Northern Kentucky Water District

EXHIBIT A-3

PRELIMINARY ENGINEERING REPORTS

TAYLOR MILL TREATMENT PLANT

UPGRADES AND IMPROVEMENTS

Preliminary Engineering Report

Submitted to

Northern Kentucky Water District
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INTRODUCTION

The Northern Kentucky Water District (NKWD or District) owns and operates multiple facilities for supplying water to 82,600 residential, commercial, industrial and wholesale customers in Northern Kentucky. The NKWD owns and operates three water treatment plants: the 44 mgd Fort Thomas Treatment Plant (FTTP), the 10 mgd Taylor Mill Treatment Plant (TMTP), and the 10 mgd Memorial Parkway Treatment Plant (MPTP). The surface water treatment plant receives raw water from the Licking River, which is a branch off of the Ohio River. The TMTP consists of conventional flocculation and sedimentation, followed by mixed media filtration, and ultraviolet light (UV) disinfection. The treatment plant was originally constructed in 1953 and has had several upgrades and improvements with the last major improvements done in 2007 (UV system).

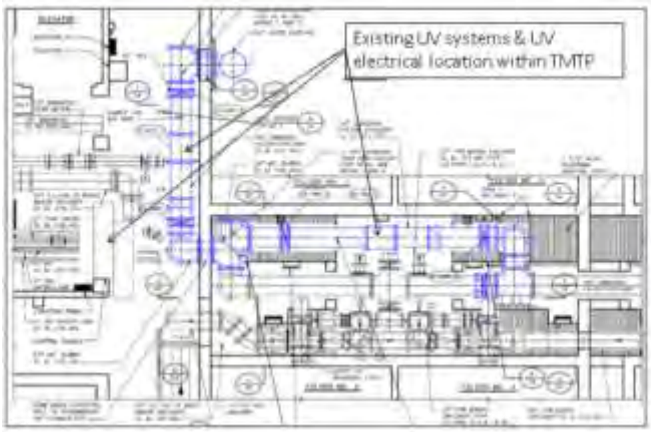
Cornwell Engineering Group (Cornwell) was retained by the NKWD to conduct a condition assessment and recommend improvements for areas of the TMTP requested by the NKWD that includes:

- the existing ultraviolet (UV) treatment system, including the uninterrupted power supply (UPS) system;
- the powdered activated carbon storage (PAC) and feed systems;
- the filtration system valves and actuators;
- high-service (finished water) pump #3;
- relocating the discharge point for the Fort Thomas water main diversion water;
- and structural repairs for the effluent launders around the perimeter of the two clarifier basins as well as the tunnel connecting the Chemical Storage Building and the Main Treatment Building.

Cornwell's assessment and recommendations are based on available data and information furnished by the NKWD, correspondence and discussions with NKWD staff, and a site visit conducted in October 2020 as well as correspondence and discussions with equipment sales and manufacturer representatives.

ULTRAVIOLET (UV) TREATMENT SYSTEM IMPROVEMENTS

Existing Conditions



The Ultraviolet Disinfection System (UV DS) at the Taylor Mill Treatment Plant was installed in 2007 and includes two TrojanUVSwift 24 reactors (24" diameter). Each reactor is connected to the combined filter effluent header so they can treat flow independently or simultaneously to the finished water clearwell. UV Train 2 (UV-UVE2 in the sketch) is currently not functional; UV Train 1 has experienced intermittent failures. An uninterruptible power supply (UPS) was installed along with the UV units about 250 ft away in the tunnel connecting the Chemical Building and the Filter Building and it is currently not functional.

This memorandum considers replacement of both UV Trains versus only the non-functioning UV Train 2; possible upgrade to LED UV; possible relocation of the reactors, the controls or both; and accreditation of the UV system.

Background, Current Operating Conditions, and Accreditation

The UV DS was installed in response to preparedness for cryptosporidium treatment under the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). NKWD staff confirms that the District currently was and currently remains in Bin 1, which does not require additional treatment such as UV. The original installation was related to a proactive stance by NKWD management to be ready for possible rule tightening and to provide redundancy and alternate systems for emergency conditions, and UV treatment at TMTP is not at this time required by regulation.

The existing Taylor Mill Treatment Plant UV systems are not accredited, based on historical communications suggesting that the original manufacturer (Trojan UV) was unwilling to share accreditation data considered proprietary at the time. The manufacturer has suggested that the historical issue was a misunderstanding and states that they are currently willing to pursue accreditation for existing or new units. Accreditation is necessary for NKWD to receive credit for UV treatment, and because UV treatment is not required today the accreditation is also not a regulatory requirement. Again, NKWD has chosen to be proactive in seeking accreditation for UV units throughout the system.

Reported failures, typically of the ballasts that drive the UV lamps, have been attributed to the humid and dusty conditions in the filter pipe gallery area. The ballasts require replacement 3 to 4 times annually. Since 2012, the lamps are warranted for 9,000 hours of operation, which is just over a year of continuous operation. Ballasts are warranted for up to 10 years, with full replacement in the first year. It is reported that since the UPS system ceased operating, the UV system experiences shutdowns several times daily, although the system typically restarts without further difficulty. Historical work with the local power provider, Duke Energy, showed that the TMTP's larger pumps can create a general voltage sag resulting from inrush when the pumps are started. This type of voltage sag can have effects on many types of equipment. UV equipment is typically designed for continuous operation, and cycling the equipment frequently could reasonably decrease lamp and driver life.

It is also reported that the dosage rate for the existing UV DS, which was designed for 40 mJ/cm^2, has typically been operated about 90 mJ/cm^2. This higher dose rate would also be expected to impact the service life of the lamps and ballasts.

The Taylor Mill Treatment Plant does not currently have a facility backup power system. NKWD acknowledged that an emergency generator backup system has been designed (by others), and is scheduled for bid in Spring 2021, and, upon approval, construction over the following 18 months. This generator project includes providing backup power to the UV system during emergency power operations. The current UPS for the UV system is located in the tunnel between the Chemical Building and Filter Building, which is an area somewhat removed from the UV reactors and controls, and experiences similar although less severe environmental conditions.

While the existing UV reactor locations were provided with appropriate harnessed couplings to allow removal, there is some question if the installation provides sufficient straight pipe runs to create the flow conditions required for validation and accreditation. NKWD staff is verifying this in the field, as existing drawings are not believed precise enough to allow a determination.

Extensive discussions with representatives of the original UV manufacturer revealed:

- The manufacturer has previously suggested the environment is the primary cause of failures for both the UV units and the UPS. However, they were not aware of the equipment cycling issues, which affect lamp and ballast life. Daily cycling 4 or more times is recognized as an issue for lamp and ballast early failure.
- While various material and functional upgrades have been made to the equipment since 2006, there were no changes that would substantially improve functionality in this environment.
- There are no specific available upgrades for new equipment that would substantially improve the functionality for this environment, although the cabinets themselves could be ordered as stainless steel. An outdoor rated (NEMA-4) enclosure is not an available option.
- The reactors must be placed within 70 ft of the controls. We did not observe available space within 70 ft of the existing reactor locations that would have a substantially different environment.

- Power line conditioning is not normally required, and a UPS is recommended only where backup power is not available to prevent excessive "off-spec" water or when excessive cycling occurs.
    - NKWD has designed and expects to bid in Spring 2021 a backup generator system that would include the UV units. Expected response time for the new generator system is 30 seconds. However, it is not clear that the new system or changes in the Duke Energy network would prevent a general power sag from the larger pumps. This requires further investigation and confirmation.
    - The cool-down and warmup time for the Trojan UV Swift system is 5 minutes cool-down and 3 minutes warmup.
- Trojan does not routinely offer a factory refurbishment program. A refurbishment could be considered, although pricing and schedule would not be provided in advance.

NKWD has Calgon UV units installed at their other water treatment facilities – Fort Thomas Treatment Plant and Memorial Parkway Treatment Plant. The UV units at those facilities are in the process of being accredited. While the Calgon units are similarly situated in filter pipe galleries, they have not experienced the same type of failures as the Trojan units. Even so, NWKD reports that the Calgon UV control cabinets have needed to be vacuumed annually to remove rust debris. Discussions with Calgon revealed:

- Calgon reactors may be up to 500 ft away from the controls because of the use of electromagnetic ballasts versus electronic ballasts.
- While a "hardened" version of the controls is not available, an upgrade to stainless steel is available for the cabinets and has been included in the estimates.
- Calgon does not require line conditioning, and UPS again is recommended only where backup power is not available. Cooldown and warmup times are 3 minutes each.

Options and Alternatives – UV Treatment System Improvements

When looking at available options for the Taylor Mill Treatment Plant, potential considerations for upgrades and improvements for the UV treatment system include: replace one UV train or both, upgrade to LED UV lamps, relocate the UV treatment system components, provide UPS and complete accreditation of the system.

Replacement of Train 2 Only Versus Both Trains

Table 1. Primary Issues Related to Replacement of the UV Trains

Replacing Both Trains	Replacing Train 2 Only
UV Train 1 has experienced maintenance challenges similar to UV Train 2, although UV Train 1 has remained operable	Lower initial capital costs, although eventual replacement of UV Train 1 on an earlier cycle would require separate mobilization and overheads resulting in increased lifecycle costs
New systems would be expected to have substantially reduced maintenance challenges	Unless specified for Trojan as sole source, there would be two sets of equipment requiring additional stocking, training and maintenance. Even with Trojan specified, the new equipment does not have identical parts. The matching systems today also allow transfer/cannibalization to keep one of the trains operating at need
Certain new systems have greater range from the controls to the reactors, allowing the controls to be relocated without the expense of relocating the reactors	UV Train 2 is the more challenging in terms of access and would be the more costly to replace in either option
While capital costs would be higher, there would be two matching new trains in place, with expected lower maintenance/downtime issues and expected service life of 20 years	Service life of UV Train 1, typically 20 years, would now be only 4 years away and replacement should be expected at that time with separate mobilization and potential for changes in equipment

Recognizing the ongoing maintenance issues, challenges of having different systems and desire to provide a long-term, fully functional solution, replacement of both trains is recommended.

It is possible for NKWD to revisit the intent to have UV since it is not currently a regulatory requirement.

Potential for LED UV Lamp Usage

Deep Ultraviolet LED or LED-C UV is an emerging technology that uses LED instead of mercury vapor-based lamps to generate UV rays. Typhon Treatment Systems had proposed using multiple 6,000 m^3/day (1.6 mgd) units to treat a 7.4 mgd flow at the Cumwhinton WTP in England to be completed by 2020, but has been delayed because of COVID-19 and will not be operational until late 2021 (see https://waterprojectsonline.com/custom_case_study/led-uv-treatment-2020/). These were the largest units known to be available. MetaWater of Japan also produces LED-C UV units, but again units that would treat larger flows are not yet available.

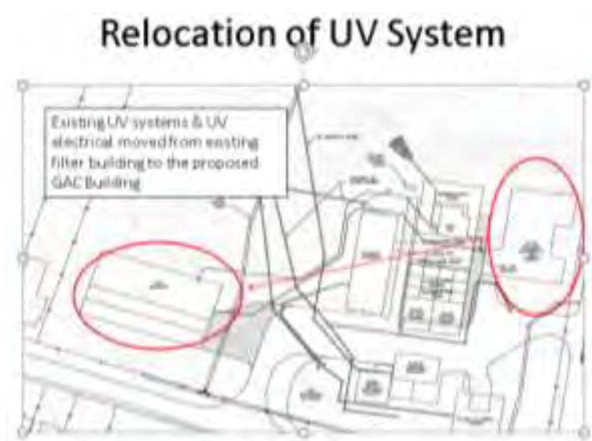
Both Trojan and Calgon advised that while they are working toward LED-C UV development, they do not anticipate commercial units being available within the next three years.

Accreditation will require validation of commercial scale units, also not yet a reality. While the literature suggests that US EPA will validate based on existing procedures, there is also some suggestion that LED-C UV should be subjected to independent regulation that has not been developed.

For the 6 mgd flow at the Taylor Mill Treatment Plant, it appears that LED-C UV technology is not ready for a production application including accreditation. A pilot program could be considered potentially using the extension area beyond UV Train 1 if further evaluation is desired.

Possible Relocation of the Reactors, Controls or Both

NKWD has previously considered moving the UV treatment system to a new purpose-built Granular Activated Carbon (GAC) building. This is a reasonable option, except that the GAC facility is not yet designed and scheduled for construction. The UV treatment system today is marginally functional, and delaying its repair/ replacement increases the likelihood of NKWD not having UV treated water. When the GAC building is constructed, relocation of the UV systems would be possible and should be considered if the system is not replaced at this time.



The existing filter pipe gallery location of the reactors was designed with harnessed couplings in the piping suitable for removal of the reactors, although Train 2 is somewhat more challenging because of its position behind several panels along with other filtration system piping. *This location remains most feasible today* because the piping network as designed allows the reactors to function together or independently as needed and is readily accessible to the combined filter effluent and finished water clearwell.

The control panels are located near the filter pipe gallery, and the lamp ballasts are located inside the control panels. The Trojan control panels are required to be within 70 ft of the reactors, and the existing location serves for that purpose. According to Calgon, the UV reactors may be up to

500 ft away from the controls because of the use of electromagnetic ballasts versus electronic ballasts. These ballasts have an in-rush power requirement higher than their electronic counterparts. They are also larger and heavier. The space in the area of the current control cabinets appears marginally adequate for both panels, but detailed measurements during design will be needed to confirm the clearances. If the space at the existing control panels is not adequate, one panel could be placed there and the other in the vicinity of the old UPS. As an option for Calgon units, both control panels could also be placed near the UPS system because of their longer separation distance. NKWD experience with the current Calgon units in other facilities suggests that relocation may not be necessary, particularly with the use of stainless steel cabinets.

Uninterruptible Power Supply and Accreditation Considerations

The original UV system was provided with a UPS, reportedly as a manufacturer recommendation to condition the line voltage. While neither Calgon nor Trojan recommends a UPS or line conditioning today, NKWD has expressed a concern that non-spec water could increase beyond regulatory limits if a UPS is not provided. The reported voltage sag is also of concern.

The Federal regulation, from the EPA UV Guidance Manual, sets non-spec water (defined as water not treated by UV equipment operating within its validated range, which has a number of specifications) at 5% maximum of the flow for a given month. Kentucky appears to adhere to the national standard.

UV reactors and controls have specific cool-down and warmup periods, during which the water would be considered non-spec. For both Trojan and Calgon, the total cool-down/warmup cycle is up to 8 minutes. The NKWD has indicated the proposed generator system will have an approximate 30-second response time from power failure. Because the cool-down period begins immediately with the power failure, the total period of non-spec water production for the UV system during a power outage would be up to 8 minutes. This would suggest that the non-spec water period for a single outage would be 8 min/(60 min/hr*10 operating hours/day) or less than 1.4% per 10-hour operating day, and less than 0.05% in a given month if one outage occurs.

The UPS supplier recommends that the UPS be placed in bypass mode while the UV system is started. This will allow the UPS to maintain continuous operation of the UV system through an outage until the proposed generator system start, while minimizing inrush loads on the UPS.

Given the timing of the generator construction and the potential for the UV systems to be on line up to a year sooner, a UPS system could be considered essential during an extended outage today. At the same time, the existing UPS being non-functional has left NKWD open to that exposure for some years already.

A replacement UPS system capable of powering the reactors and controls (60 kVA per reactor, 480 V, 3 phase, 4 wire) could reasonably be considered an investment in reliability.

Budgetary Costs – UV Treatment System

One option is to completely replace both UV treatment systems with 2 new reactors, 2 new control panels, and a new UPS system (sized for both UV trains). Another option is to replace only one of the UV treatment systems with a new reactor, a new control panel, and a new UPS system (sized for both UV trains). A detailed cost breakdown for both options as well as replacement of the UPS system is provided in Table 2. Estimated annual operating costs are shown in Table 3.

