampling performed in December 2019 by LWC, PFOA was detected at a level of 4.5 ng/l in the combined sample collected from Wells 1 and 3. USEPA has established a lifetime HA of 70 ng/L for combined PFOA and PFOS (USEPA, 2018). The observed concentrations are below the current USEPA drinking water lifetime HA. There are currently no federal or State of Indiana MCL's for PFAS. However, many states have established MCLs or response levels for various PFAS. New Jersey has established MCLs for PFOA, PFOS, and perfluorononanoic acid (PFNA). Michigan has proposed a draft rule which establishes MCL's for seven PFAS, including PFOA, PFOS, PFHxA. California has established response levels of 10 ng/l for PFOA and 40 ng/l for PFOS, requiring that wells exceeding these levels are removed from service. Table 4 summarizes the sampling results for each well and the related federal HA's, MCL's in New Jersey and Michigan, and response levels in California for comparison. PFOA was detected at concentrations close to the MCL's adopted by New Jersey and proposed by Michigan. Levels of PFOS detected in the wells are significantly lower than the least of the proposed MCL's or response levels. The level of PFHxA is far below Michigan's proposed MCL. If treatment were required for removal of PFOA, appropriate technologies include GAC, IX, and RO.

## 4.2 Treatment Plant

The existing treatment facility is located adjacent to the well field. The plant is designed for iron and manganese removal and includes aeration and detention, filtration, chemical treatment, backwash recycling, and high service pumping. The facility is equipped with an emergency generator with the capacity to operate the entire plant in the event of loss of power. Figure 14 identifies key processes and features of the plant.

The floor elevation of the plant is at elevation 457.0 ft, above the 100-year flood elevation of 453.2 ft. Since its construction, the plant has not flooded but LWC and RRDA staff reported that on occasion the plant has been surrounded by water and difficult to access.

### 4.2.1 Aeration and Detention

The treatment plant was designed around a 1,400 GPM integrated aeration, detention, and filtration unit. Raw water from the wells is pumped through a riser pipe to the top of the unit where it discharges into an induced-aeration unit. From the aeration unit, water flows down into a 72,000 gallon detention tank. There are chemical feed points for sodium hypochlorite and sodium permanganate at the bottom of the aerator and entry into the detention tank. The detention time of the aerated water is a minimum of 30-minutes. Water flows downward from the bottom of the detention tank into the filters below it. A pneumatically-actuated butterfly valve on the raw water inlet piping is adjusted to throttle flow from the wells, maintaining the detention tank level within a set range and generally matching well and high service pump flows. There is the potential to perform pilot testing and obtain permitting approval for an increased aeration rate and decreased detention time to allow uprating of the integrated filtration unit.

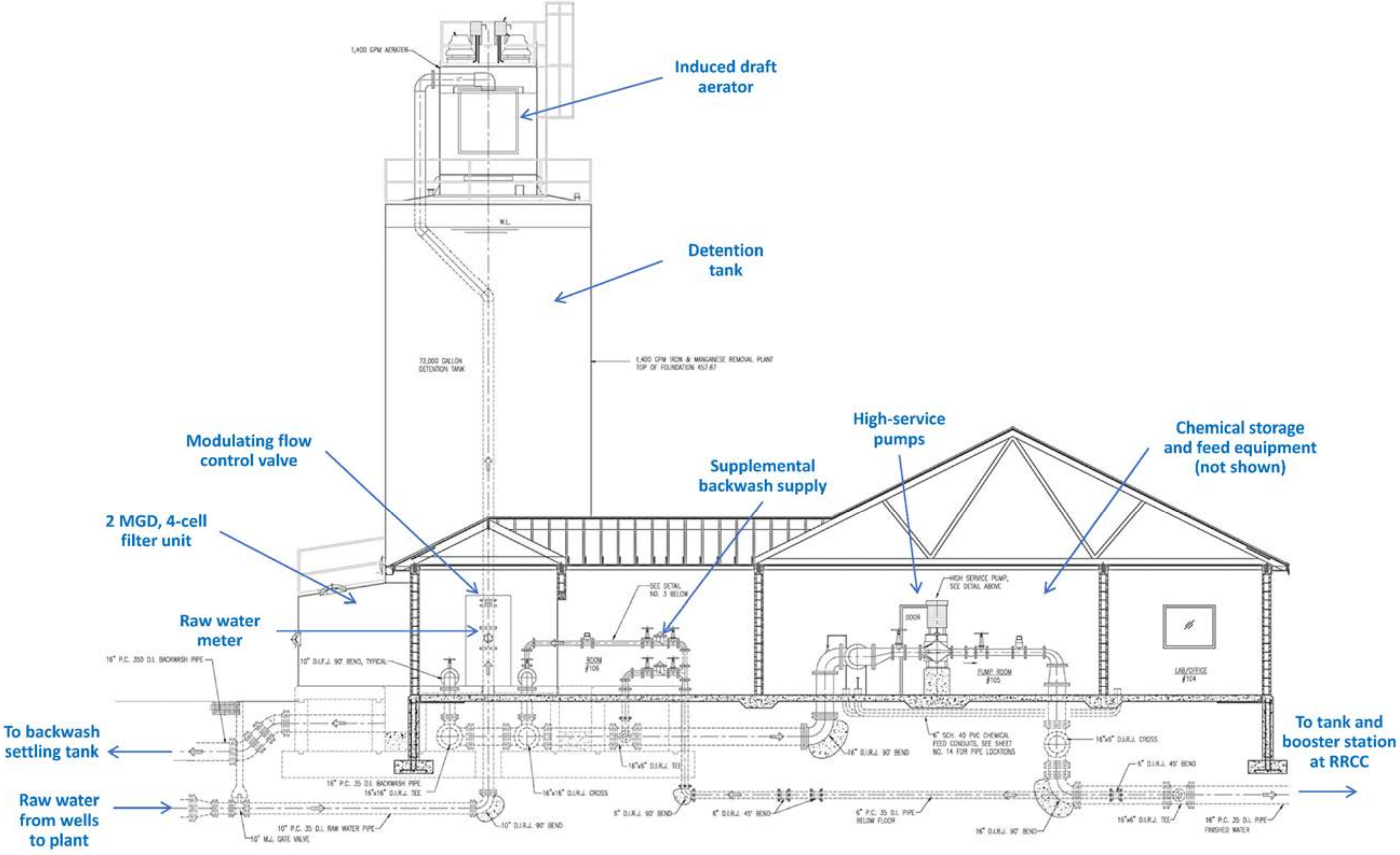


Figure 14. Charlestown State Park Water Treatment Plant

*Note: adapted from Curry, 2009*

### 4.2.2 Filtration

Four dual-media filter cells comprise the base of the treatment unit, supporting the detention tank and aerator. Each filter cell has an area of 120 $ft^2$, and the filters are currently rated for a loading rate of 3.0 $GPM/ft^2$. There is the potential to perform pilot testing and obtain permitting approval for a higher loading rate of up to 5.0 $GPM/ft^2$, effectively increasing the capacity of the existing filters. The treatment plant building was designed for the addition of a second identical treatment unit for capacity expansion. Piping and valves allow isolation of one pair of filter cells for maintenance while the other pair remain in service.

Backwashing of the filters is accomplished with filtered water from in-service cells and supplemental supply from the discharge of the high service pumps. The filters reportedly perform well, but the media has not been inspected since it was originally installed 10 years ago. According to LWC and RRDA operations staff the filter media is likely in need of replacement. Given the current level of demand in the RRCC, change-out of the existing filter media should be scheduled for after additional filtration capacity is constructed and placed in service.

### 4.2.3 Chemical Treatment

The treatment plant’s chemical feed systems are summarized in Table 5.

Table 5. Existing chemical treatment

| Chemical | Purpose | Chemical Feed Pumps | Application Points |
|---|---|---|---|
| Liquid sodium hypochlorite | Pre- and post-disinfection | (3) pre-chlorination,<br>(3) post-chlorination | Pre: base of aeration unit, Post: high service pump suction |
| Liquid sodium permanganate | Oxidation of manganese | 3 | Base of aeration unit, prior to detention tank |
| Granular sodium fluoride | Dental prophylaxis | 3 | High service pump suction |

*Source: Plans for Water Supply Improvements – Division II (Curry, 2009).*

**Chlorine.** Liquid sodium hypochlorite solution is fed pre- and post-filtration for oxidation of iron and disinfection. LWC and RRDA operations staff reported that the piston pumps used for the chlorine feed system are unreliable and require frequent maintenance. The PVC piping carrying the chlorine solution has also presented leaks.

**Permanganate.** The liquid sodium permanganate chemical feed system was designed to aid with oxidation of manganese. According to LWC and RRDA operations staff, it is not necessary to use the permanganate feed system to achieve finished water goals for manganese.

**Fluoride.** A fluoride solution is added for dental protection.

**Corrosion Inhibitor.** Corrosion control treatment has not been necessary for compliance with the Lead and Copper Rule (LCR). Currently, there are no facilities in the plant for corrosion control treatment.

### 4.2.4 High Service Pumping

The high service pumps receive suction directly from the filter effluent and pump to the 16-inch transmission main that delivers water to the Supply System ground storage tank located within the RRCC. Figure 15 shows the existing high service pumps and the pumping equipment is summarized in Table 6.

Table 6. High-service pumping equipment

| High Service Pump | Design Pumping Rate (GPM) | Design Total Dynamic Head (TDH, ft) | Pump Type | Motor (HP) | Motor Starter |
|---|---|---|---|---|---|
| 1 | 700 | 260 | Split-case, 4x5x18 HD | 75 | Soft-start |
| 2 | 1,400 | 265 | Split-case, 6x8x18 HD | 100 | Soft-start |
| 3 | 1,400 | 265 | Split-case, 6x8x18 HD | 100 | Soft-start |

*Source: Plans for Water Supply Improvements – Division II (Curry, 2009).*

### 4.2.5 Residuals handling

Backwash water from the filters is discharged to an in-ground backwash water holding tank located immediately north of the treatment plant. The tank has approximately 92,700 gallons of usable storage volume. Backwash water is held for 48 hours to allow solids to settle and then the clarified supernatant is pumped from the tank for recycling by blending with raw water from the wells. The pumping system consists of duplex submersible 200 GPM pumps and the system is interlocked with the well pumps so

Figure 15. Existing high service pumps

that it will only operate when wells are pumping. LWC and RRDA operations staff reported that sludge in the holding tank has historically been removed and hauled away (wet) for disposal every 2-3 years. That frequency corresponds to an average plant production rate over that time period of approximately 0.5-1.0 MGD. Current production rates are approximately 1.5 MGD and as a result more frequent cleaning should be anticipated.

### 4.2.6 Electrical

An in-depth review of electrical systems was not performed. Some general observations were made during inspection and well testing. The plant is equipped with a permanent diesel driven emergency backup generator. The 600 kW generator is reported to have been sized for expansion of the plant. The electrical service transformer is located southeast of the building. LWC and RRDA representatives noted that it lower than the floor elevation of the building and is vulnerable to flooding.

### 4.2.7 Instrumentation and Control

Basic instrumentation and controls were installed with the original system. An in-depth review was not performed for this study, but some observations were noted while inspecting the facilities, speaking with RRDA and LWC operations, and testing the production wells.

RRDA and LWC operations staff reported that the SCADA system provides limited capabilities and that plant operation would benefit from additional instrumentation and controls. For example, the SCADA system can be used to call for the chlorine feed pumps to run but it lacks feedback to verify proper operation. When chlorine feed pumps have failed in the past, operators have been alerted to failure only when chlorine residuals dropped below acceptable levels. The wells are not currently instrumented with pressure transducers to monitor water levels and discharge pressures.

Improved instrumentation and control systems are needed to support efficient operation of the plant and to prepare the Supply System for independent operation from the RRCC Distribution System, and future expansion as a regional water supply system.

LWC staff reported that the water supply SCADA system is connected to a laptop at LWC. Data archiving systems are apparently limited, as a continuous record of flow data into the treatment unit could not be retrieved for the period of the well field testing. No further review of the SCADA system was performed for this study. It is assumed that significant improvements may be required to ensure an adequate level of cybersecurity and modify systems in preparation for independent operation of supply and distribution systems.

## 4.3 Transmission and Storage

From the treatment plant, water is pumped to the Supply System’s 750,000 gallon ground storage tank in the RRCC. Figure 16 shows a schematic of the Supply System, illustrating the flow of water from the wells to the plant and on to the RRCC.

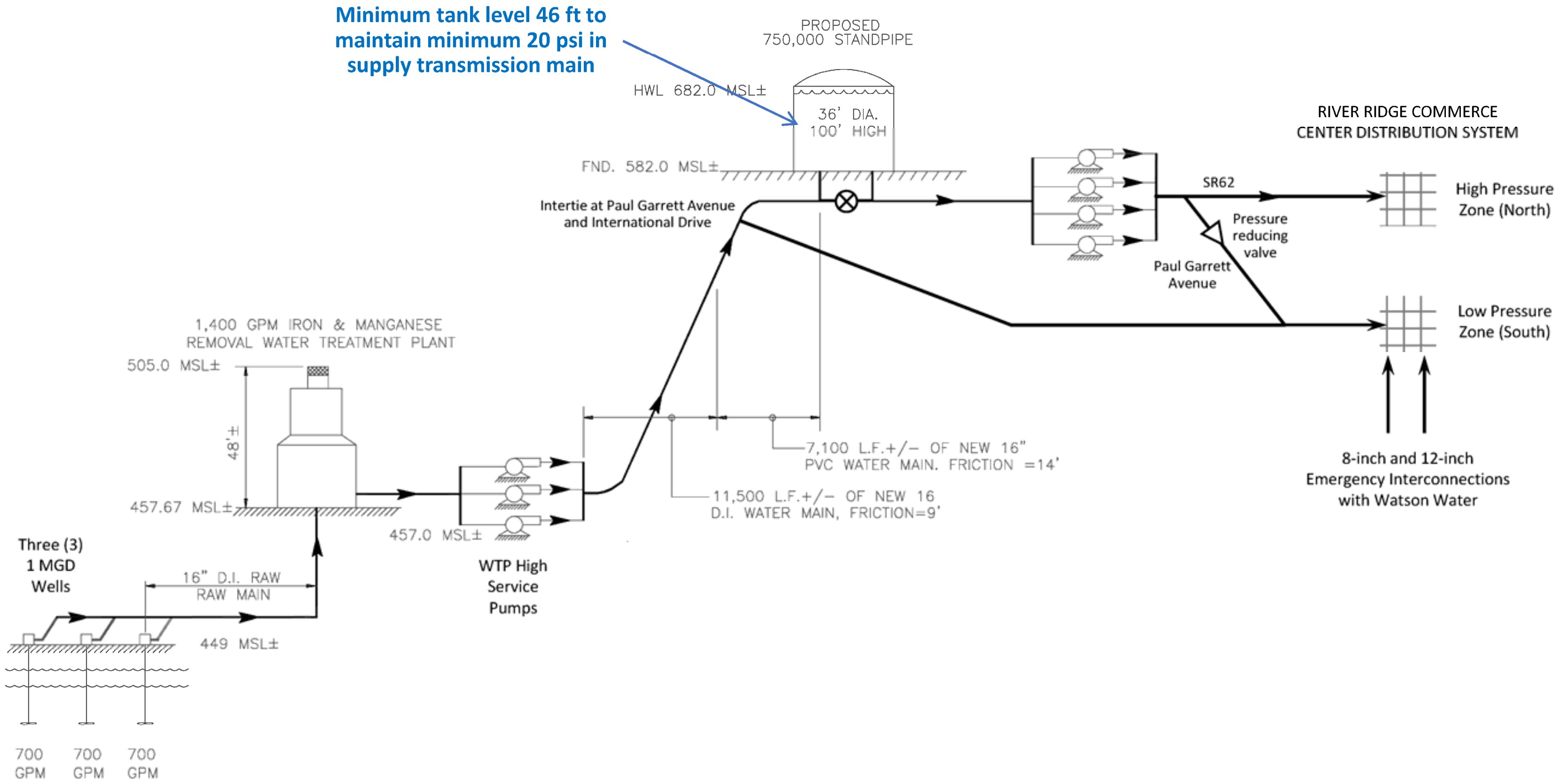


Figure 16. Schematic of existing Supply System

*Note: adapted from Curry, 2009*

### 4.3.1 Transmission Main

The supply transmission main consists of approximately 18,600 ft of 16-inch PVC and ductile iron pipelines from the water treatment plant to the Ground Storage Tank and Booster Station. The 16-inch supply transmission main has an approximate capacity of 3,450 GPM (5 MGD) assuming a maximum pipe velocity of 5 feet per second. It is not known whether the original pipeline design accounted for the pressure surges and air and vacuum release requirements that will exist at the higher flows.

There is one interconnection of the supply transmission main with the RRCC Distribution System prior to the ground storage tank and booster station. The interconnection is located at the intersection of Paul Garrett Avenue and International Drive near the site of an existing elevated storage tank (Figure 17).

### 4.3.2 Ground Storage Tank and Booster Station

The Supply System includes a 100 ft tall 750,000 gallon ground storage tank and booster station at the terminus of the supply transmission main. The supply main discharges to the storage tank. The booster station pumps draw suction from a separate outlet pipe in the storage tank. RRDA has recently installed a normally closed bypass line to allow the tank to be removed from service for inspection and maintenance. In order to maintain a minimum of 20 psi in the supply transmission main, the water level in the ground storage tank is always maintained above 46 ft.