With each option, appropriate markups for Electrical and Instrumentation/Controls as well as some demolition and prep and other incidental costs were considered as well as a Contingency appropriate for this level of costing. Typical markups for Contractor's were also included (20% Overhead and Profit and 10% for Bonds, Mobilization, and Insurance) to provide the NKWD with a cost comparison for the alternatives presented and can factor into the final decision for the preferred option.

Table 2. Budgetary Costs – UV System Improvements

Item		Cost	Comments
Complete UV System Replacement			
Two Reactors and Controls *SS cabinets, freight, startup/training*		$530,000	Note: Calgon estimate $285,000; Trojan $450,000 conceptual
Accreditation		$25,000	
UPS		$140,000	
Demolition/Removal		$30,000	
	Subtotal	$725,000	
Electrical 5%		$ 36,000	
Instrumentation/Controls 5%		$ 36,000	
	Subtotal	$797,000	
Bonds, Insurance, Mob/Demob 10%		$ 80,000	
Overhead & Profit 20%		$160,000	
Contingency 10%		$ 80,000	
Total, Complete UV System Replacement		**$1,117,000**	
Single UV System Replacement			
One Reactor and Controls *SS cabinets, freight, startup/training*		$265,000	
Accreditation		$25,000	Cost comparable for 1 or 2 Trains
UPS		$140,000	Size UPS for both Trains
Demolition/Removal		$20,000	Train 2 less accessible
	Subtotal	$450,000	
Electrical 5%		$25,000	
Instrumentation/Controls 5%		$25,000	
	Subtotal	$500,000	
Bonds, Insurance, Mob/Demob 10%		$ 50,000	
Overhead & Profit 20%		$100,000	
Contingency 10%		$50,000	
Total, Single UV System Replacement		**$700,000**	

Table 3. Estimated Operating Costs

Assumptions:	
Operating Conditions	6 mgd continuous at 92%T
Operating MS2 RED	40 mJ/cm^2
Number of Operating Reactors	1
Number of Operating Lamps	2 at 8.2 kW each
Electrical Cost	$0.08/kW-hr
Hours of Operation	8,760 hrs per year (24 hrs per day, 365 days per year)

Annual Costs	USD
Electrical Costs	$11,477
Lamp Replacement	$2,190
Total Annualized Costs	**$13,667**

Recommendation – UV System Improvements

Replacement of both UV treatments units with available mercury vapor-based UV units is recommended, with the reactors replaced at their current locations. The controls can be placed either at the current location, subject to verification during design, or in the area of the current UPS location (i.e., inside the tunnel). A replacement UPS is an optional decision based on timing of the upcoming generator project and of the accreditation process. The budgetary construction cost to replace both UV treatment systems is $1,117,000, which includes a new UPS system. This cost could potentially be reduced through refinement during the detailed design and competitively bidding the work. Competitively pre-purchasing the equipment and materials ahead of construction may also result in lower costs.

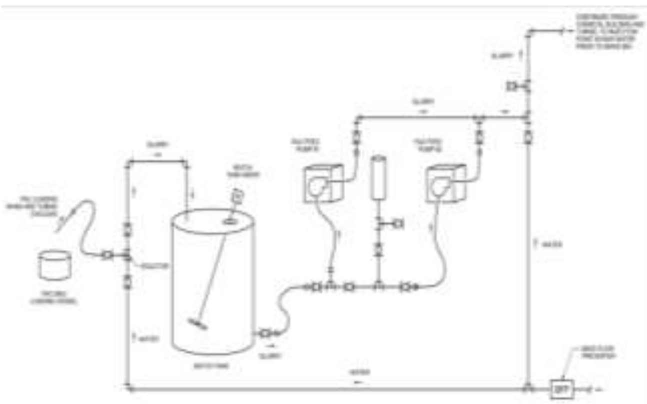
POWDERED ACTIVATED CARBON (PAC) STORAGE AND FEED SYSTEMS

Existing Conditions

The Taylor Mill Treatment Plant (TMTP) currently uses powdered activated carbon (PAC) in their pretreatment strategy to address potential taste and odor compounds. A PAC slurry is injected in the raw water influent line ahead of rapid mixing and flocculation. The TMTP staff currently batch-mix the PAC slurry by manually loading 44 to 50 lb bags of PAC into a modified tote in the Chemical Building. Using an eductor and a potable/carrier water line as the motive, the PAC is vacuumed into the eductor with piping and hosing to create the slurry that ultimately discharges into a 400 gal (est.) plastic batch tank. A mechanical mixer attached to the batch tank keeps the PAC suspended inside the tank. Peristaltic metering pumps (Watson Marlow 620U) feed the

PAC slurry through above-ground tubing and piping and injects the PAC slurry into the pre-rapid mix raw water influent line at 0.29 lb/gal.

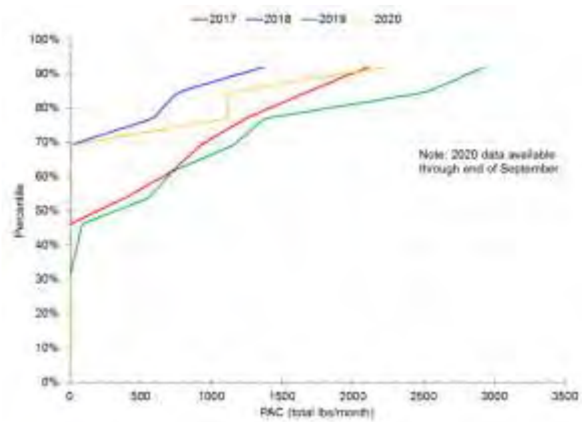
Carbon storage and feed appears to have been considered in the design and layout of the Chemical Building as part of the 1999 upgrades and improvements with a dedicated space (15’ x 20’ x 15.3’ high). Equipment was designed and constructed to operate in a hazardous environment (i.e., explosion-proof components), and the room appears to have appropriate ventilation with fans and exterior doors, including a 10 ft x 10 ft roll-up door. However, from available drawings, it appears the carbon storage and feed has been altered from the original plans, which had a dust collector, feed hopper and volumetric feeder system along with feed pumps. Most of the original equipment has been removed or abandoned for the current equipment utilized today.



When in operation and feeding PAC, it is understood that the current PAC feed strategy for the Taylor Mill Treatment Plant is to feed at least 5 mg/L to control taste and odor causing compounds with higher dosages, typically up to 10 mg/L, as required for treatment challenges such higher than normal levels of T&O compounds or algal blooms. If the PAC feed requirement is above 10 mg/L then the recent strategy is not to have the TMTP in operation to treat water. While the feed pumps are not automatically flow paced, there are reference charts for the operators in the main control room to confirm the feed rate set point and then manually input/adjust on the peristaltic feed pump (mL/min) in service. At this time, only one pump is available for service with the other pump requiring maintenance or repair, possibly replacement.

Examining monthly operating reports (MORs) for the TMTP from 2017 through September 2020, the minimum amount of water treated by the TMTP averages to around 3 mgd, and the plant’s rated capacity is 10 mgd. With a PAC dose of at 5 mg/L and up 10 mg/L and a PAC slurry concentration of 0.29 lb/gal, the feed equipment for a PAC slurry should be capable of feeding between 1,100 mL/min and 7,500 mL/min. Reviewing the technical specifications on the Watson Marlow website, the 620U peristaltic pumps appear to be capable of meeting the current PAC feed requirements for the Taylor Mill Treatment Plant.

The TMTP receives PAC in shipments of 50 lb bags with a minimum palletized order of 50 x 50 bags per shipment. The pallet with PAC bags is stored within the storage and feed room, and individual bags are physically loaded by TMTP staff to initiate the batch mixing process based on the plant demands and to create a slurry concentration of 0.29 lb/gal. For determining the 30 day storage of PAC required, normally storage would be calculated with average plant production and average dose, which in this case would be 3 mgd and 5 mg/L. This would result



in a 30 day storage requirement of 6,259 lbs, or 126 x 50 lb bags. However, as seen in the percentile graph, recent historical operating data indicates only 2,500 lbs of PAC would be sufficient to have on hand to meet the 30 days of PAC storage requirement. This would only require 50 x 50 lbs PAC bags to be on hand. NKWD staff indicate that PAC orders can typically be delivered within 1-3 days upon request.

Considerations and Alternatives for Upgrades and Improvements – PAC Storage and Feed Systems

The powdered activated carbon (PAC) storage and feed system at the Taylor Mill Treatment Plant (TMTP) is labor intensive from physically handling the PAC bags, to preparing the PAC slurry batch tank, to manually monitoring and controlling the PAC feed pumps

As the key objectives for assessing PAC storage and feed systems at the TMTP is that upgrades and improvements should be include more automated monitoring and control and reducing the time and physical demands on plant personnel. With that in mind, the existing PAC system and site conditions were considered and three feasible systems for the TMTP were evaluated to meet the objectives for PAC system upgrades and improvements: bulk bags (super sacks), silo, and a below-grade bulk slurry storage tank and above-grade feed system.

Location of PAC Storage and Feed

Utilizing the existing space in the Chemical Building for PAC storage and feed does not appear to be practical, especially if attempting to meet the key objectives for upgrades and improvements. There are some advantages in trying to make the current location work as all support equipment is rated for that environment and a dedicated space was designed and laid out for PAC; however, if considering a super-sack feeder or a silo the existing PAC space in the Chemical Building is not adequately sized for equipment to meet storage and feed requirements. Similar to the Memorial Parkway Treatment Plant, a dedicated area on-site was considered for a new PAC storage and feed facility. As seen in the Site Plan, Location 1 is (south) across the access drive from the Chemical Building and adjacent to the Residuals Building. Location 2 is on the east side of site and utilizes a small area currently utilized for overflow parking by members and visitors to the St. Anthony Church. However, it is understood that this area is technically owned by the NKWD. It should be noted that the empty area on the west side of the Chemical Building is where the proposed emergency generator system equipment is to be located. Also, the future GAC facilities are planned for an area on the west side of the plant, even beyond the current security fencing; however, this should not impact the two potential locations for a new, dedicated PAC storage and feed facility.

Shipment and Delivery of PAC

As the NKWD is well aware, powdered activated carbon (PAC) can be packaged and delivered in a number of ways. Consistent with the NKWD's most recent purchase bid specifications, bulk shipments in a certified tanker truck of up to 40,000 lbs are delivered to the Fort Thomas Treatment Plant, bulk shipments in approx. 900 lb "super sacks" are delivered to the Memorial Parkway Treatment Plant, and multiple 40 to 50 lb bags are delivered to the Taylor Mill Treatment Plant. PAC storage and feed system improvements at the TMTP will include considerations in current and projected usage as well as the delivery options available. Partial shipments or split shipments, particularly with tanker truck delivery options, can have an impact on the sizing of storage facilities and are likely to cost more than a standard, full shipment.

PAC Storage

For upgrades and improvements, chemical storage is traditionally sized on plant's projected average daily production flow rate and chemical dosage and having at least 30 days storage of the chemical on-hand at all times. When analyzing the TMTP monthly operating reports (MORs) from 2017 through September 2020, the average production flow rate when the plant was in operation is approximately 5 mgd, and the average PAC feed rate was about 125 mg/L.

A review of the Taylor Mill Treatment Plant monthly operating reports from January 2017 through September 2020 shows the plant uses an average of approximately 6,000 lbs of PAC annually with a daily average of around 113 lbs/day. As discussed, normal operations and typical usage at the TMTP shows with a percentile graph of pounds of PAC per month the 90th percentile usage is 2,500 lb/month, which should be basis of PAC storage on-site, including compliance with the minimum 30 days' storage requirement. Current operating standards are based on maintain a PAC slurry concentration of 0.29 dry lbs/gal for the batch mixing tank. As mentioned above, the PAC metering feed pumps are manually set to dose at 5 mg/L and up to 10 mg/L when in operation and as directed by the chief operator.

The PAC slurry concentration will have an impact on the sizing of storage equipment for the slurry storage option at the TMTP. Plant staff currently batch mix to maintain a PAC slurry concentration of 0.29 dry lbs PAC/gal (of water). Increasing the concentration of the PAC will have a dramatic effect on the sizing of equipment by reducing the volume required for wet storage, including day tanks. With increasing the PAC concentration, there is a risk to clogging equipment and piping requiring more frequent cleanings and flushings by plant staff, which can be problematic if not planned for. Storage facilities and equipment for the TMTP will be sized to accommodate the current PAC concentration preferred by plant staff (0.29 dry lbs/gal), but the storage will have sufficient space and, if necessary, be expandable to allow plant staff to consider increasing the PAC concentration in the future, particularly if there are significant changes to plant operations with increased plant production and/or increased dosages required.

PAC Feed

Similar to the sizing of PAC storage facilities and equipment, the PAC slurry concentration will have an impact on the sizing of feed equipment at the TMTP. Plant staff currently batch mix to maintain a PAC slurry concentration of 0.29 dry lbs PAC/gal (of water). Increasing the concentration of the PAC will have an effect on the sizing of equipment by reducing the size and requirements for the feed pumps. With increasing the PAC concentration, there is a risk to clogging equipment and piping requiring more frequent cleanings and flushings by plant staff, which can be problematic if not planned for. Feed equipment for the TMTP will be sized to accommodate the current PAC concentration preferred by plant staff (0.29 dry lbs/gal), but the feed systems will be robust enough to allow plant staff to consider increasing the PAC concentration in the future, particularly if there are significant changes to plant operations with increased plant production and/or increased dosages required.

Utilizing the same MOR's discussed above, the minimum amount of water treated by the TMTP averages to around 3 mgd, and the plant's rated capacity is 10 mgd. With a PAC dose of at 5 mg/L and up 10 mg/L and a PAC slurry concentration of 0.29 lbs/gal, the feed equipment for a PAC slurry should be capable of feeding between 1,100 mL/min and 7,500 mL/min. If a dry feeder system is used, then the equipment should be capable of feeding between 2.38 cu ft/hr and 15.8 cu ft/hr.

Feed piping should be rigid Sch. 80 PVC with minimal elbow fittings as well as some hosing and/or flush out points for periodic cleaning of accumulated PAC. This would be essential if a PAC slurry is utilized with positive displacement feed pumps. This approach would be factored in with utilizing a carrier water to convey the PAC to the feed point.

Bulk Bag (Super Sack) Storage and Feed Systems

With the lack of sufficient space in the existing Chemical Building, a new, dedicated facility would be constructed to house the bulk PAC bags, feeders, and other support equipment. The estimated 20 ft x 20 ft x 20 ft high facility should be capable of providing sufficient storage and feed space for operations and maintenance as well as maneuverability for loading/unloading the super sacks. The dry feeder system would be capable of an operating range of 2.0 cu ft/hr (3 mgd) to 16.0 cu ft/hr (10 mgd), and would be operated with variable frequency drive (VFD) so that the feed rate can be flow paced (with the raw water influent flow rate). From the feeder, it is common to see the PAC enter a high-capacity wetting cone to create the PAC slurry and, with carrier water, and transport the slurry to the application point. Although not in our cost estimates, Cornwell would recommend forgoing the wetting cone and install a batch mixing tank, with mechanical mixer, and peristaltic feed pumps to convey the PAC slurry to the application point. Water and other utilities would be brought over from the Chemical Building by way of a utility trench through the access drive or a large conduit under the roadway. The water will assist in conveying the PAC to the injection point, if a wetting cone is used, or for batch mixing to create the PAC slurry as well as for flushing, safety, and washdowns. Similar to the current PAC storage and feed room, the facility would be designated with a Class II, Division I, Group F hazardous area classification. The main control panel for the PAC feeder system would be mounted outside of the facility and have the appropriate rating to withstand continuous, outdoor exposure (at least NEMA 4X). Adequate ventilation and exhaust fan systems would be integrated into the design of this facility, and all electrically powered equipment will utilize explosion-proof components suitable for the environment. This facility would be similar to that already in service at the Memorial Parkway Treatment Plant, but with a slightly smaller footprint. With a current need to maintain a storage of 3,000 lbs this would mean the Taylor Mill Treatment Plant could have an initial request for 5 x 900 lb super sacks with one in service and the remaining as on-hand storage. The proposed facility can maintain the quantity of super sacks necessary depending on operations and usage/dosage.