Currently, there are four 1,000 GPM booster pumps installed as summarized in Table 7, with piping for three additional pumps to be added in the future. Two of the four pumps are equipped with variable frequency drives (VFDs). Each pump is equipped with an individual magnetic flow meter. The pumps are designed to deliver water with enough pressure for the high pressure zone at the north end of the RRCC. A pressure reducing valve (PRV) in the booster station reduces pressure for the low pressure (south) zone of the RRCC.

Table 7. Booster pump equipment

| Booster Pump | Design Pumping Rate (GPM) | Design Total Dynamic Head (TDH, ft) | Pump Type | Motor (HP) | Motor Starter |
|---|---|---|---|---|---|
| 1 | 1,000 | 160 | Split-case, 5x6x15 HD | 75 | Variable-frequency drive |
| 2 | 1,000 | 160 | Split-case, 5x6x15 HD | 75 | Soft-start |
| 3 | 1,000 | 160 | Split-case, 5x6x15 HD | 75 | Variable-frequency drive |
| 4 | 1,000 | 160 | Split-case, 5x6x15 HD | 75 | Soft-start |

*Source: Plans for Water Supply Improvements – Division II (Curry, 2009).*

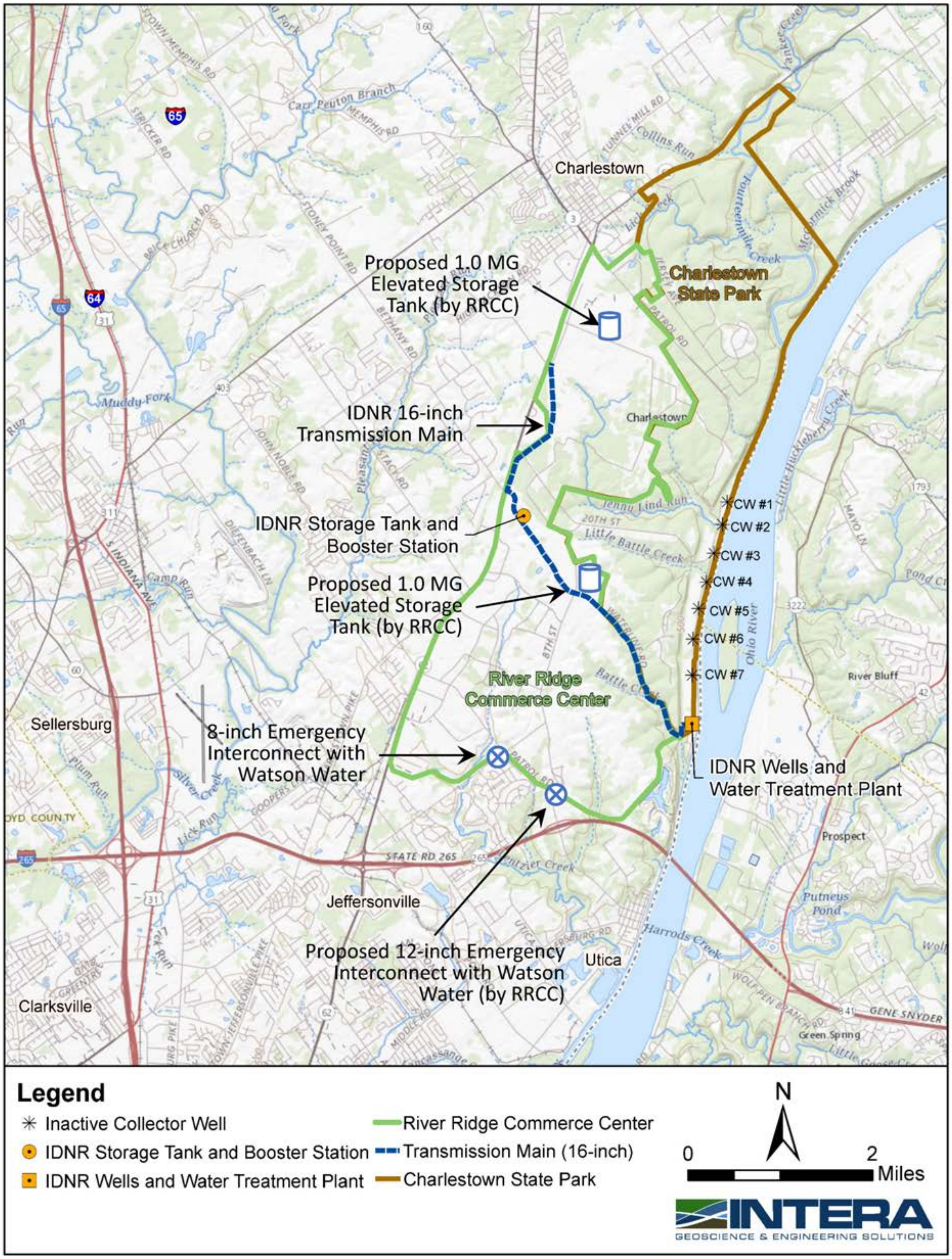


Figure 17. IDNR Supply System and RRCC Distribution System

The booster station has equipment for monitoring chlorine residual, and sodium hypochlorite storage and feed pumps for booster chlorine disinfectant as needed. The station is equipped with a 350 kW emergency generator. The discharge piping from the booster station includes two 16-inch mains connected to the low and high pressure zones of RRCC distribution system.

### 4.3.3 Interconnections

Currently, the Supply System is connected only to the RRCC Distribution System. IDNR owns the 16-inch transmission main that extends from the booster station towards State Road 62 and then north along SR62 towards Charlestown. This transmission main could be used for future connections and water deliveries from the Supply System to other wholesale water customers.

RRDA has installed two backup interconnections with Watson Water to allow for temporary supply of the RRCC Distribution System in the event of supply interruption from the Charlestown State Park System. The interconnections feed the lower pressure zone and are located on the south end of the system as shown in Figure 17.

## 4.4 RRCC Distribution System

The Distribution System includes piping, elevated storage facilities, customer service lines and meters, and hydrants used by RRDA to provide water service to their customers in the RRCC. RRDA operates the former INAAP distribution infrastructure that is still in use. New infrastructure has also been constructed by RRDA through re-development, and RRDA has planned and secured financing for additional distribution improvements.

### 4.4.1 Distribution Network

The RRCC distribution network is divided in two pressure zones, a high zone and a low zone. RRCC has existing storage tanks, in addition to the 0.75 MG of storage in the IDNR ground storage tank. RRDA is in the process of design for the construction of two new 1.0 MG elevated storage tanks, one each in the high and low pressure zones. The 16-inch transmission mains to the high and low pressure zones were recently interconnected at the entrance to the booster station facility on Paul Garret Avenue. The interconnection is normally closed but is intended to allow storage in the high zone to flow back to the low pressure zone is needed.

### 4.4.2 Metering

Customers in the RRCC have individual meters for billing purposes. Currently, there are no master meters to measure flow from the Supply System to the RRCC Distribution System. There are a limited number of RRCC customers served by connections directly tapped into the IDNR-owned 16-inch transmission main on SR62 (Figure 17).

## 4.5 Summary of Identified Improvement Needs

Based on the evaluation of projected demands and the existing Supply System facilities, needed improvements were identified to increase capacity, adapt treatment facilities to effectively comply with current regulations as well as potential future regulation of contaminants of emerging concern, such as PFAS, separate the Supply and Distribution Systems, and improve the long-term resiliency and security of infrastructure and SCADA systems. A summary of the needs is provided below, and corresponding recommendations are presented in Sections 5 to 7 of this report.

### 4.5.1 Capacity Increase

To meet projected demands in the RRCC through 2030, the total capacity of the Supply System should be increased to approximately 6 MGD, with a minimum firm capacity of 4 MGD. Firm capacity is defined as capacity with the largest separable unit out of service. The plant was designed for the addition of a second integrated filtration unit. It may be possible to obtain approval for “uprating” of the existing integrated aeration, detention, and filtration units to increase the filter loading rate by as much as 60% from the current 3.0 GPM/ft2 loading rate. The existing wells were originally designed for up to 2 MGD production and can produce the additional supply with pumping system improvements. Improvements to chemical and other systems may be required to increase their capacity.

### 4.5.2 Other Treatment Plant Improvements

In addition to the capacity increase, the treatment plant has other improvement needs, listed below and recommendations described in Section 5.

- Planning for the potential future need to add new treatment processes for PFAS or other CECs
- Improve reliability of chlorine feed system
- Evaluate need for permanganate feed system
- Upgrade high-service pumping, and change flow control to eliminate the use of modulating valves to throttle flow from the wells to the aerator.
- Improve instrumentation and SCADA capabilities to effectively monitor and track plant performance
- Review need for corrosion control
- Change-out existing filter media

### 4.5.3 Separation of supply and distribution systems

Additional improvements are needed to facilitate the separation of the IDNR Supply and RRCC Distribution Systems for operation as separate utilities. These are listed below, and recommendations described in Section 5.

- Installation of master meters, backflow prevention and emergency bypass valving at points of interconnection between the IDNR Supply System and RRCC Distribution System
- Separation of Supply and Distribution SCADA systems
- RRCC distribution improvements as required to separate customer connections from IDNR-owned transmission mains
- Evaluation of existing booster station pumping equipment and controls to adapt to RRCC's planned construction of new elevated tanks in the high and low pressure zones. Modifications as may be required.
- Evaluation of existing booster station electrical equipment, chlorination equipment, and facility security. Improvements as may be required.

### 4.5.4 Resiliency Improvements

#### 4.5.4.1 Short-term

In the short term, various improvements are needed to reduce risks and improve the resiliency of the Supply System. These are listed below, and recommendations described in Section 5.

- Surge analysis of supply transmission main, improvements as required
- Review electrical equipment, upgrades as needed
- Elevate electrical transformer, other components of electrical service if needed to protect from flooding.
- Improvements to instrumentation and SCADA systems to enhance monitoring and control, ability to monitor and operate plant remotely if flooding occurs. Physical security and cybersecurity improvements as may be required.

#### 4.5.4.2 Long-term

In the long-term, as the regional water supply is further developed, planning of future facilities should consider additional redundancy and other measures to further enhance the resiliency of the Supply System. These are listed below, and recommendations described in Section 6.

- Evaluation of the potential future flooding risk at the existing treatment facility considering increased climate variability and intensity of storms.
- Planning to incorporate additional redundancy in water treatment, transmission and storage to ensure uninterrupted supply in the event of infrastructure failure, critical maintenance, or natural disaster.

# 5.0 PROPOSED NEAR-TERM IMPROVEMENTS

This section describes the conceptual design of improvements for the *supply system expansion* and *utility system separation*. In sub-sections 5.1 and 5.2, specific recommendations are provided for use by the State to solicit and contract consulting services for the investigation, engineering design and permitting of the *supply system expansion*. Sub-sections 5.3 and 5.4 describe recommendations for *utility system separation*, to be contracted separately at a later date.

## 5.1 Expand Source of Supply

The South portion of the Aquifer where the current well field is located is the most productive area of the Aquifer (WHPA, 2010; Layne, 2011). The transmissivity of the Aquifer is very high in this area, with yields augmented by induced infiltration of water from the Ohio River. Given the productivity of the Aquifer, the existing wells can be reequipped with higher capacity pumps to expand well field capacity to 6 MGD total, 4 MGD firm. If necessary, well field capacity could be augmented in the future with an additional vertical well. Figure 18 shows the well field and water treatment plant site.

Further expansion of the well field beyond the current expansion should consider plans for the long-term development of the Charlestown State Park regional water supply system. Efficient re-development of the high-capacity well field will likely involve the construction of horizontal collector wells to replace the original WWII-era collector wells used for the INAAP system.

### 5.1.1 Increase pumping capacity of existing wells

It is recommended that the existing pumping equipment be replaced to increase the maximum production capacity of all three wells to 1,400 GPM each, providing a total well field capacity of 6 MGD and firm capacity of 4 MGD.

Estimated drawdown and recommended depth of pump intake for the three wells is summarized in Table 8. Drawdown is estimated at the current specific capacity and for a future condition with an assumed loss of efficiency due to well screen fouling and aquifer formation clogging. Historical performance of the wells suggests that efficiency loss has been minimal; as a result, a 10% future reduction in current specific capacity is assumed. Mutual well interference effects are also included.

The estimated drawdown for all three wells is less than the maximum available drawdown under worst case conditions. There is ample margin for operation of Wells 2 and 3 at the proposed rates of 1,400 GPM. Because the specific capacity of Well 1 is lower than those of Wells 2 and 3, there is a greater potential that desired capacity could be limited if loss of well efficiency is significantly greater than assumed based on historical performance. As a result, it is recommended that the pump setting in Well 1 be lowered to provide additional margin for loss of efficiency.

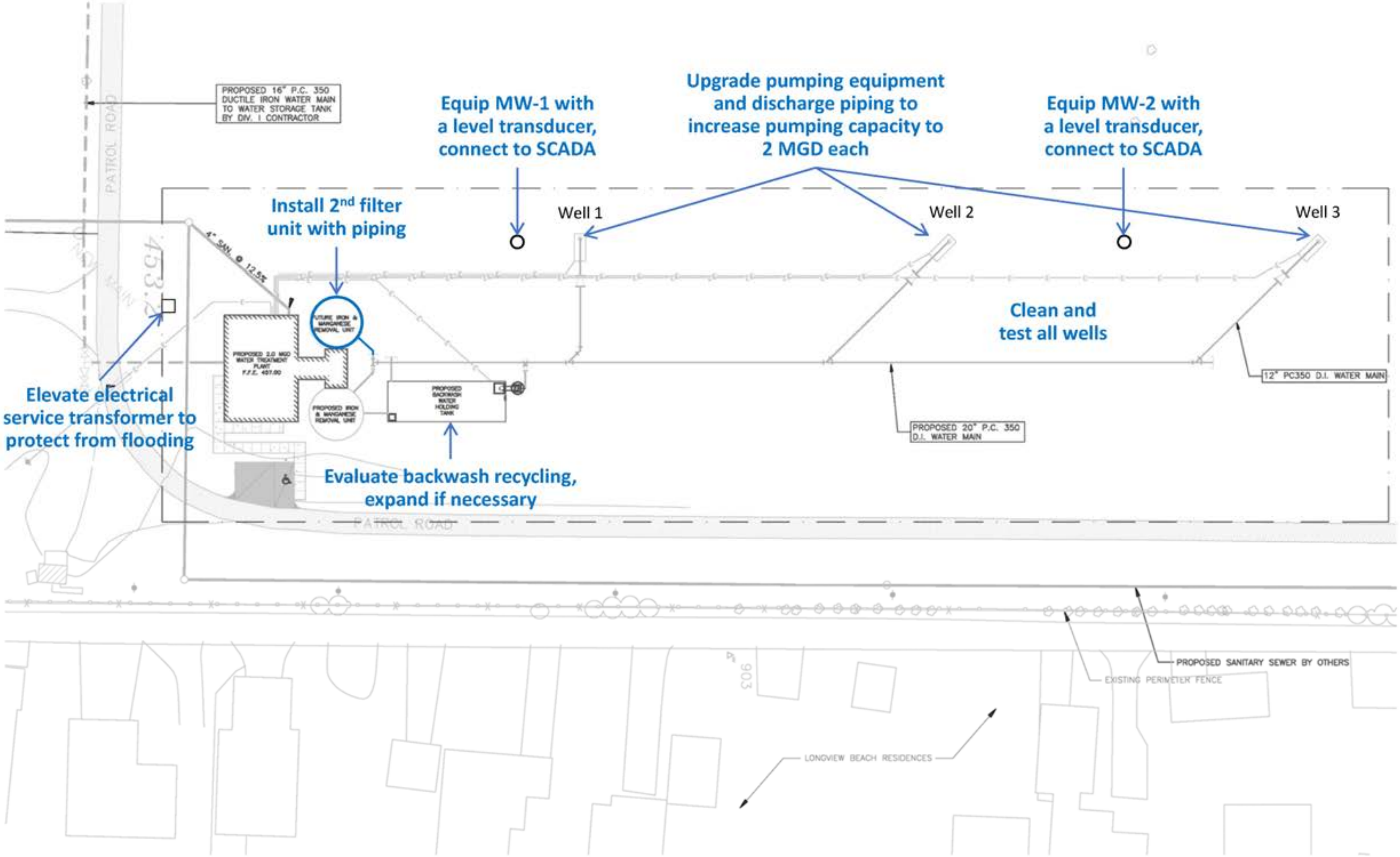


Figure 18. Site plan of recommended well field and water treatment plant improvements

*Note: adapted from Curry, 2009*

Table 8. Projected pumping water levels and proposed well pump intake settings

| Well | Design Pumping Rate (GPM) | SWL (elev, ft) | Current Specific Capacity (GPM/ft) | Reduced Specific Capacity, 10% Loss (GPM/ft) | Drawdown Reduced Specific Capacity (ft) | Pumping Interference (ft) | Pumping Water Level (elev, ft) | Proposed Pump Intake Setting (elev, ft) |
|---|---|---|---|---|---|---|---|---|
| 1 | 1,400 | 419-425 | 192 | 172.8 | 8.1 | 3 | 407.9-413.9 | 379.4 |
| 2 | 1,400 | 419-425 | 459 | 413.1 | 3.4 | 3 | 412.6-418.6 | 389.5 |
| 3 | 1,400 | 419-425 | 425 | 382.5 | 3.7 | 3 | 412.9-418.9 | 389.5 |

*Notes: SWL = static water level. Proposed pump intake setting for Well 1 is 10 ft lower than existing setting.*

Currently, all three pumps are installed with the same intake depth. It is recommended that upgraded pumping equipment for Wells 2 and 3 be installed with the pump intakes at the same depths as the existing equipment. The well screen for Well 1 was installed 20 feet deeper than the screens for Wells 2 and 3. As a result, the new pumping equipment for Well 1 can be installed with 10-15 feet of additional column pipe and pump shaft and a deeper pump intake setting to increase the available drawdown in that well. Pump intakes should not be set below the top of the screens in any of the wells.

Figure 19 illustrates the recommended improvements for the three existing production wells. In addition to the replacement of pumping equipment, it is also recommended that for each well an access port be added to the well casing and equipped with a permanent level transducer to provide continuous monitoring of static and pumping water levels. Discharge piping must be upsized for each well to support higher flows. It is recommended that the existing piping be replaced with 10-inch piping and appurtenances from the wellhead through the vault and to the connection with 12-inch pipe outside of the vault. In addition, it is recommended that pressure gauges in the vaults be equipped with pressure transducers to provide continuous monitoring of discharge pressure. Flow, water level, pressure, and electrical power data will provide the information needed to monitor well performance and alert operators to well or pump performance issues. Finally, it is recommended that monitoring wells MW-1 and MW-2 be equipped with permanent level transducers to monitor aquifer water levels outside of the production wells. This will aid in the monitoring of well efficiency and effective scheduling of well cleaning.

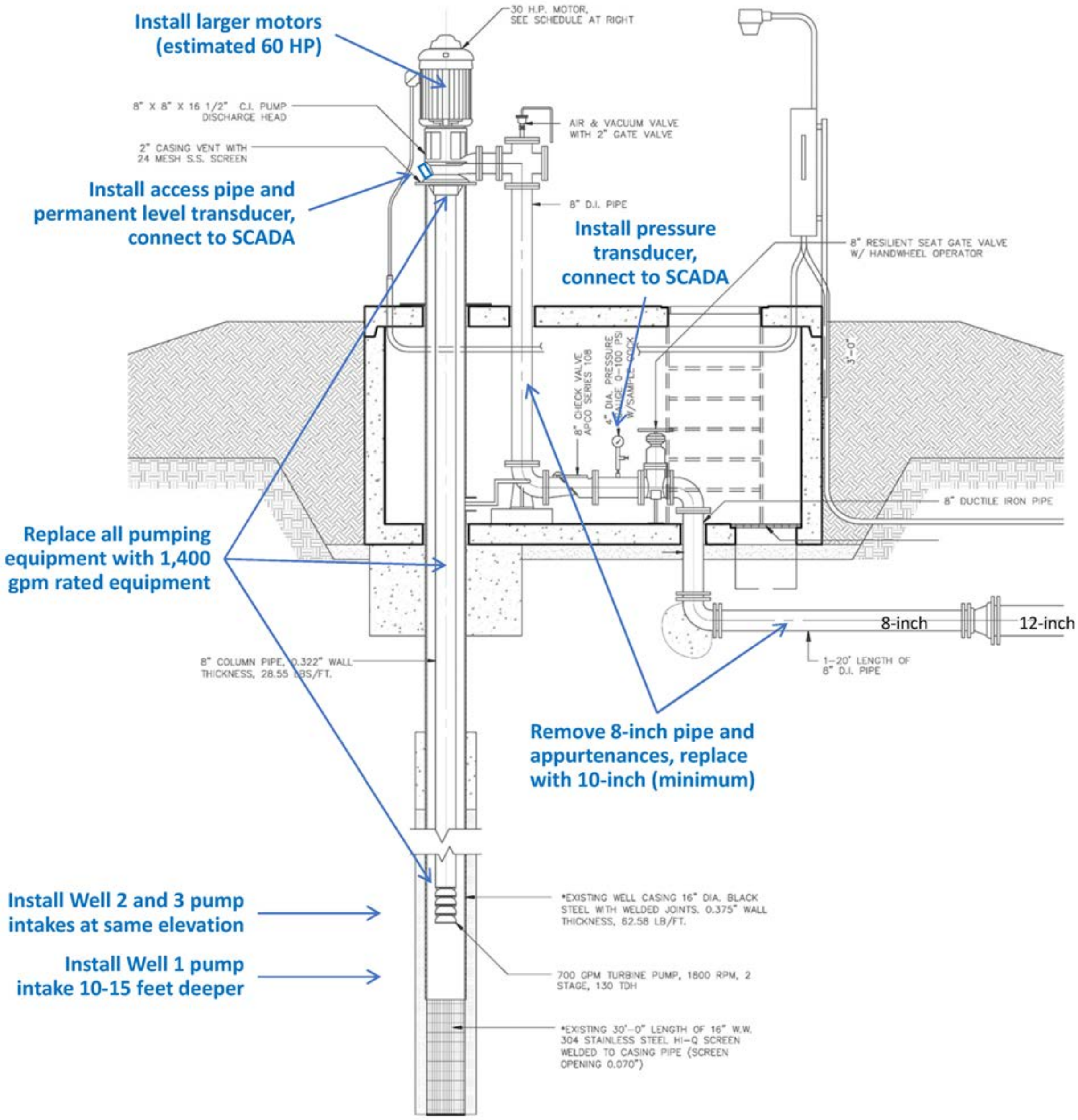


Figure 19. Recommended production well improvements

*Note: adapted from Curry, 2009*

## 5.2 Expand and Enhance Treatment

The objective of the proposed project is to expand existing treatment capacity to a total capacity of up to 6 MGD, and a minimum firm capacity of 4 MGD. The expansion should be designed in a manner that provides flexibility to design for the addition of new treatment processes for removal of PFAS or other CEC's as future drinking water regulations may require. The concept for expansion and improvements presented here is a recommended starting point for further investigation and detailed engineering design of necessary improvements.

### 5.2.1 Overview

The recommended improvements include expansion of aeration, detention and filtration capacity, improvements to chemical feed systems, planning for the future integration of additional treatment processes for PFAS or other contaminants, pumping system improvements, and improvements to instrumentation and control systems, including upgrades to enhance physical and cybersecurity. Figure 20 and Figure 21 provide an overview of the proposed improvements.

### 5.2.2 Design for Potential Future Treatment Processes

PFAS were detected at levels that approach existing and proposed MCL's in other states. It is anticipated that the USEPA will eventually establish MCL's for one or more PFAS. If additional treatment is required for PFAS removal, the integration of that treatment process will impact the hydraulics of water flow through the plant.

The current treatment plant design relies upon gravity flow from the detention tank, through the filters and to the suction of the high service pumps. The plant does not have treated water storage on site, but rather pumps directly to the ground storage tank in the RRCC. Plant hydraulics were not evaluated for this study, but it is assumed that adding granular activated carbon (GAC), ion exchange (IX), or some other additional treatment process will introduce enough additional head loss to interfere with normal high service pump operation.

The design for capacity expansion should consider how an additional treatment process could be added in the future to the existing plant. If available head from the detention tank will be insufficient, it will be necessary to plan for a potentially significant change in plant hydraulic design. This may include the addition of intermediate clearwell storage and either intermediate pumping or modifications to high service pumping.

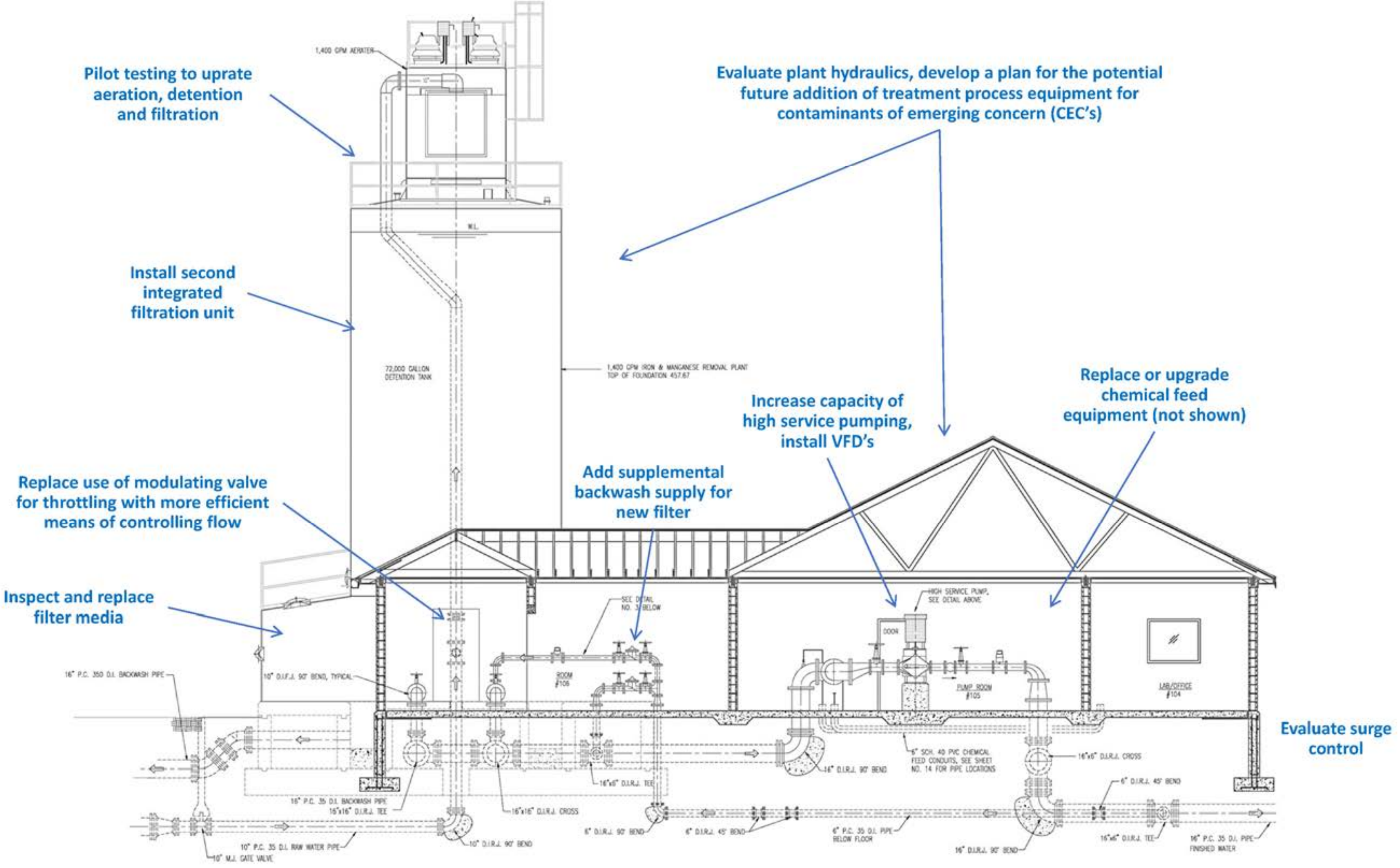
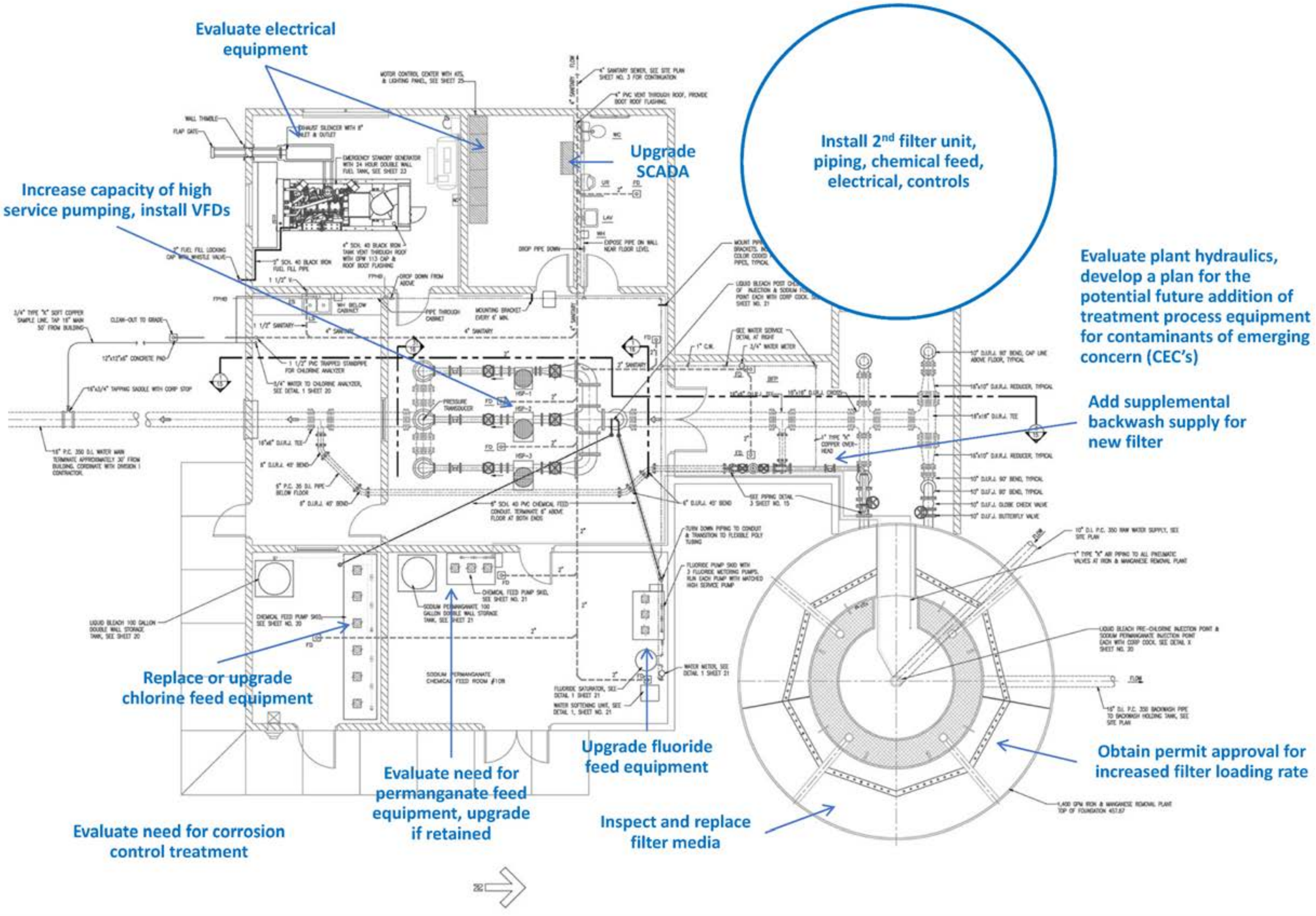


Figure 20. Profile view of recommended plant improvements

*Note: adapted from Curry, 2009*



Evaluate electrical equipment

Install 2nd filter unit, piping, chemical feed, electrical, controls

Upgrade SCADA

Increase capacity of high service pumping, install VFDs

Evaluate plant hydraulics, develop a plan for the potential future addition of treatment process equipment for contaminants of emerging concern (CEC's)

Add supplemental backwash supply for new filter

Replace or upgrade chlorine feed equipment

Upgrade fluoride feed equipment

Obtain permit approval for increased filter loading rate

Evaluate need for permanganate feed equipment, upgrade if retained

Inspect and replace filter media

Evaluate need for corrosion control treatment

Figure 21. Plan view of recommended plant improvements

*Note: adapted from Curry, 2009*

### 5.2.3 Integrated filtration unit

The existing aeration, detention and filtration equipment is described in Sections 4.2.1 and 4.2.2. In order to increase the iron and manganese removal capacity of the plant, the expansion of filtration capacity is required. Firm capacity, with the largest filtration unit out of service, must be increased to a minimum of 4 MGD, with total capacity of up to 6 MGD. The existing plant was designed for the addition of an identical integrated aeration, detention, and filtration unit.

The existing filtration unit is currently permitted for 2 MGD, based on a filter loading rate of 3 GPM/ft$^2$. It may be possible to demonstrate performance and obtain permit approval for a filter loading rate of up to 5 GPM/ft$^2$, with corresponding rating increases for aeration and detention. If a 5 GPM/ft$^2$ filter loading rate is permittable, the total and firm capacity of the existing and new treatment units would be 6.4 MGD total, 4.8 MGD firm.

It is recommended that the use of the pneumatically actuated butterfly valve on the raw water inlet line to the filtration unit to throttle flow from the wells be discontinued and replaced, in conjunction with high service pumping improvements, with a more energy efficient means of control.

The existing filter is operating with the original filter media installed in 2011. The filter and media should be inspected, and the media replaced. This could be accomplished without interruption of water service to the RRCC when expanded filter capacity is operational, allowing the existing filter to be taken offline.

### 5.2.4 Chemicals

The existing chemical storage and feed systems are discussed in Section 4.2.3. A thorough review of the existing chemical storage and feed systems is recommended to identify and address any deficiencies, maintenance issues, or capacity constraints.

**Chlorine.** It is recommended that the problematic chlorine feed piston pumps shown in Figure 22 be replaced with peristaltic pumps, or an appropriate alternative. PVC piping used for the chlorine feed solution should be inspected for leaks and replaced, as necessary. Sodium

Figure 22. Existing chlorine feed system

hypochlorite storage may need to be increased.

**Permanganate.** Review of raw and finished water quality is recommended to assess the need for the sodium permanganate feed system, which reportedly has never been used. If retained, it should be inspected to ensure that it is operable and of adequate capacity for the proposed expansion. Improvements, replacement, or repair should be completed as appropriate with the proposed project. If it is determined that the permanganate feed is not required, the building space may be made available for other future needs.