Silo Storage and Feed Systems

With the lack of sufficient space in the existing Chemical Building, a new, dedicated silo system could be constructed to house dry powdered activated carbon, feeder equipment, and other support equipment. A 12 ft diameter x 33 ft high silo structure would store approximately 1,100 cu ft of dry PAC and feed equipment would be below the storage area. A separate detached structure approximately 10 ft x 8 ft x 8 ft high would house support equipment for the silo storage and feed systems. Like the bulk bag system, the dry feeder system would be capable of an operating range of 2.0 cu ft/hr (3 mgd) to 16.0 cu ft/hr (10 mgd), and would be operated with variable frequency drive (VFD) so that the feed rate can be flow paced (with the raw water influent flow rate). Like proposed bulk bag system, it is common to see the PAC go from the feeder to a high-capacity wetting cone to create the PAC slurry and, with carrier water, and transport the slurry to the application point. As previously discussed, Cornwell would recommend forgoing the wetting cone and install a batch mixing tank, with mechanical mixer, and peristaltic feed pumps to convey the PAC slurry to the application point. Water and other utilities would be brought to the silo and support facilities by way of a utility trench through the access drive or a large conduit under the roadway. The water will assist in conveying the PAC to the injection point, if a wetting cone is used, or for batch mixing to create the PAC slurry as well as for flushing, safety, and washdowns. Similar to the current PAC storage and feed room, the facility would be designated with a Class II, Division I, Group F hazardous area classification. The truck fill station control panel would be mounted outside of the facility, and the main control panel for the PAC storage and feeder systems would be mounted inside the small support structure. Both panels would be rated NEMA 4X. Adequate ventilation and exhaust fan systems would be integrated into the design of these facilities, and all electrically powered equipment will utilize explosion-proof components suitable for the environment. This facility would be similar to that already in service at the Fort Thomas Treatment Plant. A full tanker truck load would provide enough PAC to fill the 1,110 cu ft storage area, which would be the about 40,000 lbs. With a current need to maintain a 30-day storage of 3,000 lbs of PAC and only using around 6,000 lbs/yr, this would mean the TMTP would have enough PAC stored for the next say 6 to 7 years.

Bulk Slurry Storage and Feed Systems

Another system to be considered is a bulk powdered activated carbon (PAC) slurry storage and feed system. With this alternative, bulk deliveries of PAC would be delivered to the Taylor Mill Treatment Plant (TMTP) and discharged into an above-ground or below-ground storage tank containing water such that the PAC is stored as a ready to feed slurry. In this case all PAC handling after bulk delivery is eliminated. If located across the street from the Chemical Building (Location 1), the bulk storage facility would be approximately 14 ft x 14 ft x 15 ft high to support the bulk storage operations. With Location 2, the footprint of the facility would be increased as the additional space would accommodate feed and other support equipment in addition to the bulk storage related equipment.

The PAC would be combined with water inside the bulk tank to create the slurry to the desired concentration (currently 0.29 lb/gallon). After filling the bulk storage with a pre-determined amount of water, a mechanical mixer would operate during the dry PAC loading operations, and a pneumatic mixing system would operate at all other times so that the PAC remains suspended. The pneumatic system is less energy intensive than the mixer and the mixer is only needed during the fill operation. A submersible pump would transfer the PAC slurry to a day tank system. Although modifications to the existing PAC storage and feed room do not appear to allow for bulk storage, the day tank and feed pumps could be housed in the existing space allocated for the current PAC storage and feed systems inside the Chemical Building. A 500-gal day tank with conical bottom and mechanical mixer will continue to keep the PAC in the slurry suspended for pumping to treatment. Two positive displacement feed pumps, likely peristaltic type, with tubing/hosing will convey the PAC slurry to the injection point in the raw water influent line (pre-rapid mix). These feed pumps would be similar to those currently used by the TMTP. Water and other utilities would be brought over from the Chemical Building by way of a utility trench through the access drive or a large conduit under the roadway. The water will available for the bulk slurry tank as well as for flushing, safety, and washdowns. Similar to the current PAC storage and feed room, the proposed bulk storage facility would be designated with a Class II, Division I, Group F hazardous area classification. The control panel for the PAC storage area systems, and monitoring the feed area equipment, would likely be wall mounted inside of the facility and have the appropriate rating (at least NEMA 4X). Another similar panel would be installed for the PAC feed area. Adequate ventilation and exhaust fan systems would be integrated into the design of the new storage facility, and all electrically powered equipment will utilize explosion-proof components suitable for the environment.

A bulk storage tank that is approximately 12 ft x 12 ft x 12 ft deep/high would provide a usable volume of over 10,000 gal. This corresponds to the typical monthly usage experienced in recent years at the TMTP of 3,000 and with a PAC slurry concentration of 0.29 lbs/gal. With a PAC dose of at 5 mg/L and up 10 mg/L and a PAC slurry concentration of 0.29 lbs/gal, the feed equipment for a PAC slurry should be capable of feeding between 1,100 mL/min and 7,500 mL/min. Peristaltic pumps with variable frequency drives (VFDs) would be capable of feeding at the desired dose and flow pacing with the raw water influent line.

Table 4. Advantages & Disadvantages Budgetary Costs – PAC Upgrades and Improvements

	Bulk Bag System (Super Sacks)	Silo System	Bulk Slurry Storage & Feed Systems
Advantages	• Similar system already in service at MPTP • Equipment/bags could be interchangeable between MPTP and TMTP	• Similar system already in service at FTTP • Capable of handling increased flows/ demands in future	• Less expensive/most economical option • Existing PAC room repurposed for feed operations • Relatively easy to operate/maintain
Disadvantages	• New dedicated storage and feed facility required • Existing PAC room not repurposed	• New dedicated storage and feed facility required • Most expensive option • Existing PAC room not repurposed • Split delivery (with FTTP) or reduced load delivery, both would likely result in higher delivery costs	• A third different PAC storage/feed system for operators/ maintenance staff • Small bulk storage facility required

Budgetary Costs – PAC Upgrades and Improvements

For the PAC storage and feed alternatives discussed, the budgetary costing presented considers the construction of new support facilities in an available area across the access drive from the Chemical Building (Location 1). With each option, appropriate markups for Civil-Sitework, Electrical and Instrumentation/Controls were considered as well as a Contingency appropriate for this level of costing. Typical markups for Contractor's were also included (20% Overhead and Profit and 10% for Bonds, Mobilization, and Insurance) to provide the NKWD with a cost comparison for the alternatives presented and can factor into the final decision for the preferred option.

Table 5. Estimated Budgetary Construction Cost

Item	Cost	Comments
Bulk Bag (Super Sack) Storage & Feed		
Bulk Bag Unloader and Feed System *feeder, unloader, wet cone, control panel, freight, startup*	$200,000	Based on quote received from Acrison
New Storage & Feed Facility	$140,000	
Miscellaneous Piping Est	$25,000	
Demolition/Removal	$10,000	
Subtotal	$375,000	
Civil-Sitework 10%	$ 37,500	
Electrical 15%	$ 55,000	
Instrumentation/Controls 15%	$ 55,000	
Subtotal	$522,500	
Bonds, Insurance, Mob/Demob 10%	$ 55,000	
Overhead & Profit 20%	$110,000	
Contingency 15%	$80,000	
Total, Bulk Bag System	**$777,500**	
Silo Storage and Feed System		
Silo Storage and Feed Systems *silo, bin vent filter, fill control panel, bin activator, silo discharge valve, feeder, wet cone, main control panel, auxiliary enclosure and equipment, freight, startup*	$620,000	Based on quote received from Acrison
Silo and Enclosure Support Pads	$20,000	
Miscellaneous Piping Est	$20,000	
Demolition/Removal	$10,000	
Subtotal	$670,000	
Civil-Sitework 10%	$67,000	
Electrical 10%	$67,000	
Instrumentation/Controls 10%	$67,000	
Subtotal	$871,000	
Bonds, Insurance, Mob/Demob 10%	$ 88,000	
Overhead & Profit 20%	$176,000	
Contingency 15%	$130,000	
Total, Silo System	**$1,265,000**	

Table5. Estimated Budgetary Construction Cost (Continued)

Item	Cost	Comments
Bulk PAC Slurry Storage and Feed System		
PAC Slurry Storage Tank	$25,000	
Mechanical Mixer	$15,000	
Pneumatic Mixer System	$35,000	
PAC Slurry Transfer Pump	$25,000	
PAC Storage Facility	$55,000	
PAC Feed Pumps	$25,000	
Day Tank & Mixer	$20,000	
Miscellaneous Piping Est	$30,000	
Demolition/Removal	$5,000	
Subtotal	$235,000	
Civil-Sitework 10%	$25,000	
Electrical 20%	$47,000	
Instrumentation/Controls 20%	$47,000	
Subtotal	$354,000	
Bonds, Insurance, Mob/Demob 10%	$ 35,000	
Overhead & Profit 20%	$70,000	
Contingency 20%	$70,000	
Total, Bulk PAC Slurry	**$529,000**	

Summary and Recommendation – PAC Upgrades and Improvements

The current PAC storage and feed room within the Chemical Building is time and labor intensive to operate and maintain for TMTP staff. Additionally, the current room does not appear to have sufficient space for upgrades and improvements, especially to meet potential future increases in plant production and treatment. With considerations to reduce the time and physical demands on TMTP staff, three feasible alternatives are presented that would not only reduce the demands on plant staff, but also allow the PAC storage and feed systems to operate more effectively and efficiently.

The silo storage and feed systems were worth consideration as the NKWD staff are familiar with operating and maintain a similar system already at the FTTP; however, for the TMTP, this alternative did not appear to be in the NKWD's best interest as it was the most expensive option and would likely experience storage issues, such as excessive storage time and/or increased storage/delivery costs. The silo system would also require some civil-sitework to accommodate the silo and support systems and does not repurpose any portion of the existing PAC room.

The bulk bag storage and feed system (super sacks) is worth considering and has a number of advantages, namely that it is a system the NKWD are experienced with from a similar system in service at the MPTP and equipment and/or super sacks could be interchangeable between the two facilities. The disadvantages of the super sacks system are that a larger dedicated building would be required to house the equipment and support systems and does not repurpose any portion of the existing PAC room.

The bulk slurry storage and feed system is easiest to operate and has a number of advantages, namely that it is the least expensive option. Although a small, dedicated facility is required for the bulk storage of the PAC slurry, this alternative repurposes a portion of the existing PAC room for feed operations. The one major downside is that it is an approach not currently used by the NKWD at any of the treatment facilities; however, there are elements of this alternative that are, such as the mechanical mixers and the peristaltic feed pumps.

Ultimately this is a NKWD decision since any of the proposed alternatives are feasible.

Also, a discussion regarding potential design scope/fee modifications may be necessary as a new, dedicated storage and/or feed facility is not currently factored into the design phase work.

FILTRATION SYSTEM VALVES AND ACTUATORS

Existing Conditions

The Taylor Mill Treatment Plant has eight (8) filter basins and has butterfly valves with electric motor actuators for filtration system operations. All the current valves are DeZurik or DeZurik/SPX flanged (FL) butterfly valves (BFV) with AUMA electric motor operators (EMO). Approximately 14 years ago (c. 2006), the valves and actuators for the wash water supply and the filter effluent were replaced. The age or service life of the remaining valves and actuators was not determined, but was understood to be considerably older than those replaced in 2006. The valve actuators are powered from a 115-volt, 1 phase source and utilizes 115-volt, 1 phase power for the actuator controls. The filtration system controls were upgraded in 2011 with control panels on the main floor of the filter gallery, and improved monitoring and controls through the plant's SCADA system. The existing filtration system valves are summarized below in Table 1. It should be noted that manually operated valves or other shut-off valves are not included and are understood to be in good working order.

Table 6. Existing Filtration System Valves and Actuators

Description	Quantity	Type	Size/Dia (in.)	Actuator/Type	Remarks
Influent	8	BFV, FL	12	Yes, EMA	115v power, 115v controls
Effluent	8	BFV, FL	12	Yes, EMA (modulating)	115v power, 115v controls
Filter-to-Waste	8	BFV, FL	12	Yes, EMA (modulating)	115v power, 115v controls
Wash Water Supply	8	BFV, FL	16	Yes, EMA	115v power, 115v controls
Drain	8	BFV, FL	16	Yes, EMA	115v power, 115v controls
Air Scour	8	BFV, FL	6	Yes, EMA	115v power, 115v controls

In addition to concerns with age and service life, it is understood the plant occasionally experiences operating issues with the valves and actuators by not fully opening or closing or responding at all, and often times the operating issues can vary by location (i.e., not predictable). Also, there were a few valves identified as needing additional investigation to determine if the valve, actuator, and/or other components or instruments are negatively impacting the filtration system operations.

- Filter #3, Filter-to-Waste: Not working remotely through SCADA, but will locally/manually
- Filter #6, Effluent: Hard to dial-in, not sure if valve/actuator issue or flow meter
- Filter #6, Wash Water: Not operable, actuator refurbished/replaced about 1 year ago, still not working

Options and Recommended Improvements – Filtration System Valves and Actuators

There were discussions regarding whether to maintain the 115 volt, 1-phase power to the valve operators or to change to 460 volt, 3-phase power. Valve operators with 460 volt, 3-phase would operate more efficiently and have a reduced power consumption (potential cost savings); however, there are no cost differences between 1-phase and 3-phase valve operators and all new wiring would be required, including panelboards, which would counter any potential cost savings from having 3-phase valve operators and would take many years to pay for itself. Also, the issues experienced by the plant staff are not likely due to the power requirements of the valve operator. Therefore, it is recommended that any electric motor actuators refurbished or replaced remain with 115 volt, 1-phase power, and no changes to the 115 volt, 1-phase power for controls.

The consensus from experience and discussions with manufacturer representatives is that the operational issues experienced by staff at the Taylor Mill Treatment Plant can be attributed in large part to the age and service life of the valves and actuators and/or communication with electric motor operators through the plant's SCADA system. Generally, refurbishment of the valves and/or actuators at best may offer some short-term improvements, but it can be difficult to easily install a new actuator in place of an old actuator, especially if they are not from the same manufacturer and the contractor is not experienced in this type of work. Also, it is not likely to be a cost-effective approach for resolving the filtration system operating issues as the cost of refurbishment in most instances will likely approach the cost of replacement. NKWD staff and available info indicate the valves do not seem to have an issue with the seats and seals for the valves; however, this cannot be confirmed without being able to physically remove to inspect. Therefore, replacement for all filter valves and electric motor operators is recommended along with having wall-mounted remote-control stations for the air scour valves, the influent valves, and the wash water valves that are in locations where they can be easily accessed by plant operators and maintenance staff.

Normally, a carefully phased approach would be necessary in order to have minimal impact on plant operations, but for the Taylor Mill Treatment Plant this work could be done during times of the year when there are extended shutdowns. Turning over say four filter basins (i.e., one side of the filtration system) would take roughly six weeks to complete, and another six weeks to complete the work for the remaining filters, so it would take approximately 12 weeks to complete the valves and actuators upgrades and improvements for all eight filter basins.

Based on the above information and recommendations, the budgetary cost to replace all the filtration system valves and actuators, with the wall-mounted remote-control stations for select valves, would be approximately $875,000. For comparison, to replace all the filtration valves and actuators except for the drain valves and effluent valves, replacing the actuators only for the drain valves and effluent valves, and having wall-mounted remote-control stations for select valves would be approximately $840,000. Lastly, to leave all the existing valves and replace only the electric motor actuators would be about $685,000. Note the additional cost to convert or install a wall-mounted remote valve actuator control station is approximately $2,000 per valve.

The recommended option may be the most costly of the options discussed, but the advantages of this option are worth considering. The NKWD and Taylor Mill Treatment Plant would reset the age and service life of the filtration valves) and actuators and can focus on future upgrades and improvements elsewhere at the plant. The operational concerns with the valves and actuators would improve and reduce maintenance issues would allow staff to focus their efforts elsewhere.

HIGH SERVICE PUMP NO. 3

Existing Conditions

High Service Pump No. 3 (HSP No. 3) at the Taylor Mill Treatment Plant (TMTP) was installed in 1996 and is a Goulds Model 20ELC-3 pump rated for 5,600 gpm at 375 feet total dynamic head. The motor is a US Electric Motors Titan model rated for 700 hp drawing 2,300 volts, 3 phase, 60 Hz and operating at 1,780 rpm. In 2006, it was retrofitted with a MagnaDrive adjustable speed drive to accommodate lower flow rates (the typical plant production flow rate is 6 mgd or 4,167 gpm). The MagnaDrive uses magnetic induction rather than a solid drive shaft, minimizing vibration and alignment issues while allowing a speed change from the motor speed (rpm) to a lower pump speed (rpm).

According to NKWD staff, there had been operating issues since the installation, but finally the system failed in 2012 reportedly because of high heat generated within the MagnaDrive, and HSP No. 3 has not been operated since. The machinery has not been exercised during the outage, and is currently abandoned in place and disconnected from power and controls.

This memorandum considers possible repair or replacement of HSP No. 3 and the advantages of reducing the rated capacity of a replacement pump to 6 mgd. It was asked that the replacement include a new pump control valve, as the other original valves have been replaced over the years.

Background and Operating Conditions

The Taylor Mill Treatment Plant High Service Pump Station includes the following pumps and uses:

Pump	Design Flow and TDH		Tested Flow and TDH 9/2016		Use
Pump No. 1	8,750 gpm	150 ft	8,160 gpm	153 ft	Booster
Pump No. 2	8,500 gpm	145 ft	7,431 gpm	155 ft	Booster
Pump No. 3	5,600 gpm	375 ft	N/A	N/A	Plant Flow
Pump No. 4	7,700 gpm	372 ft	8,125 gpm	120 ft*	Plant Flow
Pump No. 5	7,700 gpm	372 ft	7,847 gpm	116 ft*	Plant Flow
Pump No. 6	8,750 gpm	150 ft	6,875 gpm	120 ft	Booster

*These head readings appear to be typographical errors. It is believed the head is approximately the 372 ft design head.

Pumps 1, 2 and 3 (“Front Room”) are physically separated from Pumps 4, 5 and 6 (“Back Room”) at the TMTP. The pumps designated as “Plant Flow” draw from the Taylor Mill finished water clearwell at Elevation 520.0 ft and discharge to transmission mains toward the Dudley 1080 and 1040 tanks in Pressure Zone 5 (Elevation 876.0 ft). The pumps designated as “Booster” draw from the surrounding Pressure Zone 1 (elevation 763.0 ft) system supplied by the Fort Thomas Treatment Plant. These differing uses account for the different design heads of the pumps.

NKWD provided a draft EPANet version of the overall water system model. The model has not yet been fully calibrated and delivered, but appears generally functional. It includes:

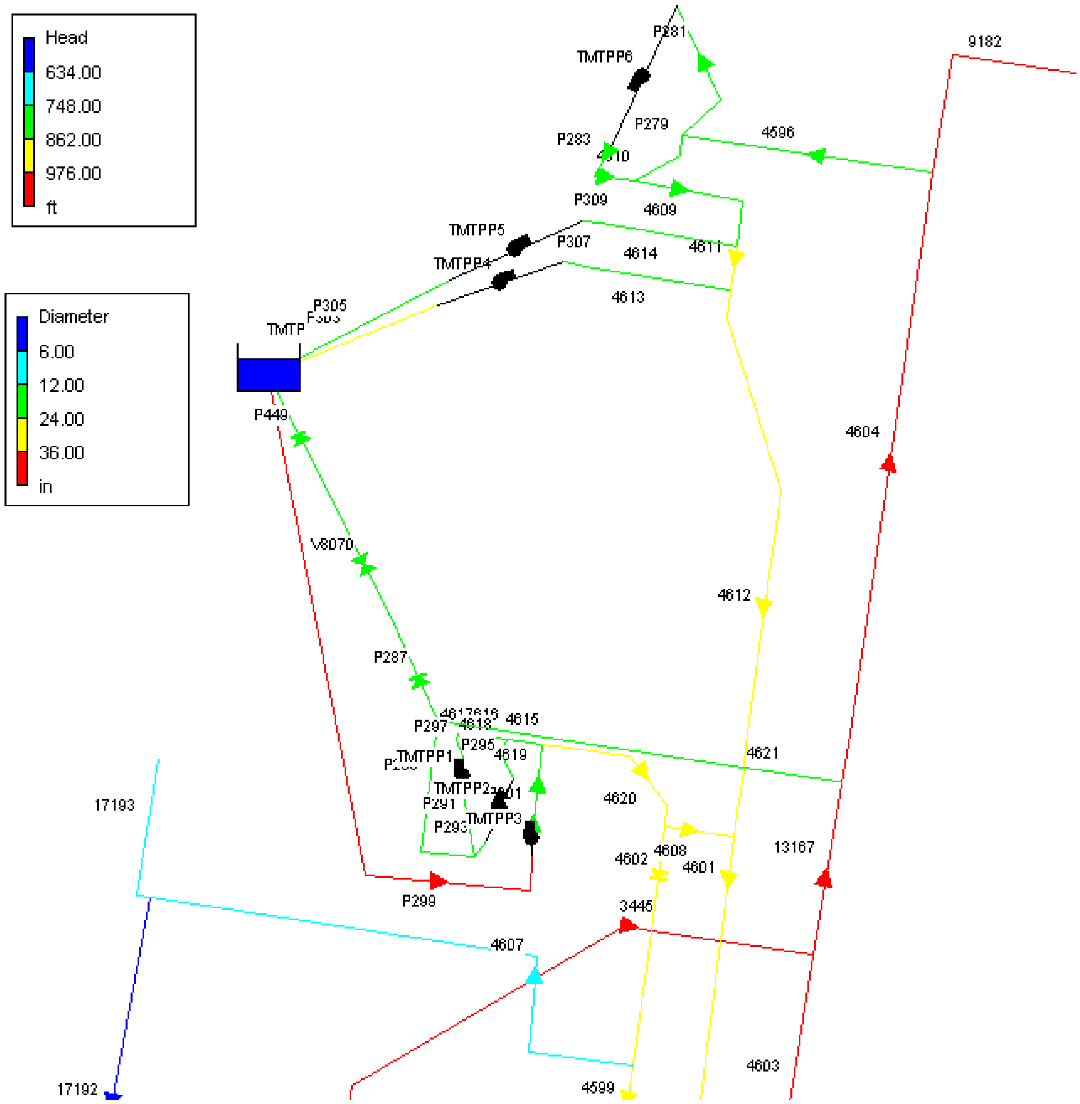
Property	Value
*Tank ID	DUDLEY1080
X-Coordinate	1557232.438
Y-Coordinate	555240.401
Description	NKWD ID 46
Tag	
*Elevation	832.000000
*Initial Level	30.780000
*Minimum Level	0.000000
*Maximum Level	44.000000
*Diameter	10.000000
Minimum Volume	0.000000
Volume Curve	TANK_DUDLEY1080
Can Overflow	No
Mixing Model	Mixed
Mixing Fraction	
Reaction Coeff.	
Initial Quality	
Source Quality	
Net Inflow	12158.57
Elevation	861.99

Number of Junctions	14,062
Number of Reservoirs	3
Number of Tanks	22
Number of Pipes	15,960
Number of Pumps	43
Number of Valves	36

The model includes Pumps No.3 (Plant Flow) and 6 (Booster) operating, with all other pumps off.

Trace analysis within the model was used to determine that flow from Taylor Mill Treatment Plant HSP is primarily delivered through the area surrounding the Dudley 1080 and 1040 ground storage tanks, with a ground/bottom Elevation of 832.0 ft; diameter of 138 feet, approximate capacity of 5,000,000 gallons and a maximum Elevation of 876.0 ft. These tanks generally serve the 876.0 ft Pressure Zone No. 5. The system, though, is extensively interconnected and flows distribute widely through the system over time. Note that the diameter shown of 10 ft is overridden in the model by a capacity curve.

A sketch taken from the draft water system model is shown below:



Since HSP No. 3 has not been in service for an extended period, HSP Nos. 4 and 5 provide plant flow to the distribution system. These pumps, each rated at 7,700 gpm, individually operate at nearly double the plant's typical production rate. This is reported to result in frequent stop/start cycles of the pumps. Note that the plant finished water clearwell is modeled as a reservoir node. It could potentially be modeled as a tank with the plant supply on the upstream side to clearly define clearwell behavior. In the meantime, operations staff has reported an ongoing clearwell balancing issue, and it is reasonable based on the flow differences that the problem is real.

Options and Recommended Improvements ‑ HSP No. 3

Potential for Rehabilitation of the HSP No. 3 Components

Rotating machinery (which would include the pump, motor and MagnaDrive along with their shafts) includes bearings and other moving parts that are subject to flattening and/or warping over time if not routinely operated. These pieces of equipment have not been operated for a period exceeding 8 years, and there is significant risk that they would not operate effectively even with significant rehabilitation because even small imperfections in roundness and trueness of bearings, races and shafts can create severe vibrations and result in rapid failure. As well, the equipment failed for a cause believed to be related to heat issues, which can warp and stress metal components severely. The cause of failure has not been fully identified, and while that may be some relief in terms of heat issues it also presents risks of other types of undetermined pre-existing damage.

Discussion and evaluation with the local representatives for Goulds Pumps indicated they would consider an extensive rebuild attempt at a cost approximating 60% of the replacement cost for the pump and motor and would provide a "new" warrantee, although they also acknowledge the risks of long-disused equipment and noted that any specific pricing would require that the pump be returned to them for a complete evaluation. We have estimated the cost of rehabilitation to be at 80% of the cost for replacement because of the risks. Some concern was raised about potential for obsolete sizes or materials with an existing 24-year old casing. Concern was also raised about MagnaDrive with larger pumps having a history of overheating issues, although we note that the original installation reportedly operated effectively for six years. This issue would arise only if the pump was rehabilitated and fitted with either a new or rehabilitated MagnaDrive.

Discussions with the MagnaDrive factory representative indicated similar concerns about extent of rebuild required and potential for obsolete components. We also found that the two representatives closest to Northern Kentucky were shown on the Magna-Drive website with phone numbers that had been disconnected. We did not check further for representatives, as a factory representative did respond. The factory representative claims that there were issues with the original installation and that factory records show the MagnaDrive was repaired once. The factory does not recommend attempting rehabilitation. A new drive for the rehabilitated pump was conceptually estimated at $160,000 for the equipment only, and a new drive for a 6 mgd pump was conceptually estimated at $90,000, after discounts for return of the original equipment. The factory representative acknowledged that the original equipment did tend to overheat, and claimed that design changes and upgrades, especially to the water-cooling system for the MagnaDrive, have solved the problem.

Other options for a rehabilitated pump would be to allow it to remain constant speed or to provide a variable frequency drive. While a rehabilitated constant speed pump would produce a lower flow rate than the pumps on site today (5,600 gpm to complement the 7,700 gpm each of the current pumps), that is the condition that originally led to the MagnaDrive installation because of difficulty in maintaining clearwell levels. A variable frequency drive would allow lower flow rates, but would require mating a new VFD to the rehabilitated pump. This is a delicate procedure even when selecting new equipment and not recommended.

Replacement Considerations – HSP No. 3

Replacement offers several advantages:

1. Historical damage risk is eliminated.
2. The plant flow can be matched closely, eliminating start/stop issues and reducing maintenance costs.
3. Higher efficiencies can be gained by using a constant speed pump rated for the desired flow and head conditions, reducing overall operating costs.
4. A properly sized constant speed pump would eliminate the need for a speed-reducing component and reduce both capital and operating costs.

While it could be argued that a smaller pump would reduce overall flexibility in emergency conditions, the plant has operated for some eight years through several emergency conditions without the use of Pump No. 3 at all. The overall combination of pump uses and types lends itself to multiple paths for providing flows, and the two existing plant service pumps that will remain are each nearly double the target plant operating capacity.

Capital cost for new equipment would be somewhat higher than rehabilitation (estimated between 10 and 30%, not counting the significant cost for replacing the variable speed equipment), but presents improved operations, greater efficiency and lower risks.

A variable frequency drive (or an even smaller pump) was also considered. Variable frequency drives (VFDs) are in common use and generally reliable. They do impose an efficiency loss, particularly at steeper flow reductions. They can also create electric harmonics in some conditions. In this case, the target flow rate of 6 mgd to match the typical plant flow rate is not normally reduced because if lower flow is needed the plant operating time is reduced. The extensive distribution system has capacity to store and distribute the flow within a fairly broad range. The current issue of clearwell limitations causing start/stop conditions would be resolved by a near match of the new pump. Accordingly, it is feasible to avoid the cost, efficiency penalty and operations costs/risks of a VFD or replacement MagnaDrive and use a simple constant speed pump.

Budgetary Costs – HSP No. 3

While this preliminary conceptual estimate is based on a Goulds pump, specifications will allow manufacturers consistent with NKWD purchasing policy.

Table 7. Budgetary Costs - Pump System Improvements

Item	Cost	Comments
NKWD Pump Replacement Estimate		
Pump and Motor, 6 mgd, 375' TDH, 500 Hp, soft start drive	$185,000	
Control valve	$45,000	
Demolition/Removal	$30,000	
Installation	$100,000	
Subtotal	$360,000	
Contingency	$90,000	25%
Total	**$450,000**	
NKWD Pump Refurbishment Estimate		
Pump Evaluation	$2,500	
Motor Evaluation	$3,500	
Estimate Repair	$148,000	
New MagnaDrive	$160,000	
Removal	$20,000	
Shipping	$10,000	
Reinstallation	$100,000	
Subtotal	$444,000	
Contingency	$111,000	25%
Total	**$555,000**	

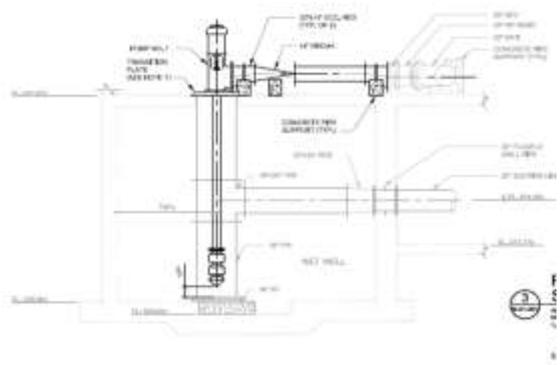
Recommendation – HSP No. 3

A new replacement constant speed pump, motor and soft-start system rated for 4,167 gpm (6 mgd) at 375 ft TDH is recommended, at a conceptual cost of $450,000, installed. A comparable refurbishment is estimated at $555,000 because of the added costs for variable frequency drive or MagnaDrive equipment to achieve the target flow rate.