**Fluoride.** The fluoride feed system may require improvements to increase its capacity. It is recommended that based on evaluation of raw and finished water fluoride levels and chemical consumption that the storage, feed pump and piping systems be evaluated for consideration for improvements or expansion.

**Corrosion Inhibitor.** The plant does not currently provide supplemental treatment for corrosion control. It is recommended that a thorough review of water quality and historical LCR reporting to determine if treatment for corrosion control is needed to comply with the revisions to the LCR.

### 5.2.5 High Service Pumping

The existing high service pumps are discussed in Section 4.2.4.

Currently, because the high service pumps take suction directly from the filter effluent, there is no benefit for high service pumping capacity to be greater than that of the wells. To establish total and firm capacity of 6 MGD and 4 MGD, it is recommended that High Service Pump No. 1 be replaced with a larger pump rated at 1,400 GPM. It is also recommended that all high service pumps be equipped with variable frequency drives (VFDs) to provide the ability to balance wells and high service pump rates to maintain minimum detention tank levels in an energy-efficient manner.

It is recommended that surge analysis of the high service pumping system and supply transmission main be completed to evaluate the potential for destructive pressure surges at the anticipated maximum flow rates. Based on this analysis, it is recommended that improvements include equipment for surge control/relief to protect the system during normal start up and shut down and in the event of power failure or other sudden interruption of operation.

The design of improvements to the high service pumps will depend on other design decisions, including those discussed in sub-section 5.2.2.

### 5.2.6 Residuals handling

The existing backwash settling tank and recycling system is discussed in Section 4.2.5.

The design of the backwash settling tank was not evaluated for this study. It is possible that the existing tank is adequate for increased production from the plant, albeit with greater frequency of removal and disposal of residuals. If the volume and design of the existing backwash settling tank is inadequate to allow settling of filter backwash water between backwash cycles, it may be necessary to construct additional backwash settling and recycling capacity.

The existing tank should be inspected, and residuals removed and disposed of as part of the expansion project.

### 5.2.7 Electrical

The existing electrical system is discussed in Section 4.2.6. It is recommended that the electrical service, generator, switchgear, and other equipment be inspected to identify any deficiencies that may require improvements. In addition, it is recommended that options be evaluated for elevating the service transformer sufficiently above the 100-year flood elevation to protect it from flooding.

### 5.2.8 Instrumentation and Controls

The existing instrumentation and control systems are discussed in Section 4.2.7. It is recommended that the existing instrumentation and controls be evaluated, and improvements designed to enhance the efficiency and control of operations and facilitate the separation of systems for the IDNR supply and RRCC distribution systems.

## 5.3 Transmission and Storage

With respect to transmission and storage, the objective of the proposed project is to ensure that the increased water supply can be reliably delivered to the RRCC Distribution System by the Supply System. An overview of recommended improvements is shown in Figure 23.

### 5.3.1 Transmission Main

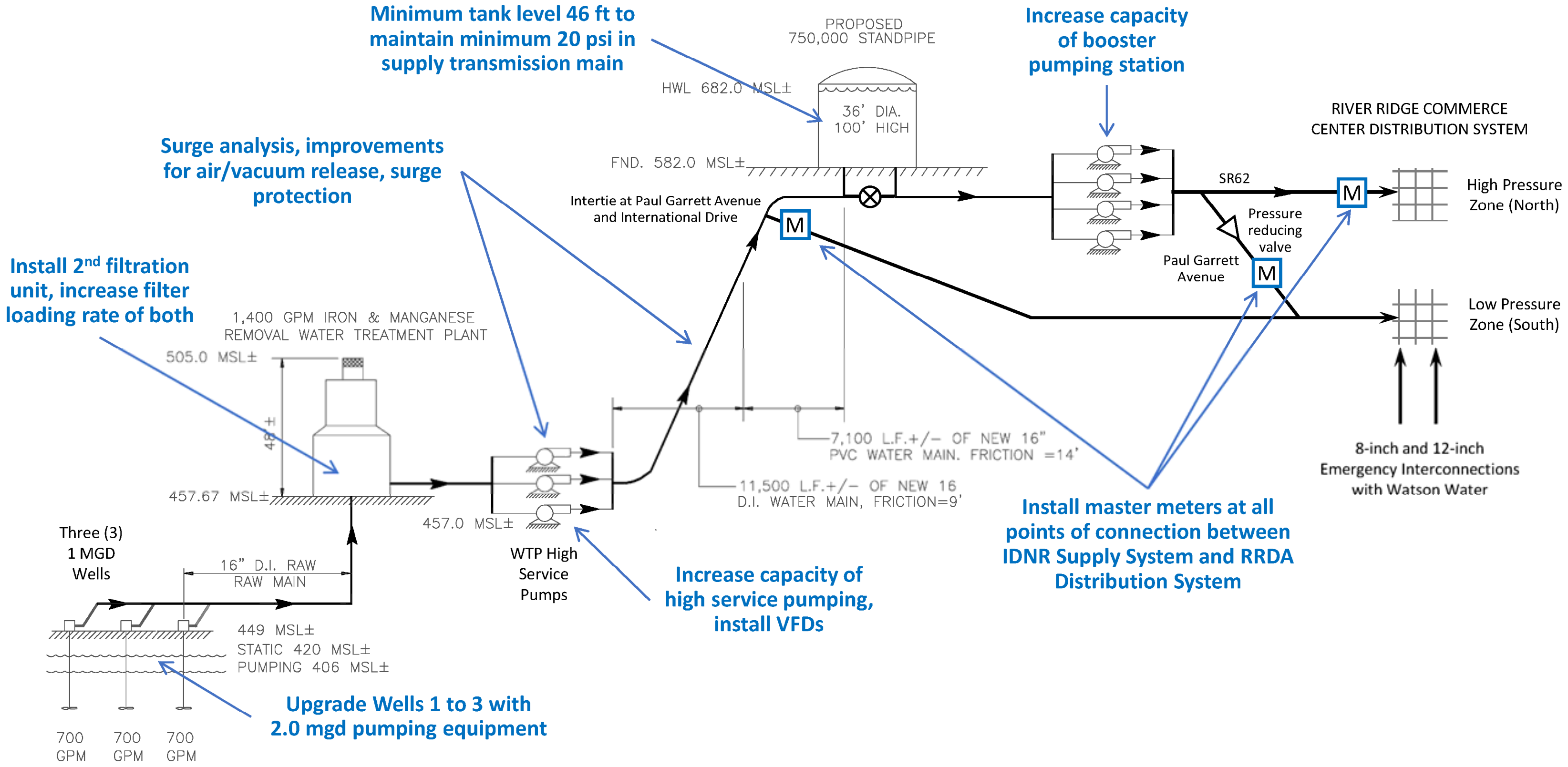
The existing supply transmission main is discussed in Section 4.3.1.

Improvements may be required to protect the transmission main from destructive pressure surges. It is recommended that the transmission main design be evaluated to identify any deficiencies that may require improvements for proper operation of the transmission main at increased flow rates.

### 5.3.2 Ground Storage Tank and Booster Station

The existing ground storage tank and booster station are discussed in Section 4.3.2. No changes are proposed to the existing ground storage tank.

RRDA has begun design of two new 1.0 MG elevated storage tanks and other Distribution System improvements. The booster pump station equipment should be evaluated and modified if necessary, for current and anticipated hydraulic conditions. It is recommended that the pumping capacity of the booster station be evaluated, and consideration be given to upsizing or adding an additional pump to the booster pump station to provide firm capacity for peak demand and fire protection requirements. It is recommended that the booster station's pumping, chlorine feed, monitoring, emergency generation and other equipment be inspected to identify any deficiencies that may require improvements (Figure 24).



**Minimum tank level 46 ft to maintain minimum 20 psi in supply transmission main**

**Increase capacity of booster pumping station**

**Surge analysis, improvements for air/vacuum release, surge protection**

**Install 2nd filtration unit, increase filter loading rate of both**

**Install master meters at all points of connection between IDNR Supply System and RRDA Distribution System**

**Increase capacity of high service pumping, install VFDs**

**Upgrade Wells 1 to 3 with 2.0 mgd pumping equipment**

Figure 23. Supply System schematic showing recommended improvements

*Note: adapted from Curry, 2009*

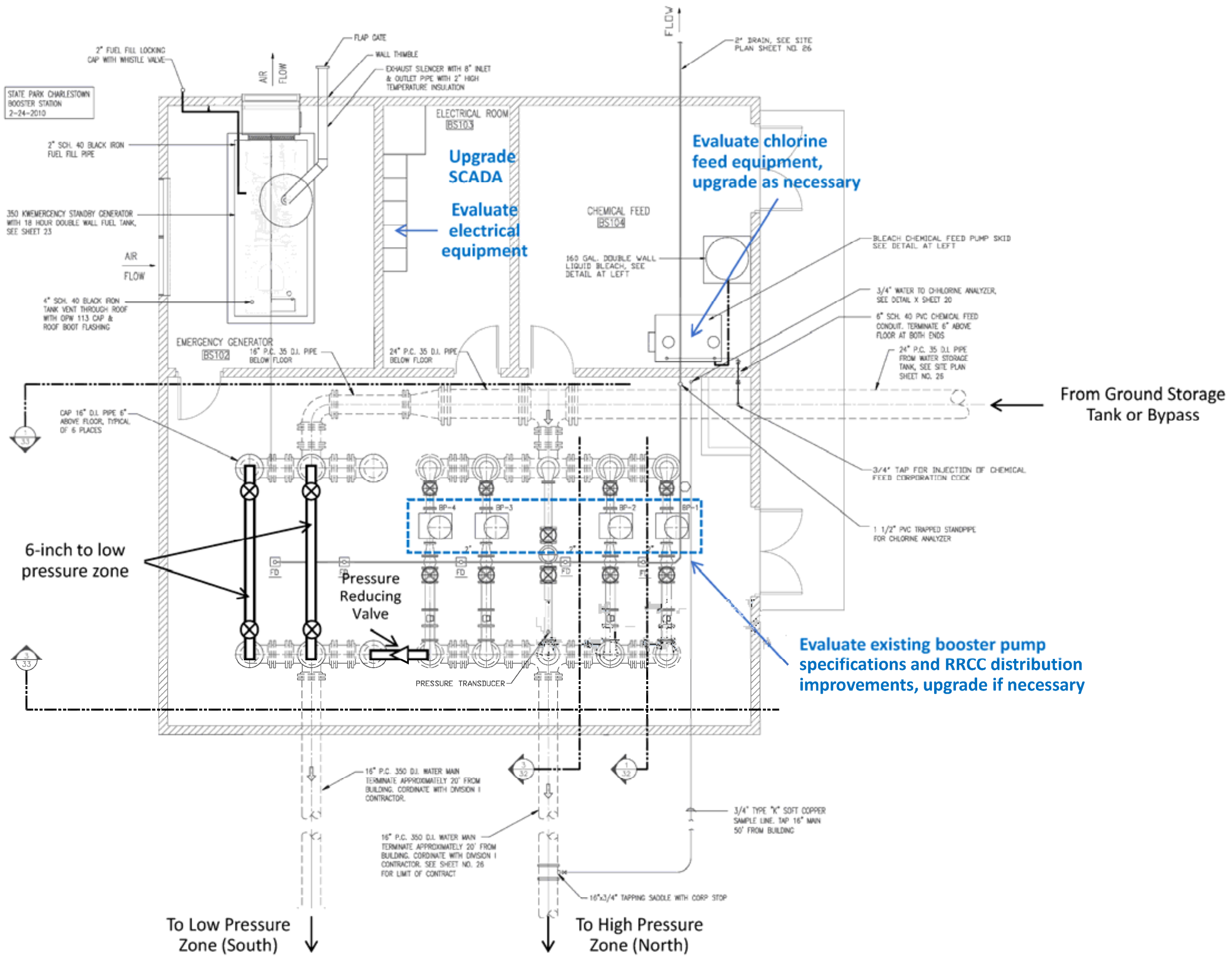


Figure 24. Recommended booster pump station improvements

*Note: adapted from Curry, 2009*

## 5.4 Distribution

With respect to distribution, the objective of the proposed project is to separate the IDNR Supply System from the RRCC Distribution System such that they can transition to operation as separate utilities. The Supply System will operate as a wholesale water supplier to RRDA, and RRDA will deliver water to its customers through the Distribution System.

### 5.4.1 Master Metering

It is recommended that master metering stations be constructed at the booster pump station and interconnection at Paul Garrett Avenue and International Drive to measure all water delivered from the IDNR Supply System to the RRDA Distribution System (Figure 25).

### 5.4.2 Separation of Supply and Distribution Systems

It is recommended that all existing and proposed points of connection of the IDNR Supply System to the RRCC Distribution System be reviewed and options developed for the complete separation and master metering of the Supply System, including the IDNR-constructed 16-inch main along SR62. This may require the construction of additional metering stations, or the construction of miscellaneous RRCC distribution improvements to isolate the two systems.

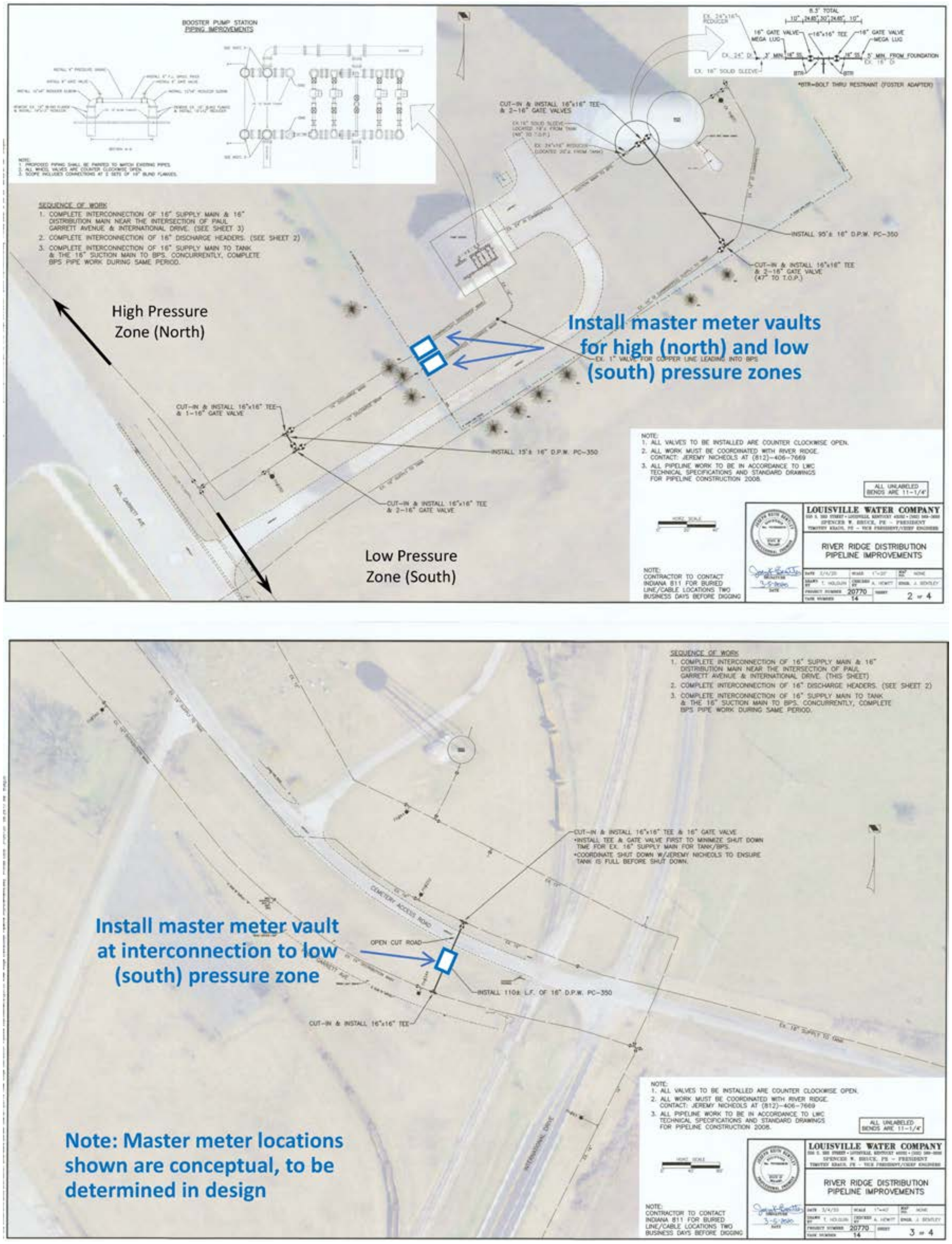


Figure 25. Potential master meter locations

*Note: adapted from LWC, 2020*

# 6.0 FUTURE EXPANSION

This section discusses recommendations and options for future expansion beyond the currently proposed project, toward development of a regional water supply. The issues addressed in this section may inform decisions made for the scope of the proposed project described in Section 5.

The future development of the regional supply system should be informed by and aligned with other planning efforts, including the RRCC master plan, the Charlestown State Park master plan, and other regional planning efforts. Figure 26 shows the location of the water supply system and the service territories of neighboring water utilities.

## 6.1 Source of Supply

As discussed in Section 3.3.2. the projected maximum day water demand of the RRCC at build out is estimated to be 8.6 MGD within the next 20 years. The actual water demand and timing of those demands may vary significantly depending on the type of commercial and industrial development that occurs in the RRCC. The current source of supply is developed at the south end of the aquifer, but the aquifer extends northward toward Charlestown where much of the future development in the RRCC will occur. Both the north and south ends of the aquifer are highly productive (Layne, 2011).