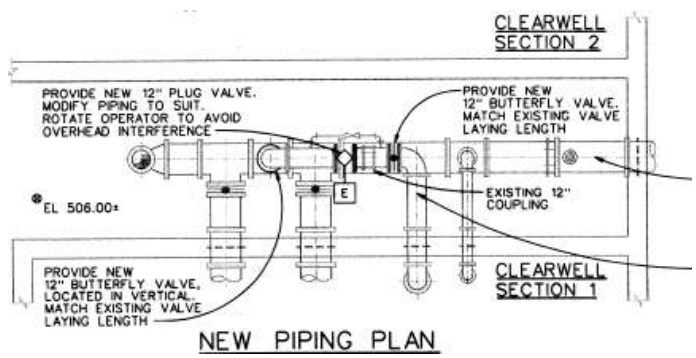
FORT THOMAS DIVERTER VALVE

Existing Conditions

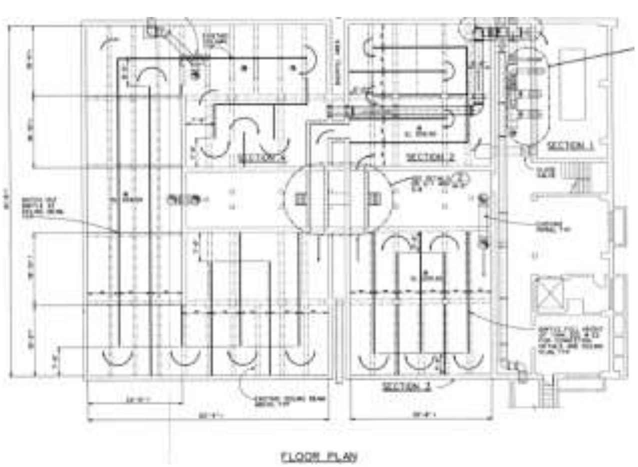
The Taylor Mill Treatment Plant is located with the Fort Thomas Treatment Plant service area (Pressure Zone 1, Elevation 763 feet), and serves two functions: 1) it provides booster pump capability from Zone 1 to the Dudley area (Pressure Zone 5, Elevation 876 feet); and 2) it is placed into treatment operation when needed to supplement the Fort Thomas Treatment Plant flows. A review of monthly operating reports for 2017 through 2020 (September) shows the plant is typically in operation sporadically from June through December each year and only has about 80 treatment operating days annually.



For the days when not in treatment operation, the Taylor Mill Treatment Plant operates as a booster pump station and provides flows from FTTP to Zone 5. There are two options today for this function. First, High Service Pumps 1, 2 and 6 are directly connected to mains served by FTTP in Zone 1, and can boost the Zone 1 head to the Zone 5 service level. The sketch of HPPS Pump No. 1 at left shows the typical booster pump arrangement, with a "can" connection to the pressurized FTTP main. The can itself is physically installed within but hydraulically separate from the TMTP clearwell.



Second, a 12-inch "diverter" plug valve was installed in about 2000 and has the ability to divert a portion of finished water from the Fort Thomas Treatment Plant into Section 1 of the finished water clearwell. High service pumps #3, #4, and #5 draw directly from the clearwell at Elevation 520 and pump to the Zone 5 service level. The intent of the diverter valve was to allow usage of the clearwell capacity and additional pumping capacity to provide options for various emergency conditions. Note in the sketch that there is an existing pipe turned upward at the left end of the FTTP main. This pipe measured 14" in the field, but will require verification.



Section 1 of the clearwell is the most downstream section of the baffled clearwell system, with the flow being directed from Section 3, thru Section 2, Section 4 (below High Service Pumps 4, 5 and 6) and finally to Section 1 (below High Service Pumps 1, 2 and 3). Because HSP No. 3 has been out of service for some years, diverted flow has not been drawn from Section 1 but moves backward through the clearwell baffle system to Section 4 under HSP No.'s 4 and 5, where it is pumped to the distribution system. This leaves a significant proportion of the water in clearwell Sections 2, 3 and part of 4 stagnant. Even with HSP No. 3 in service, the flow would be released into and drawn from Section 1, leaving the remaining Sections stagnant.

This memorandum considers options for routing the diverted flow through the entirety of the clearwell by entering at the upstream end of Section 3 versus options of wasting water to the backwash treatment system or recirculating water in the clearwell.

Alternatives and Options for Upgrades and Improvements – Fort Thomas Diverter Valve

The key to maintaining the water quality for the finished water in the clearwell is to flush and turn over the water frequently regardless of whether or not the Taylor Mill Treatment Plant is in operation. This would mean having the Fort Thomas finished water discharge into Section 3 of the clearwell. By doing so, the flow path for the finished water should sufficiently flush and turn over most, if not all, the finished water in the clearwell ahead of the high service pumps.

In reviewing the options, it was observed that the existing plug valve and connections could be left in place as an emergency system under all of the proposed new conditions. Leaving this functionality is recommended.

Options and considerations include: connecting the Fort Thomas water main to Section 3 of the finished water clearwell, draining the finished water clearwell to the backwash waste system, and recirculating the water in the finished clearwell between operations.

For connecting the Fort Thomas water main to Section 3 of the finished water clearwell, four alternatives were considered and evaluated:

Option 1-A: The existing Fort Thomas water main in the basement of the Filter Building would be modified to include branch piping that would be installed to connect to the existing 24" CFE line upstream of UV Train 1. A plug valve would allow water from Fort Thomas to flow in piping run overhead in parallel with the 24" raw line in the basement, then would turn down and connect to the 24" CFE piping with standard fittings and appurtenances. An existing 24" FL 90 deg elbow would be replaced with a tee fitting. The Fort Thomas water would be able to discharge into Section 3 of the clearwell, which will allow for water turn over and flushing of the clearwell when the distribution pumps are in service. The existing diverter valve and piping arrangement would remain and would be available as a backup. The estimated budgetary construction cost for this alternative is $192,500. A cost breakdown is provided in Table 8 following the descriptions for the evaluated alternatives.

Option 1-B: The existing Fort Thomas water main in the basement of the Filter Building would be modified to include branch piping that would be installed through the wall into Section 2 of the finished water clearwell. The new diversion water piping would be installed to come out through the wall into the filter pipe gallery area to connect either into the 24" CFE piping or through the wall into Section 3 of the clearwell. This alternative is feasible, but is not likely to be practical with the congestion of piping and utilities in the filter pipe gallery as well as impacts to access and maneuverability for plant staff. The estimated budgetary construction cost for this alternative is $300,000.

Option 1-C: The existing Fort Thomas water main would be intercepted outside of the Filter Building along Howard Avenue. A diversion valve vault would be constructed so that water could be diverted to the basement of the Filter Building or diverted in new piping that would be routed around the outside of the Filter Building to ultimately connect into the top of Section 3 of the finished water clearwell. Again, this option is feasible, but comes at a very high cost plus there would be long sections of piping that would be above grade and subject to cold weather/freezing. The estimated budgetary construction cost for this alternative is $700,000.

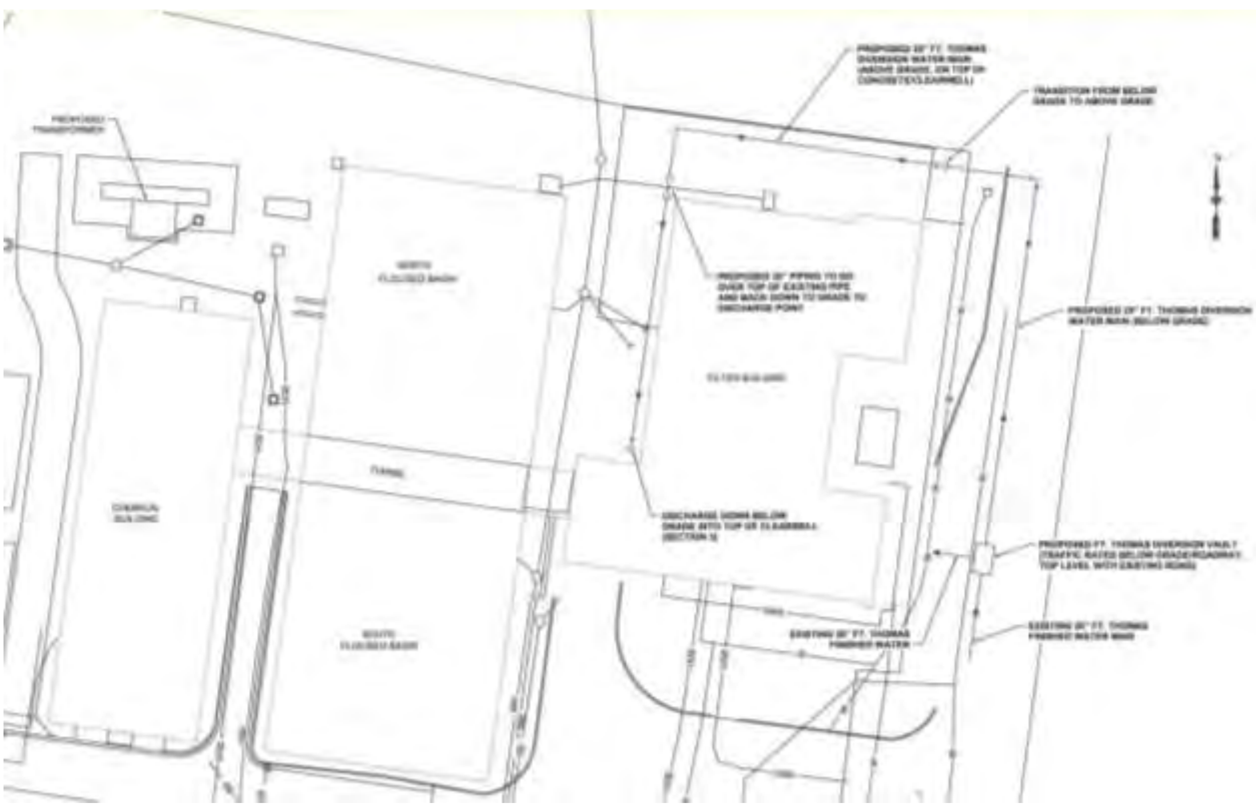
Option 1-D: The existing Fort Thomas water main in the basement of the Filter Building would be modified to include branch piping that would be connected to the existing 20" raw influent line. The Fort Thomas water would be conveyed through a portion of the existing 20" raw line until in the vicinity of the 24" CFE discharge in Section 3 of the finished water clearwell and downstream of UV Train 1. The Fort Thomas water would be able to discharge into Section 3 of the clearwell, which will allow for water turn over and flushing of the clearwell when the distribution pumps are in service. The existing diverter valve and piping arrangement would remain and would be available as a backup. This option is risky, and, although this approach is relatively simple to construct, it would require strict controls, multiple valves, and disinfection of the connections at each change of use. It would also require strict adherence to standard operating procedures, heightened attention to monitoring and controls by operators, and may require specific waivers, possibly exemptions, from NKWD and KDOW. The estimated budgetary construction cost for this alternative is $350,000.

Draining the finished water clearwell to the backwash waste system is not recommended. There does not appear to be a means to allow gravity discharge of the clearwell to the waste system, so a pumping arrangement (new pump or piping and valving configuration) would be needed. In addition, disinfection would be recommended at each change of use. While wasting the water in and of itself is not costly, the capital cost of piping, pump power cost, and disinfection operation at each change will exceed the costs of a new diverter within the first year or two.

Recirculating the water in the finished clearwell is not recommended. Recirculation could potentially be achieved, but requires the same essential connections to the upstream of Section 3 as the diversion because simple recirculation alone (without adding "younger" water) will not decrease the water age. The source of the "younger" water would also still be the FTTP mains, because TMTP would not be operating. Recirculation would also require a pumping system, either a new dedicated system or a pipe and valving configuration to make use of an existing pump.

Table 8. Budgetary Costs – Ft Thomas Diversion, Option 1-A

Item	Cost	Comments
New Ft Thomas Diversion Water System – Option 1-A		
Piping, Valves, Fittings & Appurtenances	$105,000	
Demolition/Removal	$2,500	
Subtotal	$107,500	
Electrical 10%	$10,000	
Instrumentation/Controls 10%	$10,000	
Subtotal	$127,500	
Bonds, Insurance, Mob/Demob 10%	$13,000	
Overhead & Profit 20%	$26,000	
Contingency 20%	$26,000	
Total, Option 1-A	**$192,500**	



Option 1-C – Diversion Valve Vault and Piping around Filter Building

Summary and Recommendation – Fort Thomas Diverter Valve

With the current installation, Fort Thomas water is diverted into the Taylor Mill Treatment Clearwell in Section 1, which directly below High Service Pumps Nos. 1, 2, and 3 ("Front

Pumps”). This does not allow the majority of the finished water to be turned over or flushed in the clearwell, which can be problematic when not in regular for day, weeks, and even months at time. When considering feasible options for the TMTP to divert the Fort Thomas water into Section 3 of the Clearwell, Option 1-A, connecting a new diverter to the existing combined filter effluent main near UV Train 1, is recommended. This approach appears to have a relatively simple construction path and is relatively low cost, and can also allow the existing diverter to remain as an emergency backup. The estimated budgetary construction cost estimate for this option is approximately $180,000.

STRUCTURAL ASSESSMENTS AND RECOMMENDATIONS

Existing Conditions

The Cornwell Team performed a condition assessment for the reinforced concrete structural elements in the tunnel connecting the Chemical Building to the Filter Building, and for the concrete effluent launder troughs around the perimeter of both sedimentation clarifier basins. Assessment findings and recommendations are based on observations made of the visible structural members, and there was roughly 12 to 15 inches of standing water in the troughs at the time of the assessment. There were also some additional items of note regarding the flocculation basins and a walk around the outside of the sedimentation clarifier and flocculation basins. A detailed report for the concrete assessment and recommendations is provided in Attachment A, which includes photographs and reference drawings for observed deficiencies.

Tunnel

There is visible deterioration and fallen concrete fragments in the tunnel indicating the corbel is an area of concern. Cracks and spalling concrete at the corbel correspond to the termination of the expansion joint running along the north side of the South Flocculation Basins. The paint of both walls, particularly the south side, is peeling at numerous locations due to water intrusion. There were several minor cracks observed, but there was no evidence of water leaking through.

Sedimentation Clarifier Effluent Launder Troughs

The sedimentation clarifier basins were observed from the walkways between the two basins and from walking in the effluent launder troughs around the troughs of the basins. The surface of the concrete at or above the water line has deteriorated at a number of locations. It should be anticipated that additional damage exists below the water line of the basins. For both clarifiers, there were a number of minor cracks visible around the perimeter as well as a numerous locations where exposed reinforcing steel was observed. Also, both clarifiers had several areas with larger cracks were visible through the inner trough wall, which corresponded to expansion joint locations in the exterior walls.

Flocculation Basins

Cracks visible in the flocculation basin wall at the termination of the expansion joint appear to be related cracks in the concrete corbel observed in the tunnel. Also, surface corrosion was observed on the metal walkways spanning over the flocculation basins and supporting the mixing systems, some of which is severely corroded and will require structural reinforcing.

Exterior

Based on available information, some repair work was performed in 2016 for exterior concrete surfaces on the sedimentation clarifier and flocculation basins. However, there were several areas that were observed to deteriorating and appear to be at the same location as a recent repair was made. A number of locations had cracks with mineralization indicating water may be leaking through. There were cracks in the clarifier trough bases with mineralization indicating water may be leaking through at these locations too. There was evidence of surface runoff erosion washing out the substrate under a concrete support pad near the wooden access stairs on the north side of the North Sedimentation Clarifier Basin.