There are several options for further development of the source of supply. In the short term, additional vertical wells may be added to incrementally increase the capacity of the existing well field near the existing treatment plant. Long-term, development of larger capacity wells for the regional system should be based on collector wells.

Groundwater investigations including sampling and monitoring completed at the former INAAP property as part of a Phase II RCRA Facility Investigation determined that the potential impact of upland INAAP activity on the aquifer was little to none (URS, 2003). Nonetheless, potential water quality risks should be carefully evaluated when siting new wells.

### 6.1.1 Additional Vertical Wells

For additional marginal increases in capacity, new vertical wells could be installed at the well field with design capacities of 1-2 MGD each, dependent on local Aquifer conditions. If new vertical wells are added, planning should allow for a larger separation distance to accommodate additional well interference. For larger increases in capacity, a radial collector well should be considered.

### 6.1.2 Radial Collector Well

The sustainable yield of this aquifer is estimated to be between 80 and 100 MGD, based on extensive field testing and groundwater flow modeling. Layne (2011) evaluated various Aquifer development scenarios, which included rehabilitation or replacement of the seven former INAAP collector wells and construction of two new, collector wells located south of existing

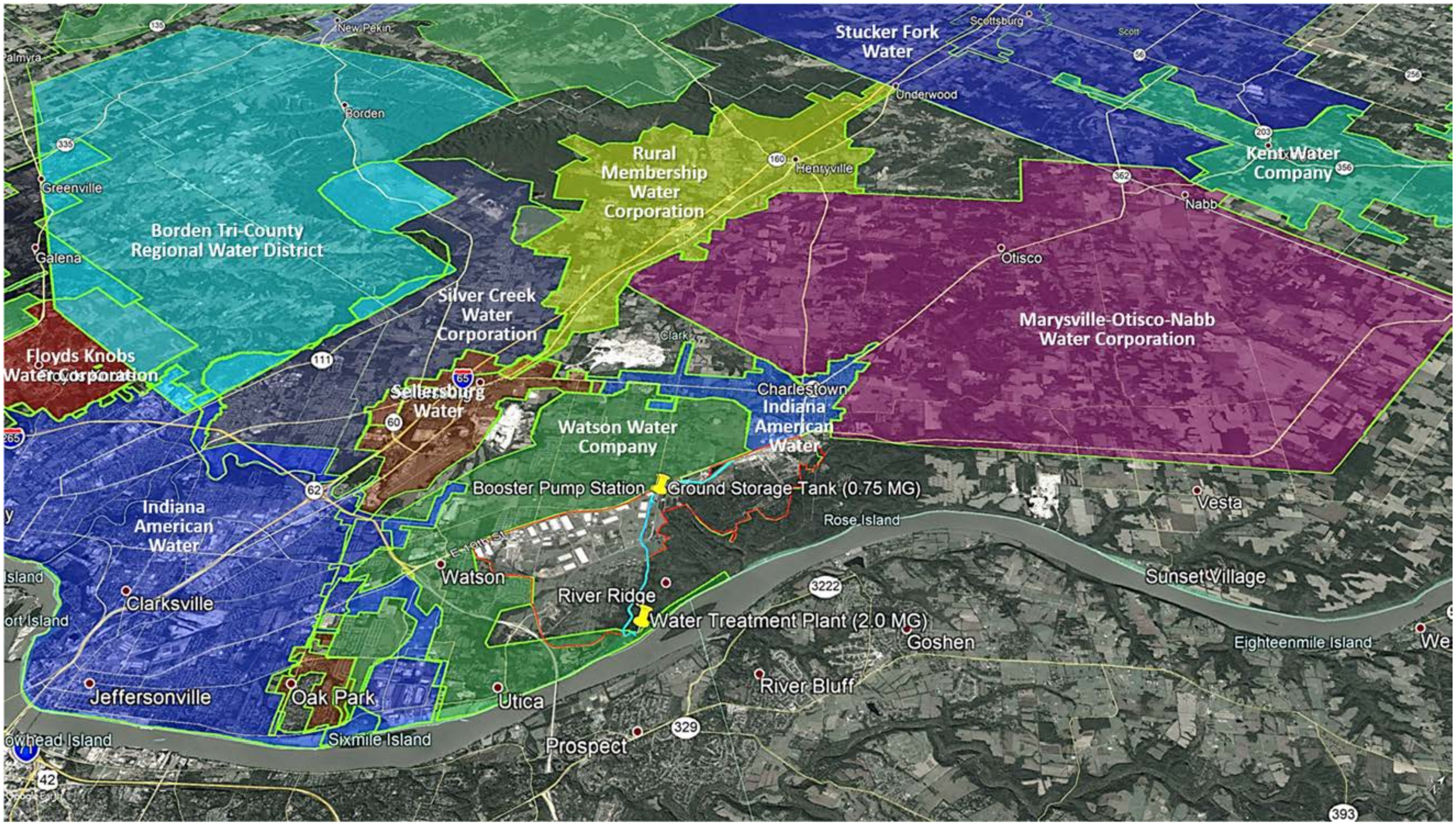


Figure 26. Water utility service territories

*Source: IFA, 2018*

collector well CW-7. Figure 27 shows the locations of the existing and proposed collector wells and conservative estimates of their water supply yield. To meet future RRCC and regional demands beyond the capacity of the currently proposed water supply expansion it is recommended that one or more high-capacity collector wells be constructed, rather than numerous vertical wells.

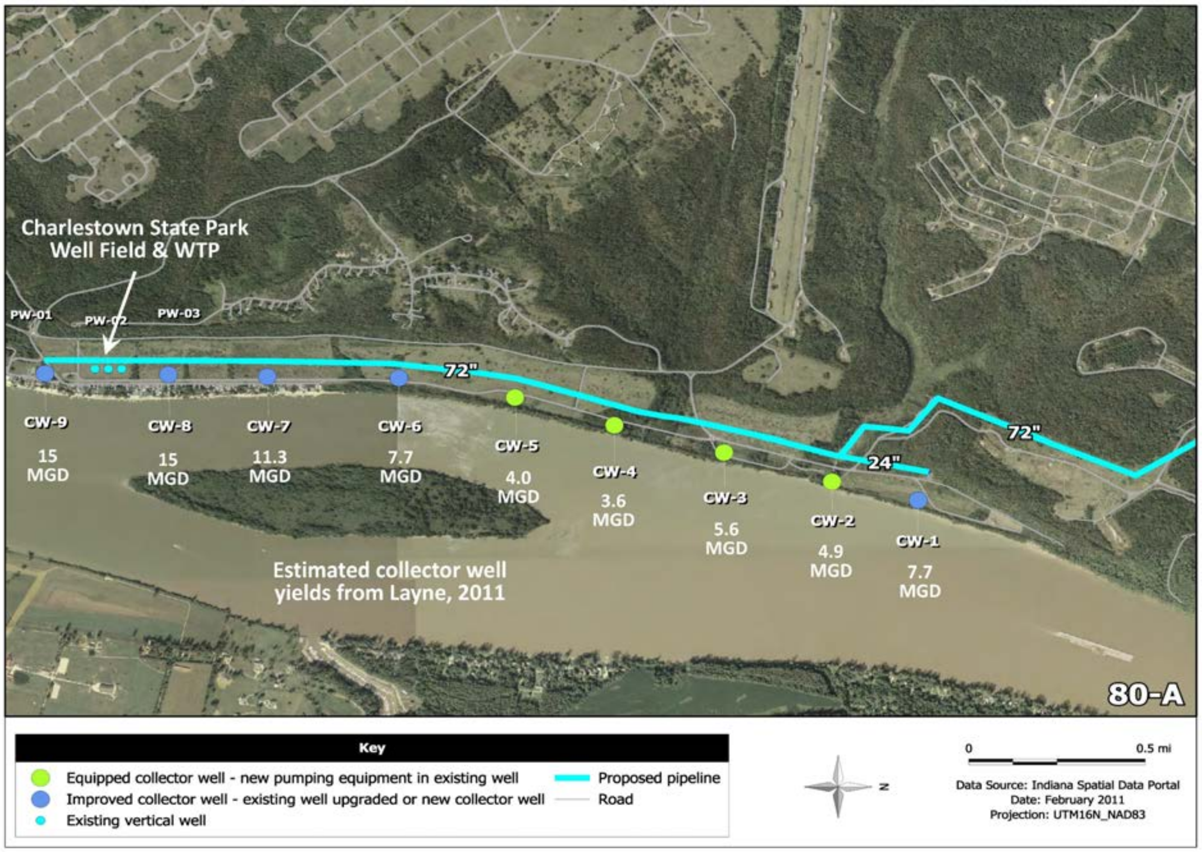


Figure 27. Charlestown State Park Wellfield and INAAP Collector Wells

*Note: Adapted from Layne, 2011*

## 6.2 Treatment

When demand exceeds the practical buildout capacity of the existing plant, a new treatment facility will be required. It is recommended that future treatment capacity be located further north and at a higher elevation to provide additional resiliency to the IDNR supply system in the event of major flooding on the Ohio River or failure of critical infrastructure in the current supply system.

The existing plant is built at an appropriate elevation above the 100-year flood level. However, as seen in Figure 28, the floodway and flood zone surround the plant.

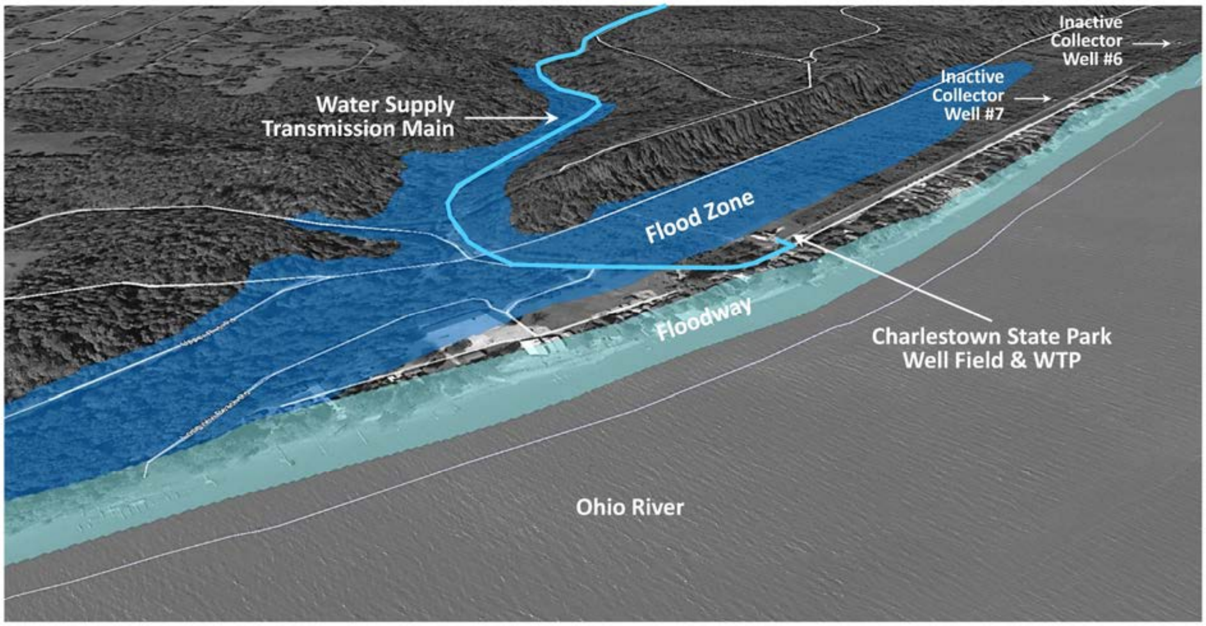


Figure 28. Existing water treatment plant and floodway and flood zones

## 6.3 Transmission and Storage

The capacity of the existing transmission main to the RRCC will be reached with the proposed expansion. When future source of supply and treatment facilities are developed, it is recommended that a separate transmission main route be chosen to provide greater flexibility for transmission main maintenance and resiliency to failure. It is also recommended that additional treated water storage be added. The location and alignment of these should be coordinated with the Charlestown State Park and RRCC master plans. The Charlestown State Park master plan includes new facilities, including a future lodge and aquatic park facility. Figure 29 shows the location of proposed state park facilities and a conceptual location for a future raw water transmission main and treatment facility.

## 6.4 Distribution

It is recommended that when future supply, treatment, and transmission facilities are developed that they be connected to the RRCC Distribution System further north to provide greater efficiency and flexibility of water supply to the RRCC. The north end of the system is also the most probable point of connection to neighboring water utilities which may become wholesale water customers for direct use or wheeling through their systems to other interconnected utilities. Figure 30 shows the conceptual design of a regional water supply system for Southeast Indiana as described in IFA (2018).

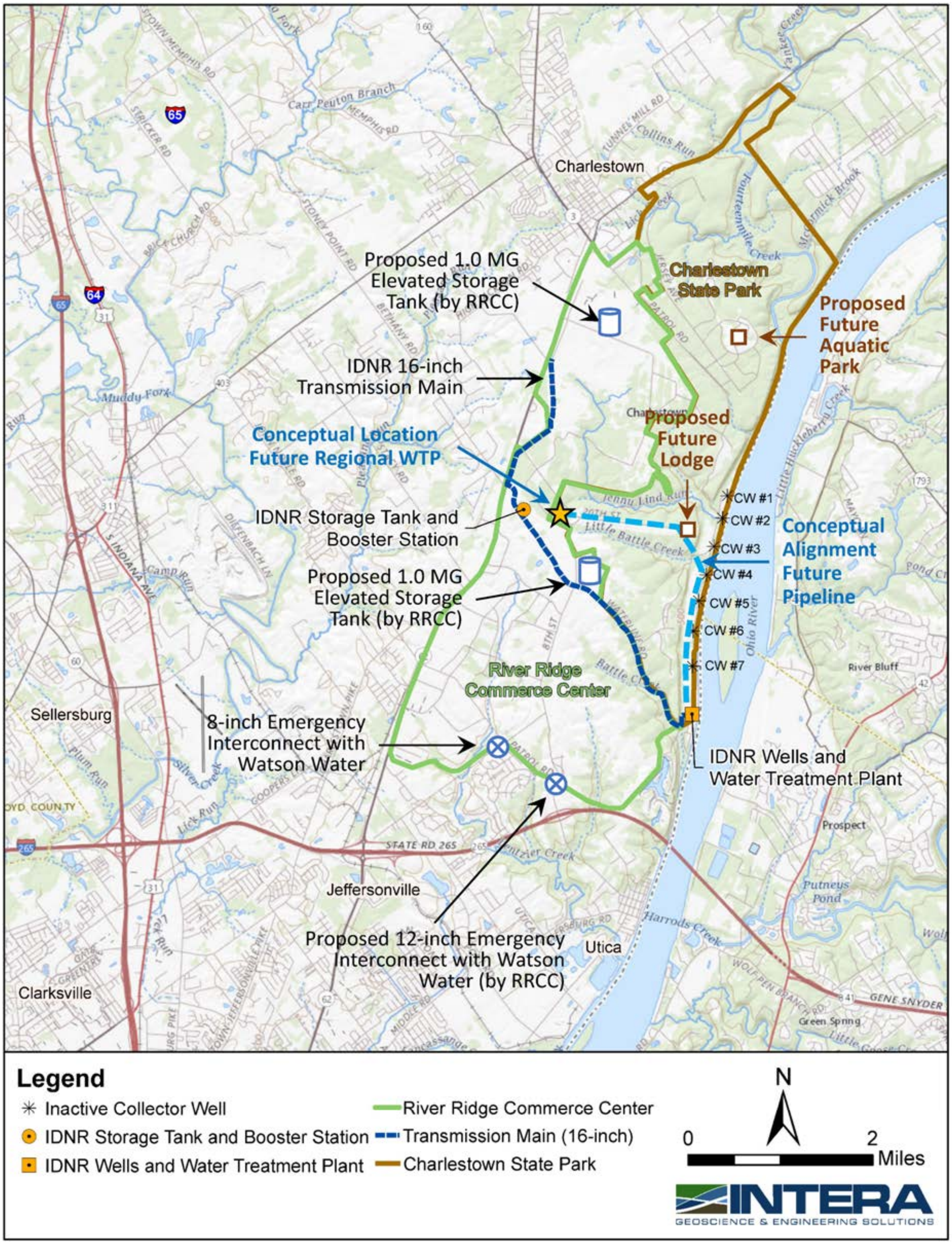


Figure 29. Proposed Charlestown State Park facilities and conceptual location of future regional water supply infrastructure