Recommended Improvements – Structural

Tunnel

The reinforced concrete corbel supporting the concrete slab is heavily damaged and requires repair. The damage extends from the topside through the trough and into the corbel. To minimize potential damage the concrete slab should be separated from the corbel with a bearing pad. During repair the loads supported by the corbel will require shoring. The damaged concrete should be removed to sound concrete, all corrosion removed the exposed reinforcing, reinforcing coated with a corrosion resistant coating and repaired with an epoxy modified repair mortar.

Cracks through the basin wall should be repaired from within the tunnel by using hydrophilic chemical grout pressure injected into the cracks.

Sedimentation Clarifier Basin Effluent Launder Troughs

Prior to proceeding with any repairs, the basins should be completely drained to allow a thorough examination of the basins' concrete components and surfaces. The troughs at the perimeter of both the North and South Sedimentation Clarifier Basins are experiencing deterioration presenting as cracks, spalls and exposed reinforcing steel.

To repair the spalled surface the troughs will need to be completely drained. All loose surface concrete removed. The concrete should be cleaned by pressure washing, a bonding agent applied, and an epoxy modified repair mortar placed and finished smooth.

Areas with exposed reinforcing should have the concrete surrounding the exposed reinforcing steel a minimum of 1/2" all around the reinforcing. All corrosion should be mechanically removed and a corrosion inhibiting coating applied. A bonding agent should be placed in the repair area and an epoxy modified repair mortar installed.

Vertical cracks through the trough walls that align with the exterior wall expansion joints should be repaired with a soft joint to allow movement of the cracks as the wall expands and contracts. This will require the cracks to be routed to a depth of 1/2" and filled with a silicone caulk. The repair should be done at both side of the wall.

Cracks that are not in line with an exterior expansion joint should be repaired using a hydrophilic chemical grout by pressure injection.

Once surface repairs are completed consideration should be given to lining the effluent launder troughs around both of the Sedimentation Clarifier Basins with a protective coating to minimize continued damage.

Flocculation Basins

In the areas where the walkway platform steel is severely corroded, repair should involve the corroded steel being removed at the bearing end and replacing with new steel that is field welded into place.

All exposed steel for the walkway platforms and supports should have the corrosion removed to bare metal and coated with a zinc-rich paint or cold galvanizing.

Exterior

The deteriorated concrete areas should be completely removed to sound concrete. Any cracks emanating through the wall should be repaired using a hydrophilic chemical grout by pressure injection. The perimeter of the repairs should be squared off. Any exposed reinforcing steel should have the any corrosion mechanically removed and have a corrosion inhibiting coating applied. The area should be patched back with an epoxy-modified repair mortar. Cracks outside previously patched areas should be repaired using a hydrophilic chemical grout by pressure injection.

The eroded soil at the basin stair should be repaired by deepening the footing. The soils should be excavated in sections and footing placed to a minimum depth of two feet below existing grade to minimize the effect soil erosion on the structure. Voids under the stair slab should be filled with flowable fill or non-shrink grout. This area should also be regraded to allow for surface runoff flows to be directed away from the structures to mitigate potential erosion issues from reoccurring.

Budgetary Costing - Structural

The opinion of probable cost for recommended repairs was prepared based on observations made during an on-site visit in October 2020. Note that the items are categorized as Type A (urgent) or Type B (to be addressed in the near future). Also, as noted, the sedimentation clarifier basins were only partially drained or accessible during the site. This mostly impacts the Type A (urgent) structural items; therefore, a contingency of 50% was utilized for budgetary cost estimating purposes to account for unforeseen repair issues and for anticipated additional repair areas that were not visible during the assessment. For those items considered to be Type B, these items were more visible and less concealed by the water within basins; therefore, a contingency of 25% was utilized for budgetary cost estimating purposes to account for unforeseen repair issues. For all the repairs indicated below, a qualified contractor specializing in concrete repairs should perform the work.

The budgetary costs for the noted items include all materials, labor and equipment based on current industry standards as well as the preparatory work and supporting elements. The cost estimates are intended to provide the NKWD with budgetary costs for the repair work, and could possibly be less if the basins can be entirely fully drained and inspected (potentially reduce costs and/or contingency) and if competitively bid, which could potentially result in reduced costs for materials, labor, and/or equipment.

Table 9. Proposed Structural Repairs at the Taylor Mill Treatment Plant

Item	Cost	Comment
A – Urgent Structural Work		
Repair Corbel and Expansion Joint	$20,000	
Repair Cracks in Launders Troughs and in Tunnel and Clarifier Basins	$60,000	
Repair Surface Spalls in Launder Troughs with Epoxy-Modified Repair Mortars	$240,000	
Subtotal – A	$320,000	
Contingency – A	$160,000	50%
Total – A	**$480,000**	
B – Structural Items to be Addressed at the Earliest Opportunity		
Removed Failed Concrete Repairs/Repairs with Epoxy-Modified Repair Mortars	$120,000	
Epoxy-Modified Repair Mortar to Cover Exposed Reinforcing Steel (Launder Troughs)	$10,000	
Repair Corroded Steel for Metal Platforms (Flocculators)	$2,000	
Prepare/Recoat Exposed Metal Platforms/Walkways (Flocculators)	$25,000	
Apply Epoxy Coating to Interior Surface of Launder Troughs	$68,000	
Repair Foundation at North Side of North Sedimentation Clarifier Basin	$3,000	
Subtotal – B	$228,000	
Contingency – B	$57,000	25%
Total – B	**$285,000**	
TOTAL, ALL STRUCTURAL WORK (A+B)	**$765,000**	

CONCLUSION

Each of the areas at the Taylor Mill Treatment Plant (TMTP) assessed by Cornwell had feasible options and alternatives worth considering. Table 10 below summarizes the pre-assessment costs for each of the areas evaluated, which resulted in a total estimate of $2,135,000. Table 11 summarizes the budgetary costs for the recommendations for each of the areas evaluated, which resulted in total estimate of $3,928,500. Although cost may be key factor in the decision-making for the preferred option, other factors should be considered for the long-term service life of the equipment and strategic operational plans for the TMTP. Additionally, there are opportunities to discuss and prioritize the work should there be budgeting concerns, particularly for the larger cost items, as well as potential work the NKWD may be capable and/or willing to do in-house with internal assets. Items such as the UV treatment system may be worth further detailed discussion on the level of commitment the NKWD may want to invest into the repairs. With regard to the filter valve and actuators replacement work, it should be noted that budgetary costs were provided from manufacturer representatives, who acknowledged these costs are higher than what would be normally quoted for competitively bid projects, perhaps around 25-30% higher. The structural repair work also requires much more preparation and setup to perform the work correctly. As seen from the 2016 work, inferior or improper concrete repair work will result in having to go over redo along with additional damage.

Table 10. Initial NKWD Budgetary Construction Cost Estimates

Items	Estimated Cost
PAC Replacement	$605,000
Pump No. 3 Motor and Pump Replacement	$550,000
Filter Valve & Actuator and Diversion Valve Replacement	$510,000
UV Replacement and Concrete Repairs	$470,000
Total	**$2,135,000**

Table 11. Budgetary Construction Cost Estimates for Recommended Options

Items	Estimated Cost
UV System Replacement, incl UPS	$1,117,000
PAC Slurry Storage & Feed System	$529,000
Pump No. 3 Motor and Pump Replacement	$450,000
Filter Valves & Actuators Replacement	$875,000
Ft Thomas Diversion Water Modifications	$192,500
Concrete Repairs - Urgent	$480,000
Concrete Repairs - ASAP	$285,000
Total	**$3,928,500**

ATTACHMENT A:
STRUCTURAL ASSESSMENTS AND RECOMMENDATIONS
(LYNCH MYKINS REPORT, 11/11/2020)

lynchmykins

11/11/20

Gerald Wright
Cornwell Engineering Group
712 Gum Rock Court
Newport News, VA 23606

Re: Northern Kentucky Water District Taylor Mill
LM Project No: G20.092

Dear Mr. Wright

Per our agreement dated July 17, 2020, Lynch Mykins Structural Engineers. PC visited the Northern Kentucky Water District's Taylor Mill Water Treatment Plant. The purpose of the visit was to perform visual observations of the interior of the tunnel and the effluent troughs at both clarifiers and document observed structural damage.

The Structural sheets of the "The Taylor Mill Water Treatment Plant Electrical and Basin Improvements" drawings dated January 2014 with a Record Drawing stamped 08/24/16 were made available for use during the investigation.

OBSERVATIONS

Observations were made of visible structural members. No Testing of Material was performed. No finishes, standing water or earth was removed to expose the structure.

Photographs of observed damage are included in Appendix I of this report. Tunnel photographs are labeled Tx, Basin photographs are labeled Px and photographs of the exterior walls are labeled Ex. The locations the photos were taken are indicated in the Photograph Location Plans Included in Appendix II of this report. A Summary of the observed defects are depicted in the attached "Observed Damage Summary Sketch" in Appendix III.

The structural components observed; walls, troughs and basins are reinforced concrete. Walkways providing access to Sedimentation Basins are galvanized steel members with galvanized steel grating.

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Richmond, VA
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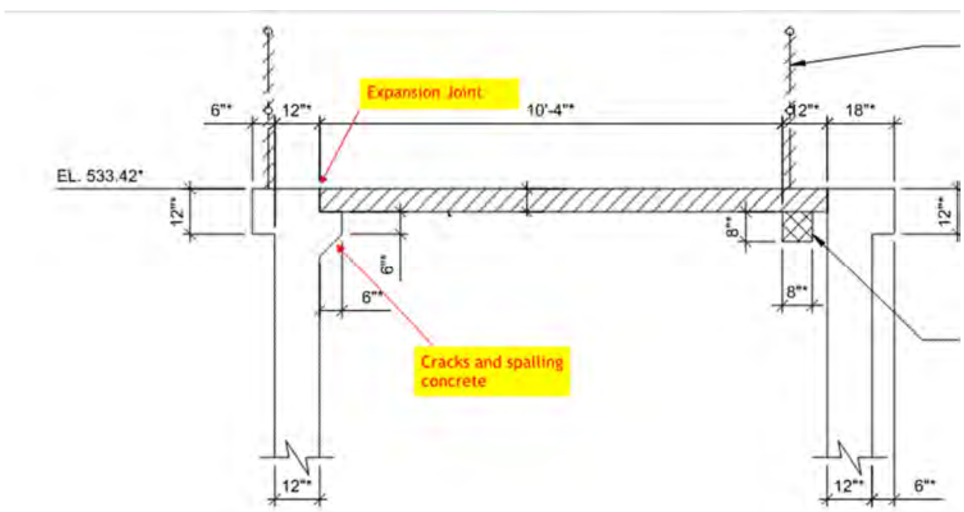
Tunnel

1. Upon entering the tunnel, it was observed that concrete has fallen from a deteriorating corbel and debris was on the floor below refer to photograph T2. The reinforced concrete corbel is at the location indicated by T1 on the attached photo location sketch. The cracks and spalling concrete at the corbel correspond to the termination of the expansion joint running along the South Flocculator Basin. See the termination of the expansion joint in the photograph below.



Section from referenced drawings

2. The paint on the tunnel walls is peeling from the basin walls in numerous locations throughout the length of the tunnel. Refer to photographs T3, T4, T5, T7, T8, T9, T10 and T16.

3. Minor cracks were observed in the basin wall of the tunnel. No water was observed to be running through the cracks. Refer to photographs T11, T12-T16 and T18.

<u>Basins</u>

The basin were observed from the walkways between the two basins and from walking the trough at the perimeter troughs of the Basins. Basins and troughs were in use at the time of observation therefore water was covering much of the structure.

The surface of the concrete at and below the water line in the troughs is deteriorate throughout both the North and South basins. It should be anticipated that additional damage exists below the water line of the basins.

North Basin and Trough

1. There were numerous minor cracks in the concrete observed throughout the perimeter trough, refer to photographs P2, P5, P6, P7 P9, P10, P11 and P12.
2. Exposed reinforcing steel was observed in numerous locations due to insufficient cover in original construction, refer to photographs P9, P12, P13, P14, P15, P16, P17 and P18.
3. Larger cracks were noted through the inner trough wall. These cracks corresponding to expansion joint locations in the exterior walls. Refer to photographs P3, P5 and P12.

South Basin and Trough

1. There were minor cracks observed throughout the perimeter trough, refer to photographs P19 and P24.
2. Exposed reinforcing steel was observed in numerous locations due to insufficient cover in original construction.
3. Larger cracks were noted through the inner trough wall. These cracks corresponding to expansion joint locations in the exterior walls.

Flocculator Basins

1. Cracks in basin wall at termination of expansion joint related to cracks in concrete corbel in the tunnel. Refer to photographs P26 and P27.
2. Surface corrosion was observed on the metal walkways spanning over the flocculator basins, refer to photographs P29-P31. The corrosion at location indicated on the Flocculator Basin Photograph Location Plan P28 is severely corroded and will require structural reinforcing.

<u>Exterior</u>

1. Previous concrete repairs performed in 2016 were observed to be deteriorating at all locations. The repair area surfaces are heavily cracked. Ref to photographs E2, E3, E4, E5, E6, E7, E8, E11, E18 and E19.
2. Cracks through the basin wall have mineralization along the cracks indicting water may be leaking through. Reference photographs E2, E4, E6, E7, E10, E11, E12, E13, E14, E18 and E19.
3. Cracks in the trough's bases have mineralization along the cracks indicating water leaks. Refer to photographs E16 and E17.
4. The foundation for the stairs at the North Wall of the North Sedimentation Basin has lost soil below the foundation caused by erosion. Refer to photograph E13.

RECOMMENDATIONS

<u>Tunnel</u>

The reinforced concrete corbel supporting the concrete slab is heavily damaged and requires repair. The damage extends from the topside through the trough and into the corbel. To minimize potential damage the concrete slab should be separated from the corbel with a bearing pad. During repair the loads supported by the corbel will require shoring. The damaged concrete should be removed to sound concrete, all corrosion removed the exposed reinforcing, reinforcing coated with a corrosion resistant coating and repaired with an epoxy modified repair mortar.

Cracks through the basin wall should be repaired from within the tunnel by using hydrophilic chemical grout pressure injected into the cracks.

Basins

Prior to proceeding with any repairs, the basins should be drained to allow a thorough examination of the basins' concrete components.

The troughs at the perimeter of both the North and South Sedimentation Basins are experiencing deterioration presenting as cracks, spalls and exposed reinforcing steel.

To repair the spalled surface the troughs will need to be drained. All loose surface concrete removed. The concrete should be cleaned by pressure washing, a bonding agent applied, and an epoxy modified repair mortar placed and finished smooth.

Area with exposed reinforcing should have the concrete surrounding the exposed reinforcing steel removed to a minimum dimension of ½" all around the reinforcing. All corrosion should be mechanically removed and a corrosion inhibiting coating applied. A bonding agent should be placed in the repair area and an epoxy modified repair mortar installed.

Vertical cracks through the trough walls that align with the exterior wall expansion joints should be repaired with a soft joint to allow movement of the cracks as the wall expands and contracts. This will require the cracks to be routed to a depth of ½" and filled with a silicone caulk. The repair should be done at both side of the wall.

Cracks that are not in line with an exterior expansion joint should be repaired using a hydrophilic chemical grout by pressure injection.

Once surface repairs are completed consideration should be given to lining the troughs around the Sedimentation Basins with coating to minimize continued damage.

The corroded structural steel at the walkway indicated in photograph 28 will require structural repair. This will involve removing the corroded steel at the bearing end and replacing with new steel field welded into place. All exposed steel should have the corrosion removed to bare metal and coated with a zinc rich paint or cold galvanizing.

Exterior

The deteriorating repairs should be completely removed to sound concrete. Any cracks the emanate through the wall should be repaired using a hydrophilic chemical grout by pressure injection. The perimeter of the repairs should be squared off. Any exposed reinforcing steel should have corrosion mechanically removed and have a corrosion inhibiting coating applied. The area should be patched back with an epoxy modified repair mortar.

Cracks outside previously patched areas should be repaired using a hydrophilic chemical grout by pressure injection.

The eroded soil at the basin stair should be repaired by deepening the footing. The soils should be excavated in sections and footing placed to a minimum depth of two feet below existing grade to minimize the effect soil erosion on the structure. Voids under the stair slab should be filled with flowable fill or non-shrink grout.

Opinion of Probable Cost

The opinion of probable cost was prepared based on observations made. An allowance is included in anticipation that additional damage will be uncovered when the Sedimentation Basins are drained. The repairs should be completed by a qualified contractor specializing in concrete repairs.

The opinion of probable cost for urgent structural repairs includes the following:

1. Repair of the Corbel and re-working the expansion joint at the corbel location. $20,000.00
2. Repair cracks in the troughs, tunnel and basins by pressure injection. $60,000.00
3. Repair surface spalls in troughs with epoxy modified repair mortars. $240,000.00

Allowance for damage hidden by water in filled Basins - Observed damage plus 50% = $320,000 x 1.5 = $480,000.00.

The opinion of probable cost for structural repair to be addressed in the near future includes the following:

1. Remove failed concrete repairs and replace with epoxy modified repair mortar. $120,000.00
2. Provide cover over exposed reinforcing with epoxy modified repair mortar. $10,000.00
3. Repair of corroded steel at walkways. $2,000.00
4. Recoating exposed structural steel with zinc rich paint. $25,000.00
5. Application of an epoxy coating to the surface of the troughs. $68,000.00
6. Install foundation under exterior basin stairs and fill voids. $3,000.00

Allowance for damage hidden by water in filled Basins in the near future - Observed damage plus 25% = $228,000 x 1.25 = $285,000.00.

The total Opinion of Probable Cost for structural repairs is Seven Hundred Sixty-Five Thousand Dollars ($765,000.00).

Conclusion

This report represents a professional opinion of the condition of specific structural elements identified above and is based upon the results of our limited observations. This letter is not intended to be a complete or comprehensive study of the structure.

Work has been performed in accordance with generally accepted principles and practices of structural engineering. Lynch Mykins cannot be responsible for any future changes in the condition of the structure. No other warranty is provided, either expressed or implied. If new conditions are observed, this office should be contacted so that the findings and conclusions can be reviewed and revised, if necessary.

We appreciate the opportunity to be of service to you. If you have any questions, or need additional information, please do not hesitate to call.

Sincerely,
LYNCH MYKINS STRUCTURAL ENGINEERS, PC

Michael Behm, EIT
Structural Investigator

Zachary Miller

Zachary J. Miller, P.E.
Project Engineer

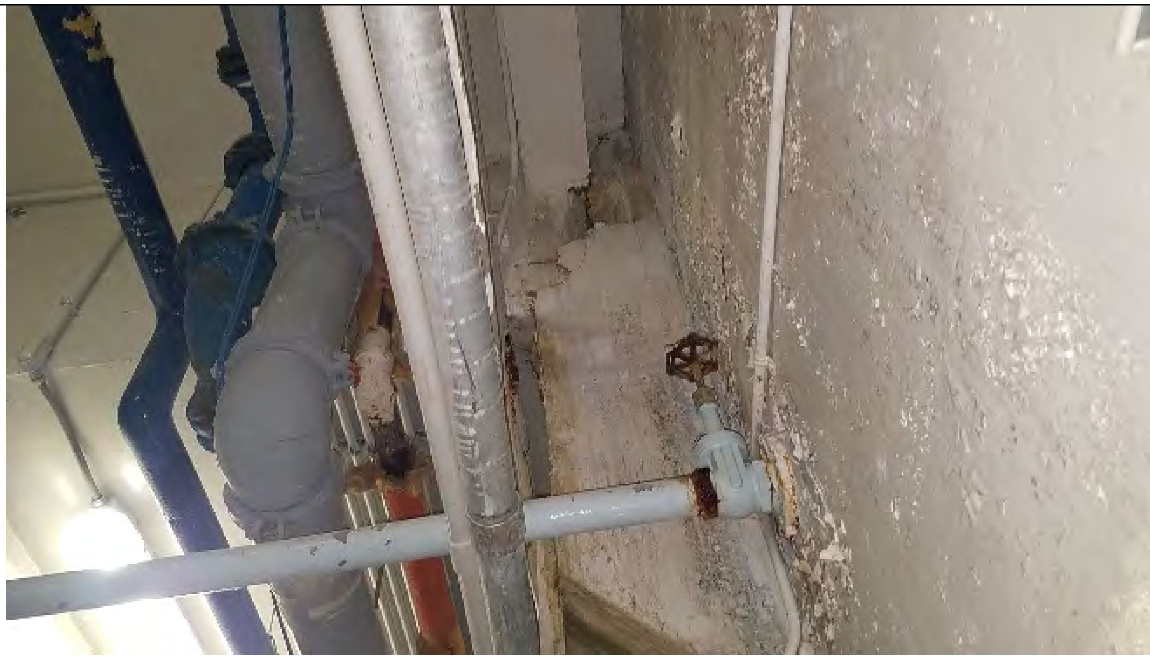
Enclosure: Appendix I - Photographs
Appendix II – Photo Location Sketches
Appendix III – Observed Damage Summary Sketch

APPENDIX I

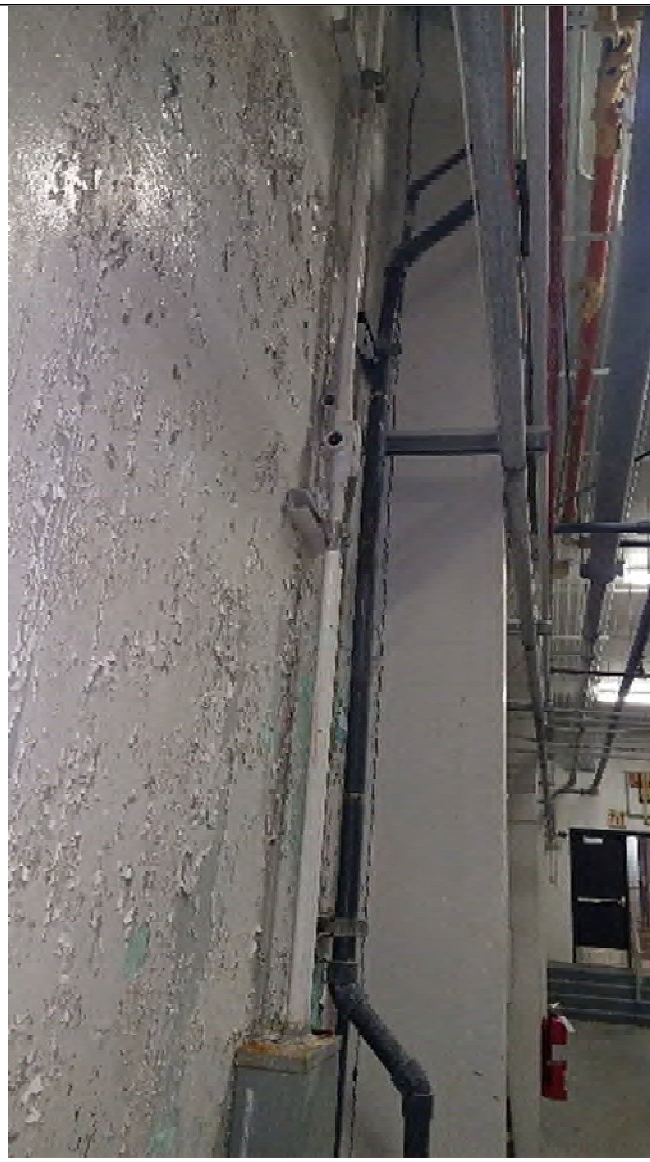
TUNNEL PHOTOGRAPHS

T1

T2



T3

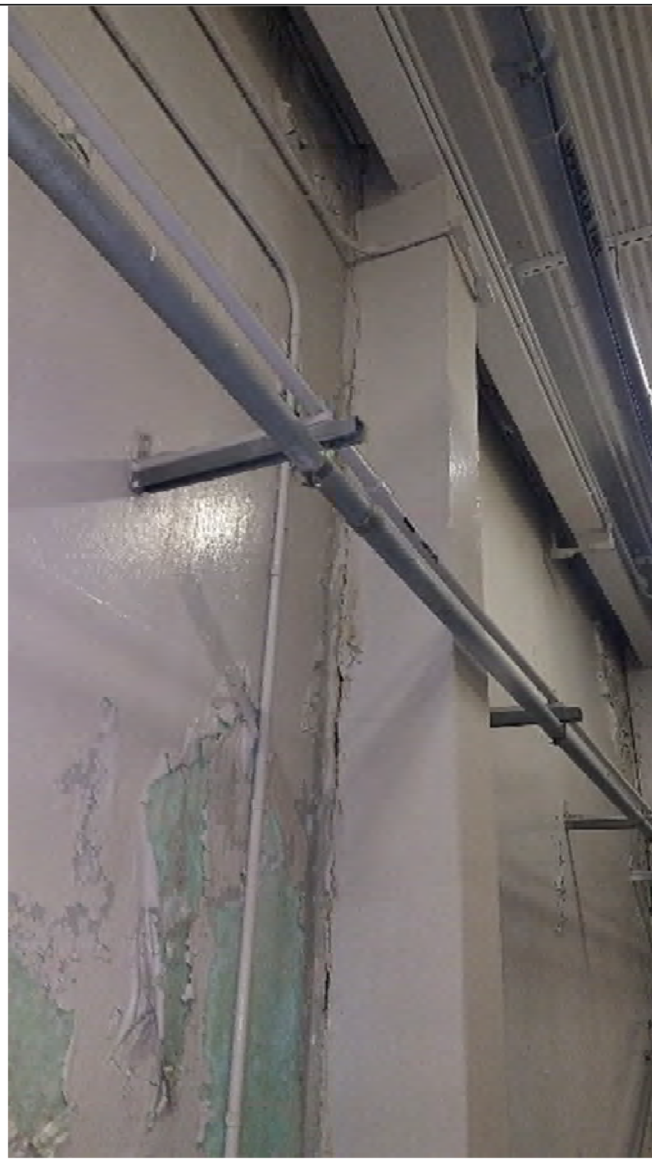


T4

T5

T6

T7



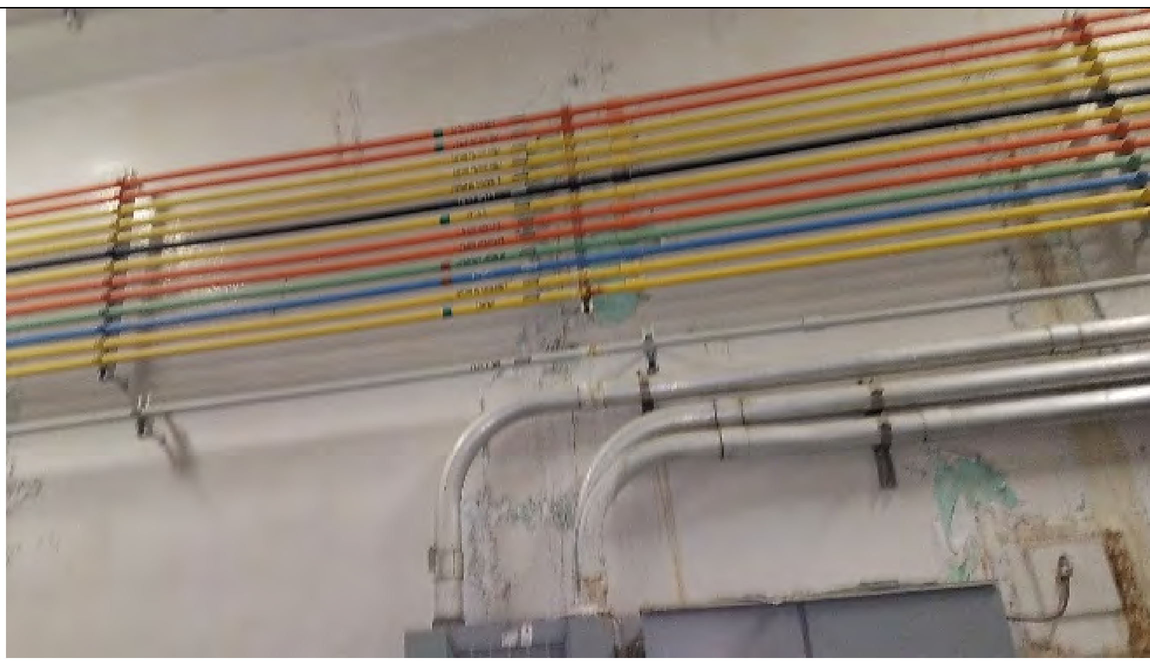
T8

T9

T10

T11


T12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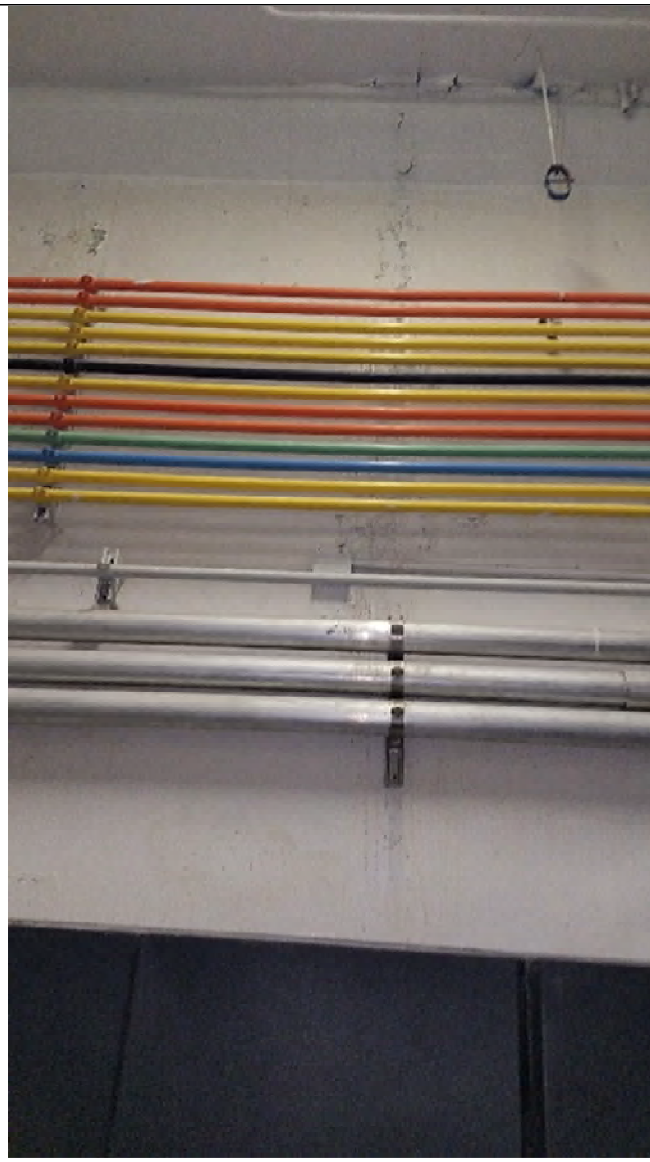
T14