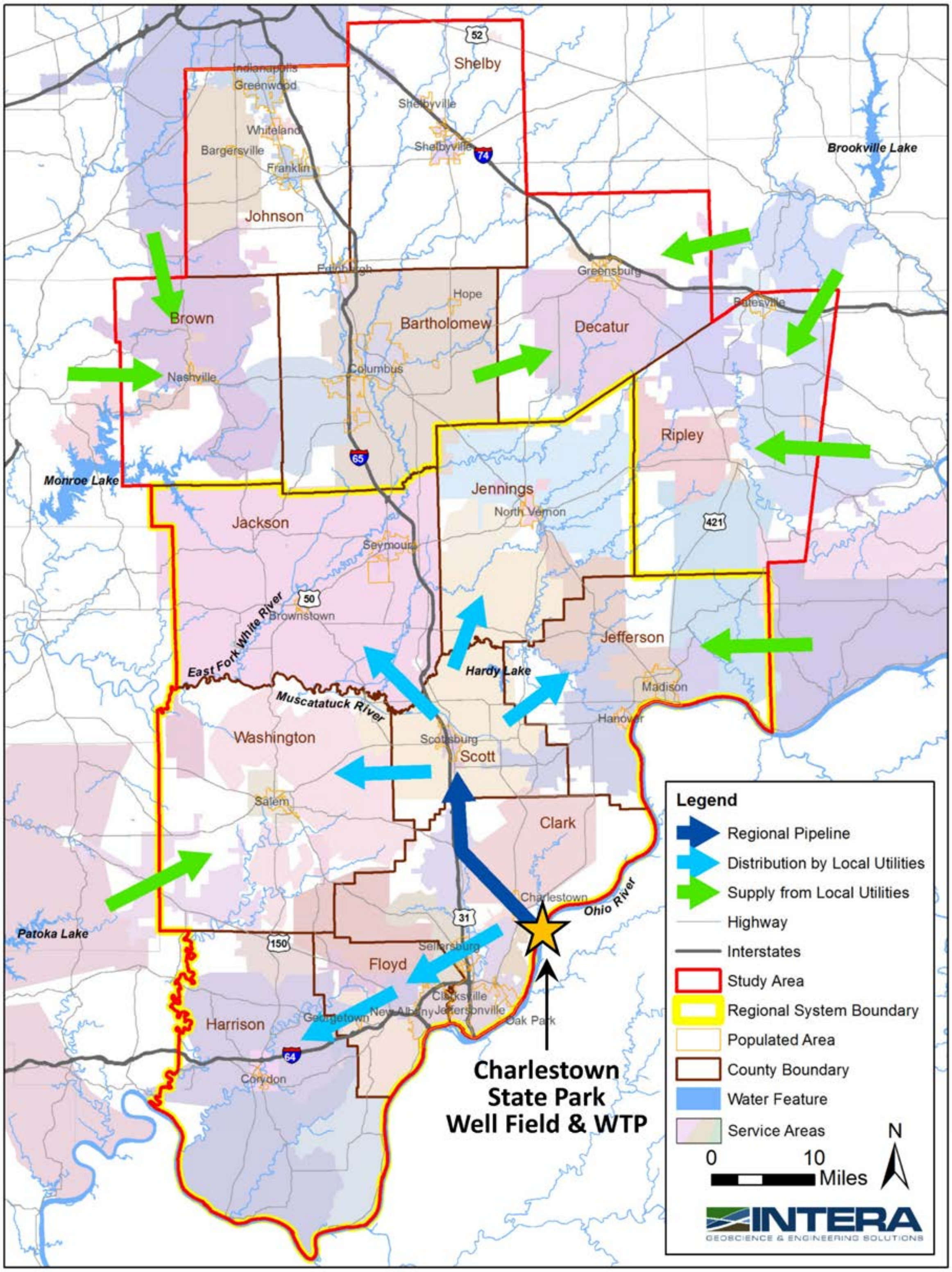


Figure 30. Southeastern Indiana regional water supply concept

*Note: Adapted from IFA, 2018*

# 7.0 RECOMMENDATIONS

Near-term and long-term recommendations are presented in this section. Near-term recommendations address the *water supply expansion* and *utility system separation* described in Section 5. Long-term recommendations address the *regional water supply* described in Section 6.

## 7.1 Near-term recommendations

Near-term recommendations are focused on increasing the capacity of the existing Supply System to meet projected RRCC demands through 2030 and facilitating the transition to operation of the existing IDNR Supply System and the RRCC Distribution System as separate utilities. These include recommendations for use in soliciting consulting services for detailed investigation, engineering design and permitting of the *water supply expansion* (7.1.3 and 7.1.4, below). Additional near-term recommendations include investigation and engineering design of improvements required for *utility system separation* (7.1.5, below), the construction of designed *water supply expansion* and *utility system separation* improvements, and the administrative actions required to establish the IDNR and RRCC systems as separate public water supply (PWS) systems.

### 7.1.1 RRCC backup water supply

It is recognized that there is a risk that RRCC water demand could exceed the capacity of the IDNR Supply System before the near-term capacity improvements are completed.

It is recommended that the RRCC complete and maintain the existing and planned emergency interconnections with Watson Water described in this report for use on a temporary basis if the capacity of the Supply System is exceeded before the *water supply expansion* is completed.

### 7.1.2 Contract design services for near-term improvements

It is recommended that IDNR contract an engineering consultant for the design of the *water supply expansion*. Contracted engineering services for the *water supply expansion* should include the design of improvements to wells, treatment plant, supply transmission main, and SCADA system upgrades, including separation of supply and distribution control systems (see 7.1.3 and 7.1.4).

It is recommended that IDNR coordinate with RRDA to determine a mutually acceptable approach to contracting an engineering consultant for the *utility system separation*. Contracted engineering services should include design of improvements to the Supply System booster station and Distribution System to separate the Supply and Distribution Systems, including master meters and other improvements to facilitate independent operation of the IDNR and RRDA systems (see 7.1.5). The final scope of work to be completed for *utility system separation* will be determined by negotiations between IDNR and RRDA (see 7.1.7).

### 7.1.3 Pilot testing to increase permitted capacity of existing plant

It is recommended that the engineering consultant hired for the design of the *water supply expansion* proceed immediately to evaluate the engineering and permitting feasibility of uprating the capacity of the existing aeration, detention and filtration unit by as much as 60% to a filter loading rate of 5.0 GPM/ft$^2$, and to initiate any related pilot testing that may be required for permitting. The permitted filter rating may be used as the basis for the permitted capacity of the new filter unit installed with the expansion.

### 7.1.4 Design for water supply expansion

It is recommended that the engineering consultant contracted by IDNR complete the investigation and design of necessary *water supply expansion* and related improvements described in sub-sections 5.1 and 5.2 of this report.

- Increase total water supply and treatment capacity to 6 MGD, with a minimum firm capacity of 4 MGD
- Evaluate and improve or replace chlorine, permanganate, and fluoride chemical storage and feed systems
- Prepare for future addition of treatment for PFAS or other CEC's
- Review of Lead and Copper Rule (LCR) monitoring and proposed LCR revisions, evaluation of corrosion control requirements
- Upgrade high-service pumping, and change flow control to eliminate the use of modulating valves to throttle flow from the wells to the aerator.
- Elevate electrical transformer, other components of electrical service if needed to protect from flooding. Review electrical equipment, upgrades as needed
- Improvements to instrumentation and SCADA systems to enhance monitoring and control, ability to monitor and operate plant remotely if flooding occurs. Physical security and cybersecurity improvements as may be required.
- Separation of Supply and Distribution SCADA systems to facilitate the independent operation of IDNR supply and RRCC distribution systems
- Review of transmission main surge protection, improvements as required

### 7.1.5 Design for supply and distribution utility system separation

It is recommended that the engineering consultant contracted by either IDNR or RRDA complete the investigation and design of improvements necessary for the *utility system separation* to facilitate the independent operation of the IDNR supply and RRCC distribution systems as described in sub-sections 5.3 and 5.4 of this report. The final scope of work to be completed for *utility system separation* will be determined by negotiations between IDNR and RRDA (see 7.1.7).

- Installation of master meters, backflow prevention and emergency bypass valving at points of interconnection between the IDNR Supply System and RRCC Distribution System
- Improvements to RRCC Distribution System as required to separate customer connections from IDNR-owned transmission mains
- Evaluation of existing booster station pumping equipment and controls to adapt to RRCC's planned construction of new elevated tanks in the high and low pressure zones. Modifications as may be required.
- Evaluation of existing booster station electrical equipment, chlorination equipment, and facility security. Improvements as may be required.

### 7.1.6 Construct water supply expansion and utility system separation improvements

It is recommended that the IDNR contract the construction of *water supply expansion* improvements (7.1.3 and 7.1.4) and coordinate with RRDA to determine a mutually acceptable approach to contracting the construction of the *utility system separation* improvements (7.1.5).

### 7.1.7 Complete administrative separation of supply and distribution systems

It is recommended that IDNR negotiate and execute asset transfers, easements, exchanges, and other agreements as necessary to separate the IDNR Supply and RRCC Distribution Systems. As part of these negotiations, IDNR and RRDA should agree on the details of the improvements required for *utility system separation*.

It is recommended that IDNR and RRDA negotiate and execute a long-term water supply agreement for wholesale water supply to meet the future needs of the RRCC and coordinate actions to separate the Supply and Distribution Systems as separately regulated utilities under IDEM, and as applicable, IURC.

## 7.2 Long-term

Long-term recommendations include measures related to planning for the development of the *regional water supply*. The existing treatment plant will be built out with the currently planned *water supply expansion*. It is recommended that investigation and planning begin in order to be prepared with a conceptual design for the next phase of regional water supply development. The water supply capacity of the expanded existing plant could be exceeded in a relatively short period of time if an industry with large water requirements is attracted to the RRCC.

### 7.2.1 Collector wells

To meet future RRCC and regional demands beyond the capacity of the currently proposed water supply expansion it is recommended that one or more high-capacity collector wells be constructed, rather than numerous smaller capacity vertical wells. It is recommended that investigation and planning begin to determine the location and conceptual design of the first collector well, in preparation for its construction when it is needed.

### 7.2.2 Develop a Long-Term Plan for Regional Water Supply Development

It is recommended that planning for the development of the regional water supply begin in order to develop a conceptual design for the additional supply, treatment, transmission, and storage infrastructure that will be required after the expanded capacity of the existing plant is exceeded. Planning should provide for additional redundancy and resiliency of operations to ensure uninterrupted water supply. The locations and alignment of facilities should consider and be coordinated with the Charlestown State Park master plan, RRCC strategic plan, and regional economic development plans. The regional water supply system should be planned to connect to other utilities in the region to provide access to water supplies for their customers use or to “wheel” through their systems to other interconnected utilities.

# 8.0 REFERENCES

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# APPENDIX A:
# WELL TESTING AND HYDROGEOLOGIC ANALYSIS

# 1.0 CURRENT SYSTEM

At the Charlestown State Park Well Field, groundwater water is pumped from three production wells located in a line parallel to the Ohio River and adjacent to the treatment plant (Figure 31). The well field was originally designed to provide a firm capacity of 2 MGD. To achieve this, the three production wells were constructed and outfitted based on a design capacity of 700 GPM (~1 MGD) each and a separation distance of 200 FT.

To assess current conditions, we conducted field tests at the well field, including hydraulic testing and water-quality testing. The primary objective of hydraulic testing was to determine if well field capacity can be increased by pumping more water from the production wells. The source of supply is a highly productive aquifer, with yields that are enhanced by induced infiltration of surface water from the Ohio River. Based on the results of performance tests that were conducted when the production wells were originally constructed, it may be possible to meet short-term increases in demand by Increasing the total well field capacity by increasing the design capacities. This could be an efficient approach to increasing well field capacity in the near-term, without constructing new production wells.

## 1.1 Source of Supply

The source of supply is a highly productive aquifer glacial outwash aquifer (the Aquifer) composed of permeable sand and gravel deposits. The deposits fill a pre-glacial bedrock valley adjacent to and underlying the Ohio River. The Aquifer extends along the Ohio River from north of the City of Charlestown to just north of Utica, terminating near the Charlestown State Park Well Field.

The Aquifer is limited in extent and relatively thin, with a saturated thickness of less than 100 feet. Perpendicular to the river, the Aquifer pinches out where the bedrock crops out along a line of bluffs ranging from 400 to 1,000 feet from the river. High yields from the Aquifer are supported by the Ohio River, which is in hydraulic connection to the Aquifer, and is the primary control on groundwater levels. The Ohio River is incised into the Aquifer and is connected to the aquifer by a layer of silt and organic material lying along the riverbed.

## 1.2 Well Field

Well 1 was constructed by Reynolds in 2009, followed by construction of Well 2 and Well 3 by Bastin Logan in 2010. Four monitoring wells that were installed during well field construction (Figure 31) are still intact and were used to assess the current levels of well interference. In 2013, one of the monitoring wells (MW-3) was converted to a US Geological Survey (USGS) gaging station that continuously measures, records, and reports water levels at the well field (USGS, 2020). The record helped us establish the range of static water levels in the well field and determine the available drawdown.

# 2.0 FIELD TESTING

To assess the potential for pumping more water the production wells, we temporarily outfitted the wells with pressure transducers so that operational water levels could be observed. The pressure transducers measure and record water-level changes in the wells. Pressure transducers were installed in the production wells to measure pumping water levels and determine current specific capacities. In addition, pressure transducers were installed in the three existing monitoring wells to help gauge the levels of mutual well interference within the well field. Pressure transducers were installed on 1/14/20 and retrieved on 2/3/20.

To assess current source water chemistry, water-quality samples were collected from the production wells on 1/23/20. The results were integrated into plans for future upgrades to the treatment plant.

## 2.1 Hydraulic testing

During the testing period, the operators ran the production wells within the normal operational framework dictated by customer demand and storage capacity (Figure 32). The depth of submergence measured by the transducers was converted to depth-to-water based on the manual measurements summarized in Table 9. Paired well combinations were run between 1/14/20 and 1/23/20 and then individual wells between 1/23/20 and 2/3/20.

Drawdown is defined as the decrease in the water level when water is being pumped. The drawdowns observed during hydraulic testing were used to measure well interference, operational pumping levels, and current specific capacities.

Table 9. Manual measurements prior to installation of transducers on 1/14/20.

| Well | Depth to Water [Feet] | Measuring point |
|---|---|---|
| Well 1 | 37.50 | Highest point on vent pipe |
| Well 2 | 37.49 | Highest point on vent pipe |
| Well 3 | 37.50 | Highest point on vent pipe |
| MW-1 | 31.31 | Top of PVC casing |
| MW-2 | 31.46 | Top of PVC casing |
| MW-4 | 20.12 | Top of PVC casing |

### 2.1.1 Pumping levels and pumping rates

To assess pumping levels in the production wells and estimate current specific capacities, some understanding of the production well pumping rates during the testing period was needed. Due to problems with the SCADA, the operators could not provide a continuous record of flows. Instead, flow rates were estimated at certain times from operating logs. Current specific capacities were estimated from stable periods in the record when single wells were being used (Figure 33).

### 2.1.2 Specific capacities

Data collected since the wells were installed, including the hydraulic testing for this study, show that the specific capacity of Well 1 has improved since the well was installed in 2010. Reportedly, none of the wells have ever been rehabilitated (Smith, 2020). This indicates that the well has continued to develop over time, becoming more efficient. It is more common for the specific capacity of a production well to decrease over time due to fouling of the well screen.

Figure 34 compares the specific capacities of Well 1 at the time of construction with the results of overboard testing by Layne in 2016 and 2019 (Appendix C) and the current test. For the step-rate test conducted at the time of construction (WHPA, 2010), the specific capacity was highest (176.1 GPM/FT) at a flow rate of 1,000 GPM (Figure 34). Subsequent testing, including the current effort, show that the specific capacity increased to over 200 GPM/FT at comparable flow rates.

Figure 35 and Figure 36 compare the original specific capacities of Well 2 and Well 3 (Bastin Logan, 2010), respectively, with the results of overboard testing in 2016 and the current testing. The original specific capacities of Wells 2 and 3 were both more than twice as high as Well 1. This could be due variations in the aquifer and/or variations in construction methods. For Wells 2 and 3, the current specific capacities cannot be directly compared to the original results because the tests were done at different pumping rates. Comparing the current estimate with the 2016 results suggests that the specific capacity of Well 2 has improved and the specific capacity of Well 3 has decreased.

For the subsequent drawdown analysis, the specific capacity of each the wells were estimated at a pumping rate of 1,400 GPM. The estimated specific capacity for Wells 1, 2, and 3, respectively, is 192 GPM/FT, 459 GPM/FT, and 425 GPM/FT.

### 2.1.3 Available drawdown

To assess the potential for increasing the design capacity of the wells, we estimated available depth for NPSHr and drawdown to be approximately 29.5 feet (Figure 37), defined here as the distance the lowest seasonal water level and the pump intakes. Note that the top of the screen of Well 1 is lower than the other two wells. Available drawdown for Well 1 could be increased by extending the pump column and lowering the intake elevation.

To define the available drawdown at the well field, we used the difference between the elevation of the pump intakes and the lowest seasonal water level observed in the USGS monitoring well at the well field. The elevation of the pump intakes of 392.5 ft was estimated from Well 1 design drawings (Appendix C) and the pump installation reports for all three wells (Bastin Logan, 2010). Based on over six years of record, the seasonal low groundwater level at the well field is at an elevation of 419 feet (Figure 38).

Water levels in the Aquifer are heavily influenced by river stage, which is controlled downstream by the McAlpine Locks and Dam in Louisville. The probability distribution of daily water levels shows that 90 percent of the time, the water level at the USGS monitoring well is between elevations of 419-425 FT (Figure 39).

### 2.1.4 Well interference

Based on the hydraulic testing conducted for this project, well interference is very low. Observed interference at the current design rates are less than one foot (Figure 32).

## 2.2 Water-quality sampling

Prior to sample collection, each production well was pumped individually for at least 30 minutes. Samples were collected from a raw-water sample port located within the treatment plant, upstream of filtration and chlorination. The samples were analyzed for a comprehensive set of drinking-water constituents, including metals, pesticides, semi-volatile organic compounds (SVOCs), and volatile organic compounds (VOCs). In addition, the samples were analyzed for emerging contaminants that are part of the Fourth Unregulated Contaminant Monitoring Rule (UCMR 4) and several compounds on the UCMR 3 list, including 1,4-Dioxane (Dioxane) and a set of per- and polyfluoroalkyl substances (PFAS). Full laboratory results are included as Appendix B.

### 2.2.1 Metals

Generally, a higher number of metals were detected and at higher concentrations in Well 1 compared to Wells 2 and 3 (Table 10). Secondary maximum contaminant levels (SMCL) were exceeded for iron (Well 1) and manganese (Wells 1 and 2). Iron and manganese concentrations in the Aquifer vary by location and are commonly above the SMCL of 300 ug/L and 50 ug/L, respectively (WHPA, 2010). A comparison of iron and manganese concentrations measured at the time of installation (WHPA, 2010) with the current results suggests that iron and manganese concentrations have stabilized or decreased over time in each of the three production wells (Table 11).

Table 10. Summary of metals detected in 1/23/20 samples.

| Analyte | Units | Reg Limit | Well 1 | Well 2 | Well 3 |
|---|---|---|---|---|---|
| Iron | [ug/L] | 300^ | **400** | 43 | 32 |
| Arsenic | [ug/L] | 10* | 1.5 | < 1.0 | < 1.0 |
| Barium | [ug/L] | 2000* | 87 | 45 | 49 |
| Copper | [ug/L] | 1300! | 18 | 5.0 | 2.1 |
| Lead | [ug/L] | 15! | 5.8 | 1.6 | < 1.0 |
| Manganese | [ug/L] | 50^ | **240** | **150** | 48 |
| Nickel | [ug/L] | -- | 6.7 | 1.5 | < 1.0 |

*Notes: detections above reg limit in bold. ug/L; microgram per liter*

**USEPA Maximum Contaminant Level*

*^USEPA Secondary Maximum Contaminant Level*

*! USEPA Action Level or Maximum Contaminant Level Goal*

Table 11. Comparison of original iron and manganese concentrations with current results.

| | | Well 1 | | Well 2 | | Well 3 | |
|---|---|---|---|---|---|---|---|
| Analyte | Units | 9/20/09 | 1/23/20 | 4/28/10 | 1/23/20 | 6/3/10 | 1/23/20 |
| Iron | ug/L | 908 | 400 | 197 | 43 | 60 | 32 |
| Manganese | ug/L | 246 | 240 | 187 | 150 | 108 | 48 |

*ug/L; micrograms per liter*

### 2.2.2 Organic compounds

No pesticides, SVOCs, or VOCs were detected in any of the samples collected for this study. However, several UCMR 4 compounds including Dioxane and three PFAS compounds were detected at levels near the respective reporting limits (0.07 ug/L for Dioxane and 2.0 ug/L for PFAS compounds). Dioxane and PFOA were detected in all three production wells (Table 12). PFOS and PFHxA were detected in two of the three production wells (Table 12). The USEPA is assessing the need to establish MCLs for exposure to these emerging contaminants in drinking water. No federal maximum contaminant level (MCL) has been set for Dioxane or PFAS compounds.

Dioxane is classified as a likely human carcinogen and is included on the fourth drinking-water contaminant candidate list (USEPA, 2017). Dioxane was detected in all three production wells at concentrations ranging from 0.08 to 0.26 ug/L. These observed concentrations are well below the USEPA drinking water lifetime health advisory (HA) for Dioxane of 200 ug/L (USEPA, 2018). An HA is an estimate of acceptable drinking-water levels for a chemical substance based on health effects information; an HA is not a legally enforceable Federal standard, but serves as technical guidance to assist Federal, State, and local officials.

Exposure to PFAS compounds may impact reproductive and development health, increase the risk for cancer, disrupt thyroid hormones, and affect the immune system (KYDEP, 2019). USEPA has issued a lifetime HA of 70 ng/L for PFOA and PFOS (USEPA, 2018). USEPA also recommends that when these two chemicals co-occur in a drinking water source, a conservative approach to protect human health is to compare the sum of the concentrations to the lifetime HA of 70 ng/L (KYDEP, 2019). The observed concentrations are well below the USEPA drinking water lifetime HA.

Table 12. Summary of organic compounds detected in 1/23/20 samples.

| Analyte | Units | Lifetime HA | Well 1 | Well 2 | Well 3 |
|---|---|---|---|---|---|
| 1,4 - Dioxane | [ug/L] | 200 | **0.18** | **0.26** | **0.08** |
| PFOA | [ng/L] | 70 | **4.7** | **4.4** | **6.9** |
| PFOS | [ng/L] | 70 | < 2.0 | **2.1** | **2.0** |
| PFHxA | [ng/L] | -- | **2.3** | < 2.0 | **2.1** |

*Notes: detections in bold. ug/L; micrograms per liter. HA; Health Advisory*

# 3.0 INCREASING WELL FIELD CAPACITY

The South portion of the Aquifer where the current well field is located is the most productive area of the Aquifer (WHPA, 2010; Layne, 2011). At the South end of the State Park where the well field is located, the transmissivity of the Aquifer is very high, with yields augmented by induced infiltration of water from the Ohio River. Given the productivity of the Aquifer, there are multiple options for increasing well field capacity, including increasing the design capacity of the existing wells, constructing new vertical wells, and constructing a new radial collector well.

## 3.1 Increasing the design capacity of existing wells

Given the available drawdown and current specific capacity of the production wells, the design capacity of all three wells can be doubled to 1,400 GPM each. Doubling the design capacity of each well would provide a total well field capacity of 6 MGD, with a firm capacity of 4 MGD. This would require upgrades to existing pumps. If this is accomplished in a step-wise approach, priority should be given to Wells 2 and 3 given that Well 1 is less efficient (lower specific capacity) and has poorer water quality (higher levels of iron and manganese).

The total drawdown in each well was calculated by assuming 10% degradation of the specific capacity and conservatively accounting for well interference (Table 13). At 1,400 GPM, the total drawdown and estimated NPSHr for each well is less than the available drawdown of 29.5 FT. The total drawdown calculated for Well 1 at 1,400 GPM is approaching the limit of available drawdown. As noted in Section 5.1.3, available drawdown in Well 1 can be increased by lowering the intake. Five to ten feet of column should be added to Well 1 when the pump is upgraded implement more of a buffer between potential pumping levels and the pump intake.

The transmitting capacity of each well screen is large enough to accommodate the increase in design capacity. The well screen submittal data for Wells 2 and 3 included in the O&M report (Bastin Logan, 2010) indicates that the total transmitting capacity is 2,580 GPM at a limiting velocity of 0.1 FT/SEC. The well screen specs for Well 1 are not available. However, we assume that the Well 1 screen has sufficient transmitting capacity given that the slot size used for Well 1 (0.06 inches) is the same as Wells 2 and 3.

Table 13. Drawdown calculations.

| Well | 10% Degraded Specific Capacity [GPM/FT] | Pumping Rate [GPM] | Pumping Drawdown [FT] | Well Inter-ference [FT] | Total Drawdown [FT] |
|---|---|---|---|---|---|
| 1 | 172.8 | 1400 | 8.1 | 3 | 11.1 |
| 2 | 413.1 | 1400 | 3.4 | 3 | 6.4 |
| 3 | 382.5 | 1400 | 3.7 | 3 | 6.7 |

*GPM=gallons per minute. MGD=million gallons per day. NPSHr=Net positive suction head requirement.*

## 3.2 New Vertical Wells

For additional marginal increases in capacity, new vertical wells could be installed at the well field with design capacities of 1-2 MGD each, dependent on local Aquifer conditions. If new vertical wells are added, planning should allow for a larger separation distance to accommodate additional well interference. For larger increases in capacity, a radial collector well should be considered.

## 3.3 Radial Collector Well

Based on extensive field testing and groundwater flow modeling, Layne (2011) evaluated various Aquifer development scenarios, which included rehabilitation of the existing seven radial collector wells located in the Park and two new, theoretical radial collector wells located south of the existing collector well CW-7 (Figure 40). For the theoretical, new collector wells, Layne predicted conservative yields in excess of 20 MGD per collector well.

Figure 31. Well field layout.

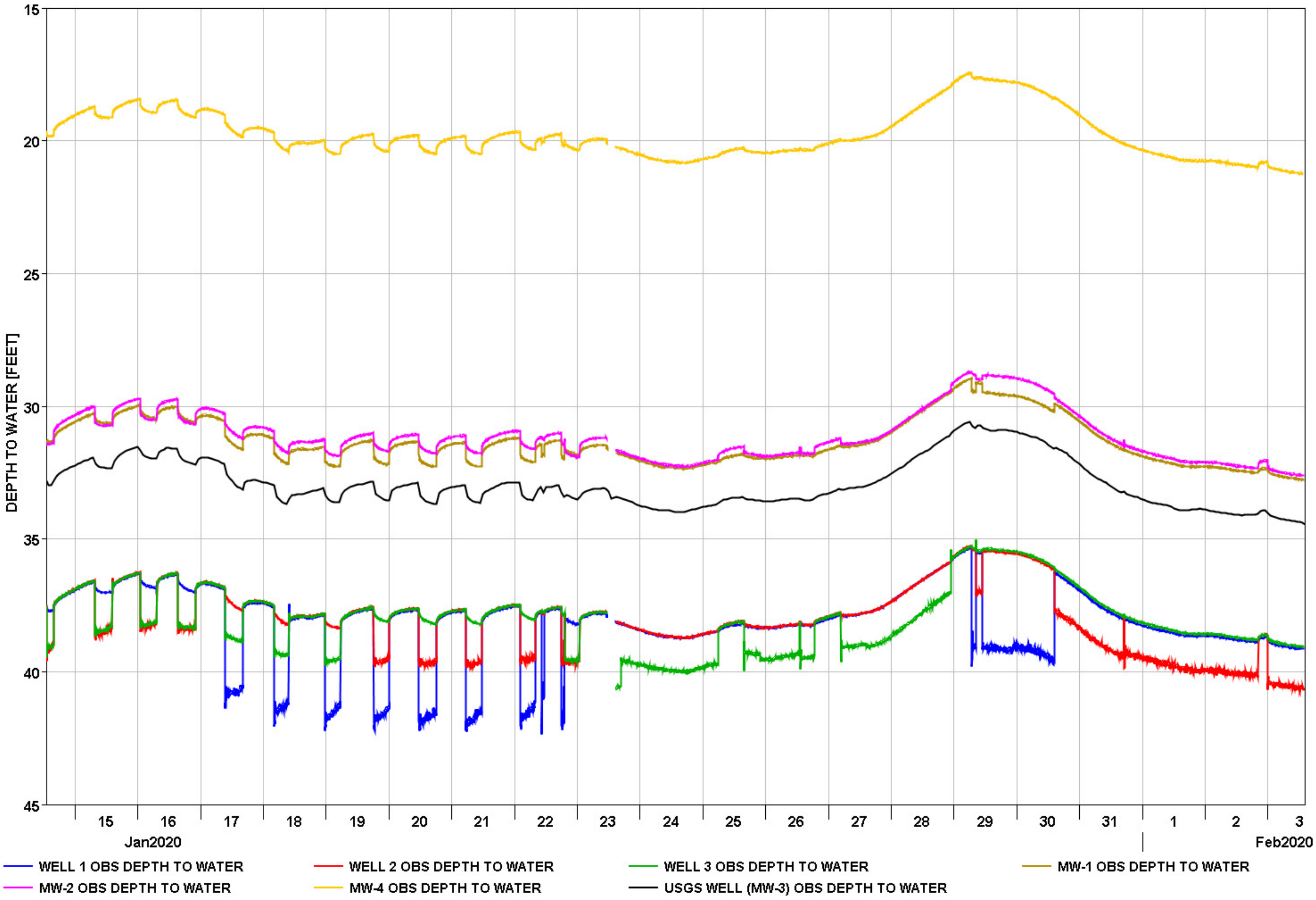

Figure 32. Water levels in production wells and monitoring wells, January 14 - February 3, 2020.

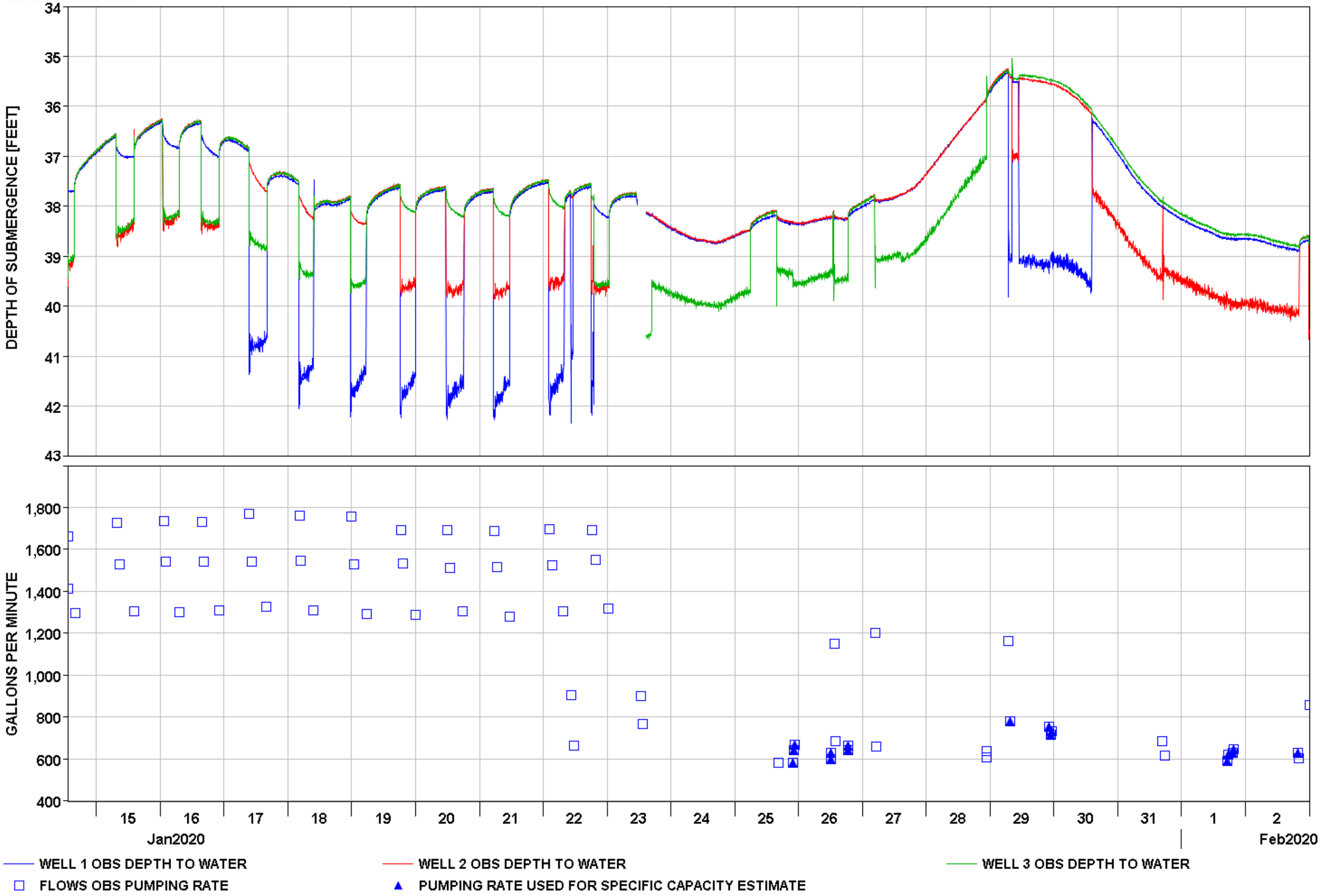

Figure 33. Water levels in production wells and estimated pumping rates.

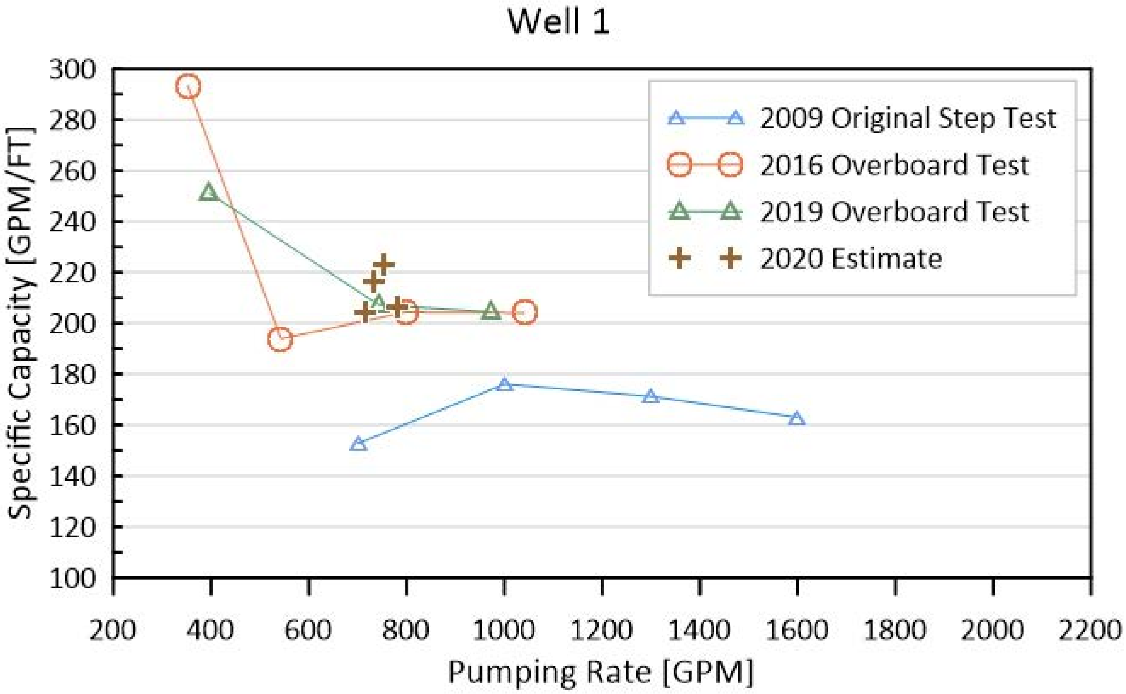

Figure 34. Well 1 specific capacity measurements.

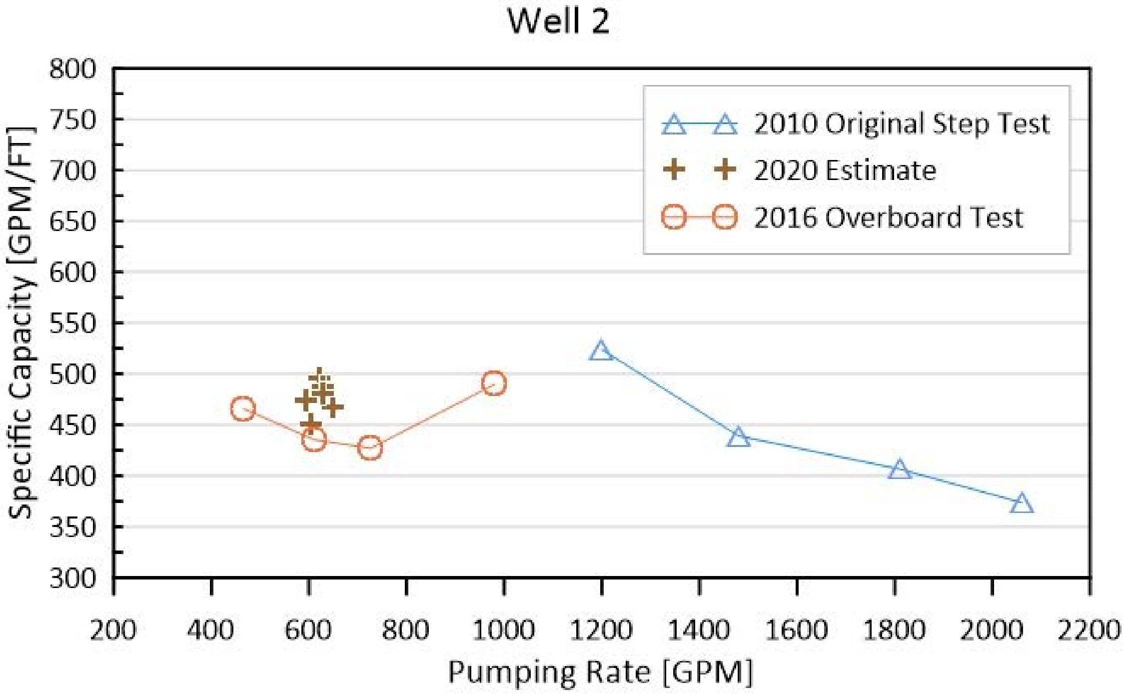

Figure 35. Well 2 specific capacity measurements.

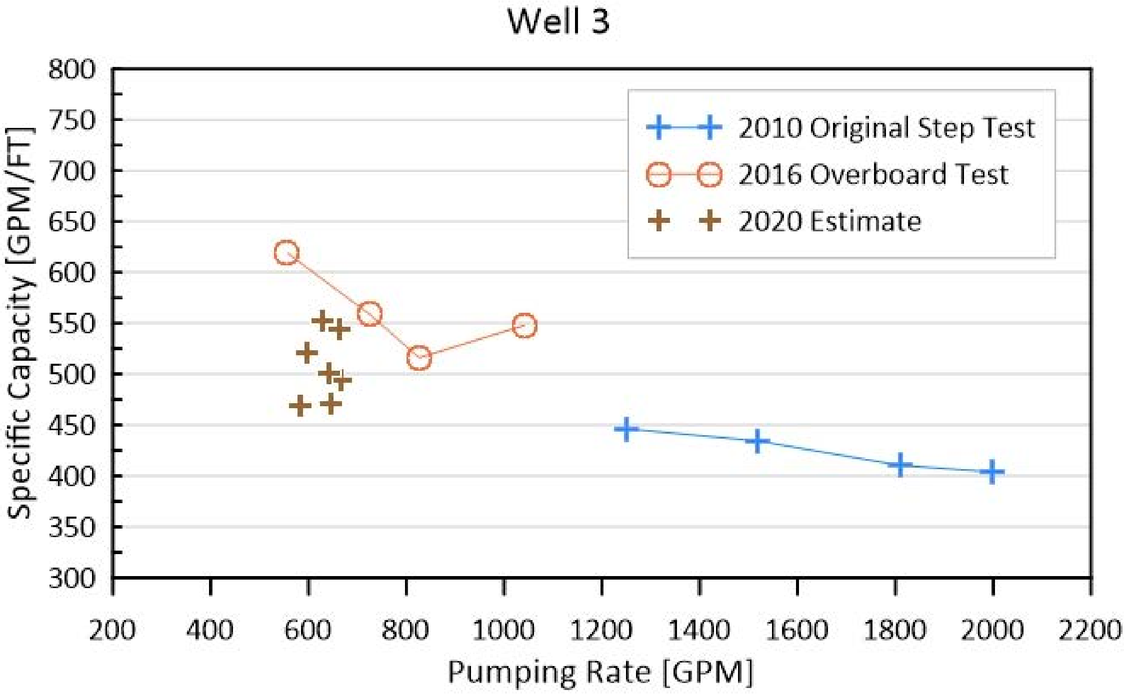

Figure 36. Well 3 specific capacity measurements.

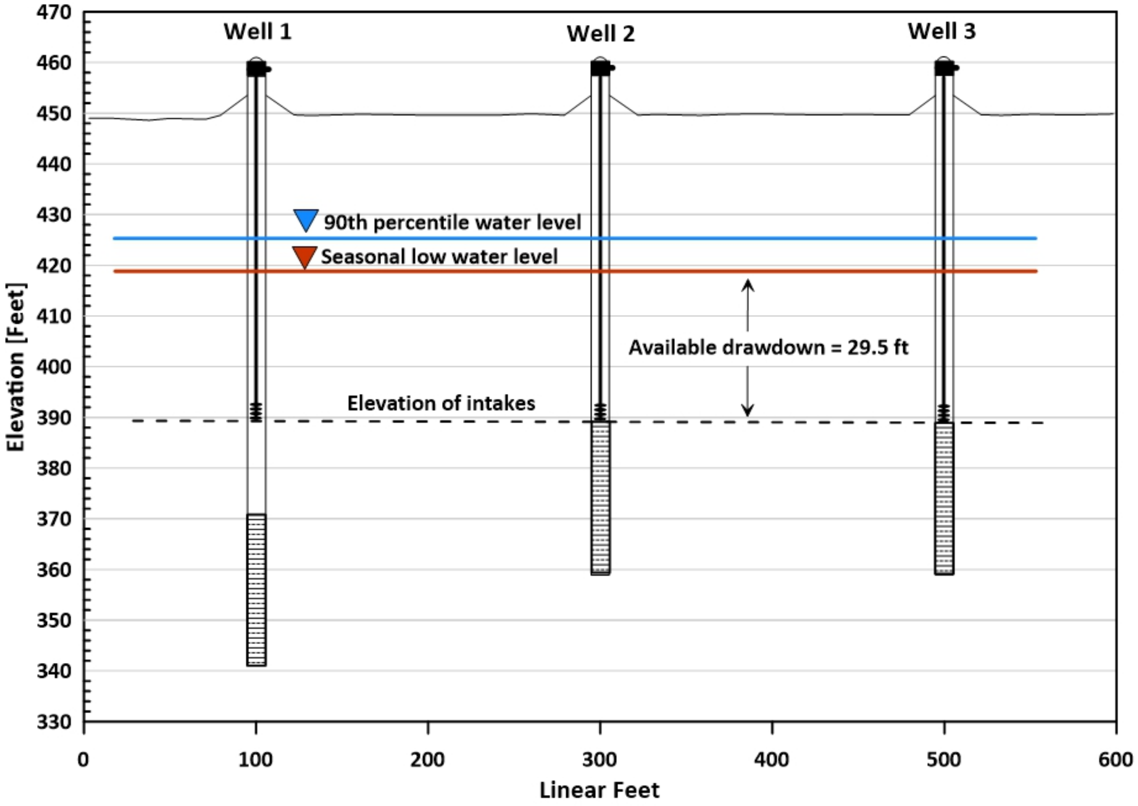

Figure 37. Well cross section showing range of static water levels, the pump intakes, and the available drawdown.

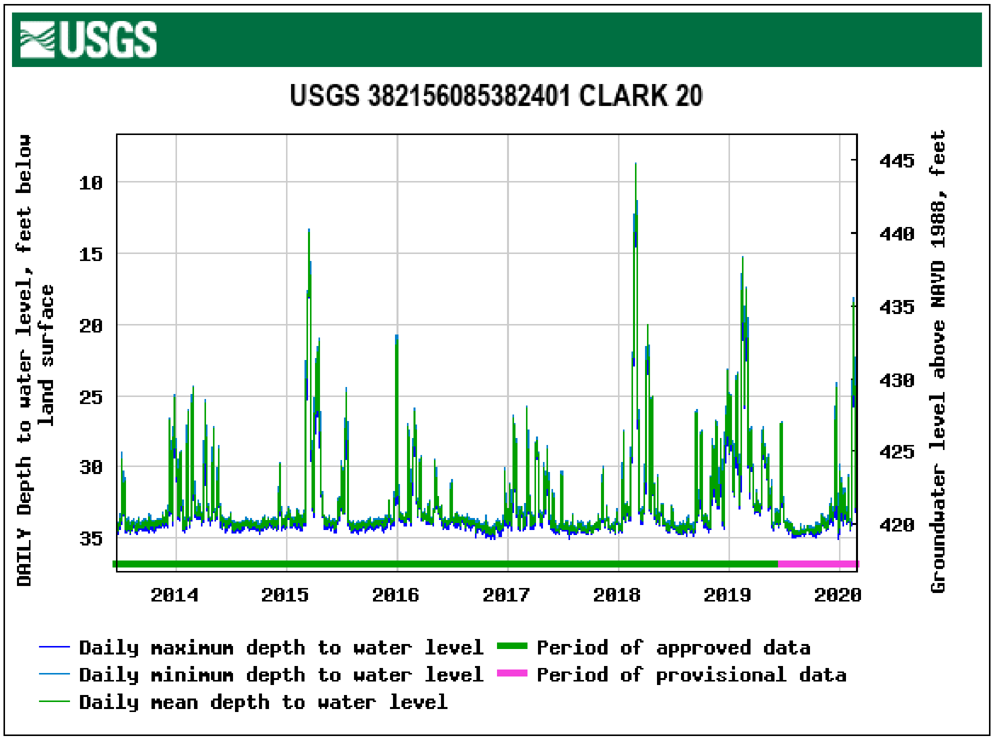

Figure 38. Continuous water levels recorded in USGS monitoring well since June, 2013.

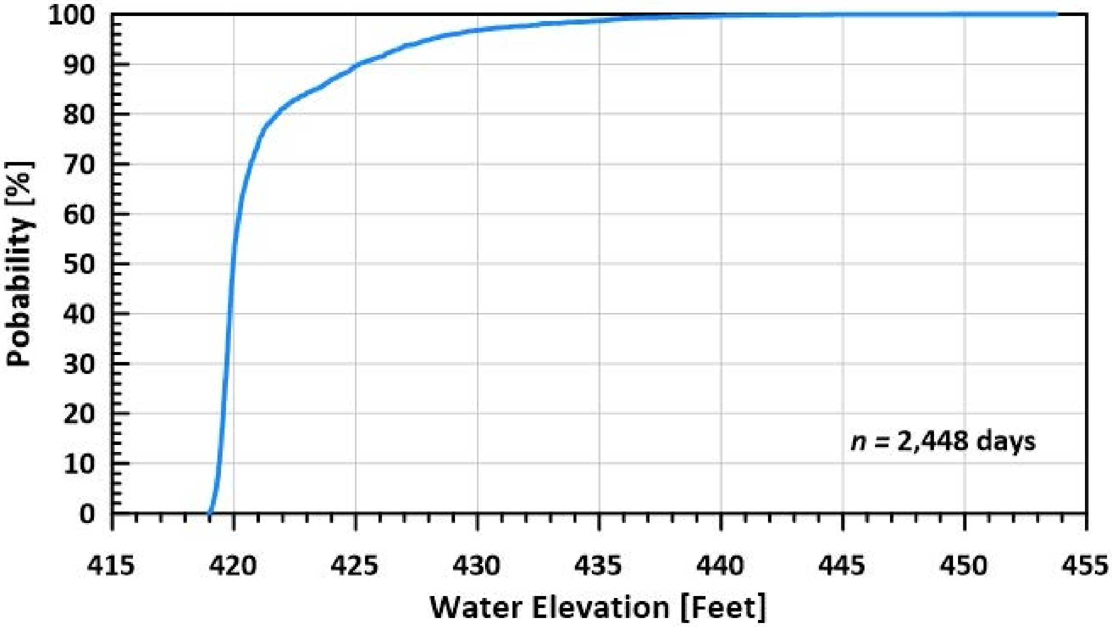

Figure 39. Probability distribution of daily water levels recorded in USGS monitoring well.

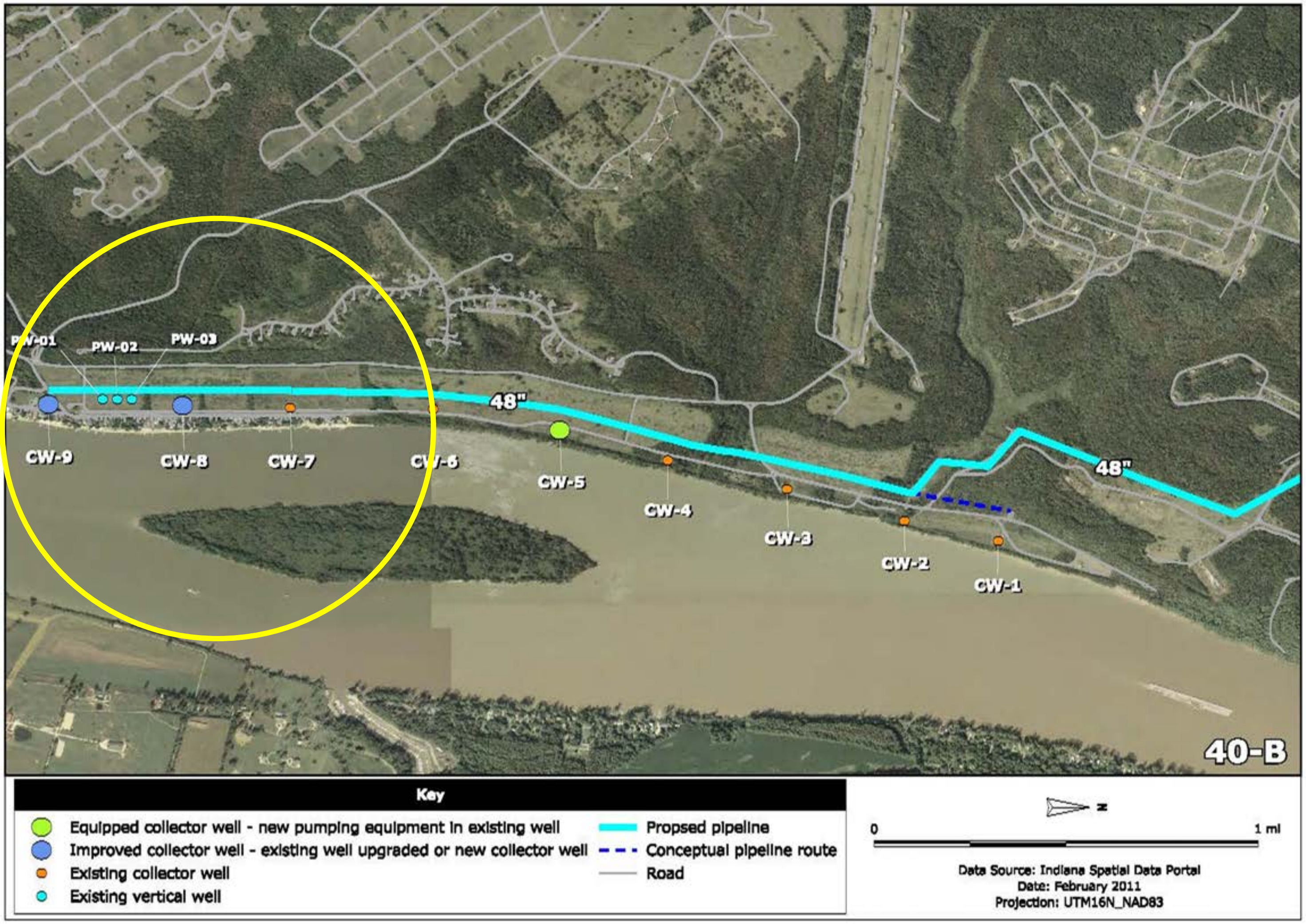

Figure 40. Layne's (2011) conceptual layout for two new, theoretical collector wells, CW-8 and CW-9, south of existing well CW-7.