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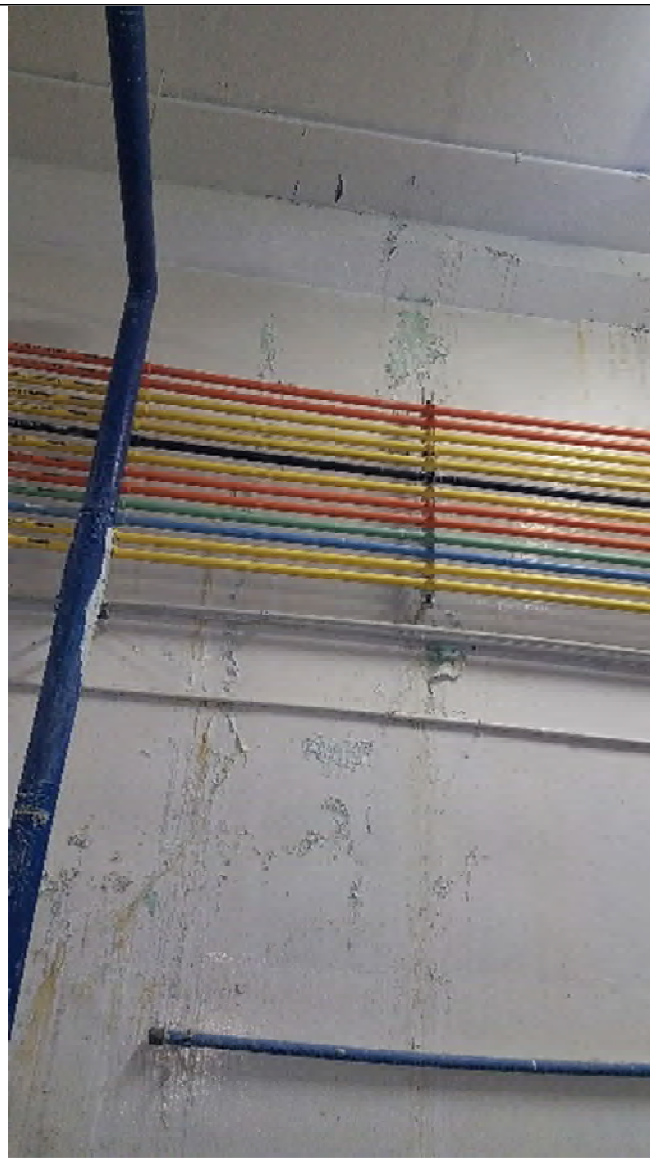
T16

T17

T18

BASIN PHOTOGRAPHS

P1

P2

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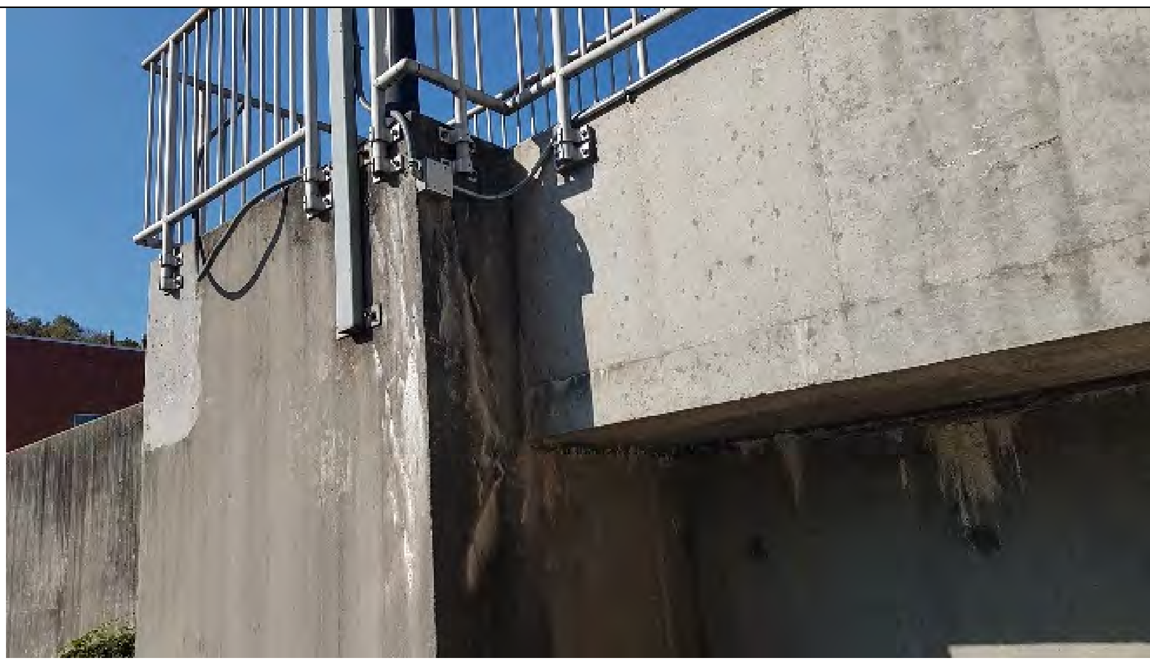
<u>EXTERIOR PHOTOGRAPHS</u>

E1



E2


E3


E4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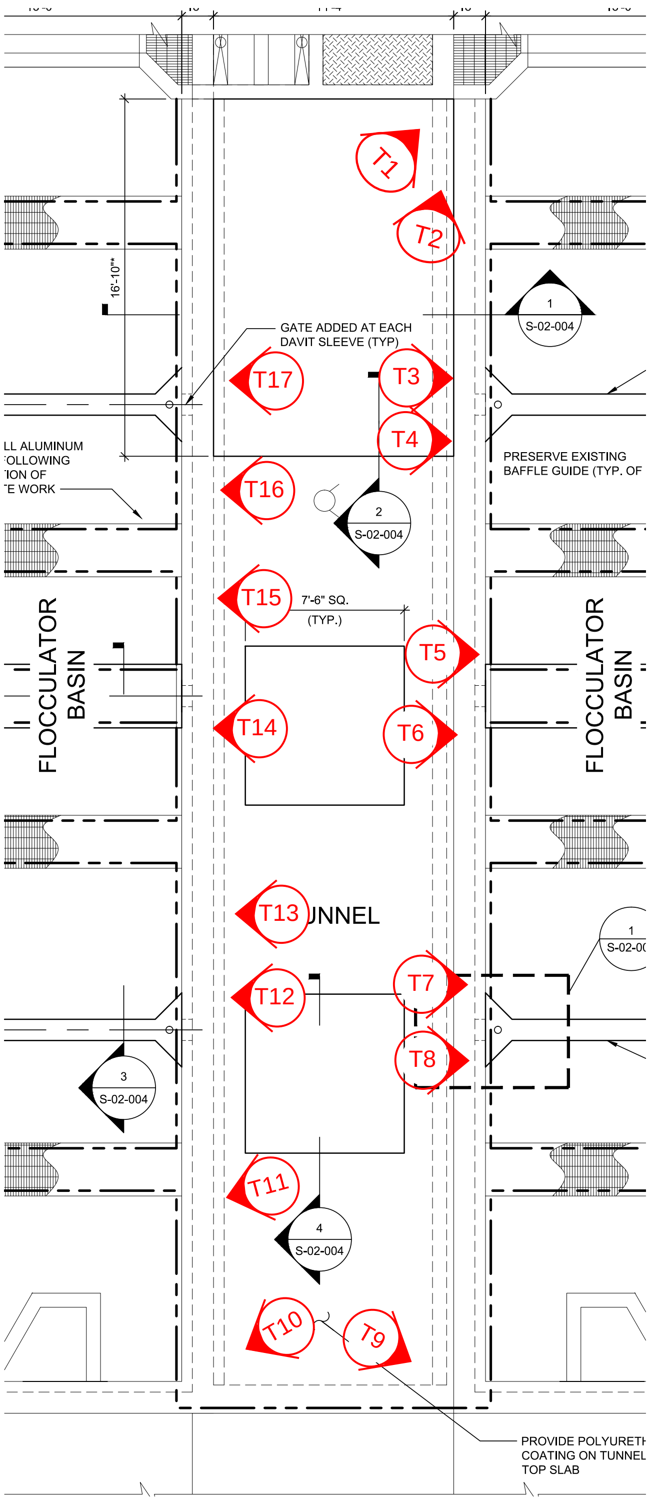
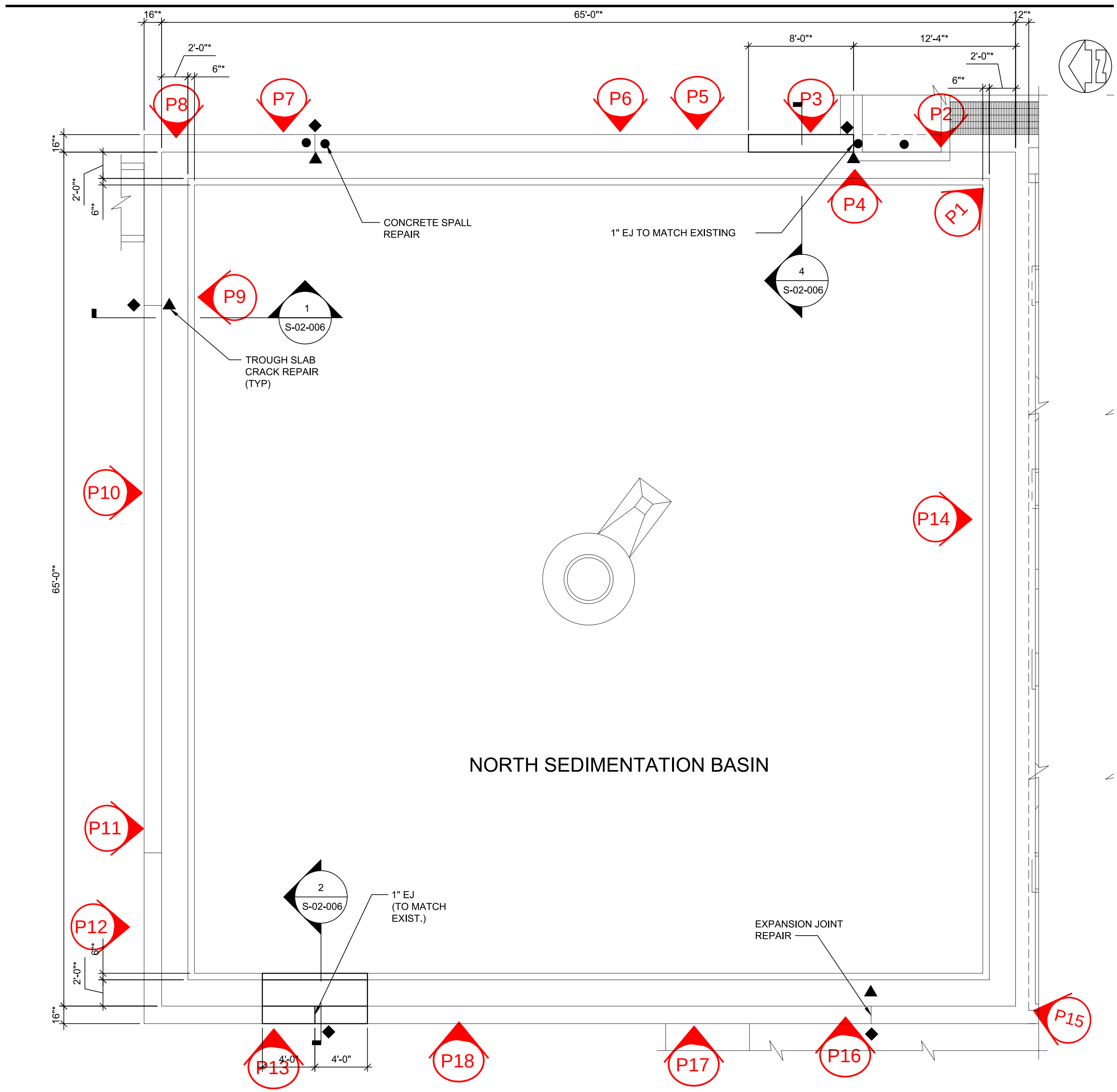
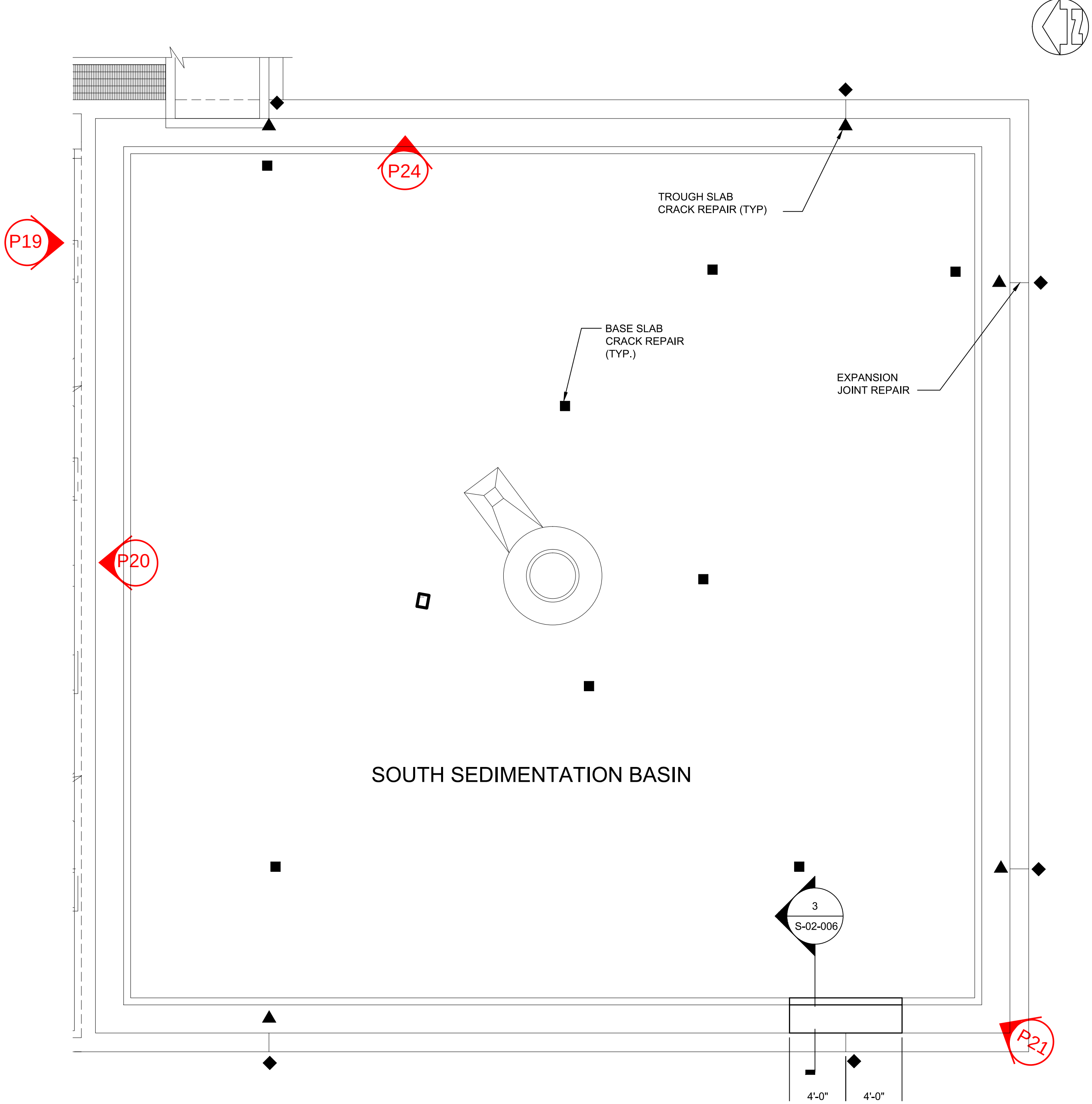
APPENDIX II



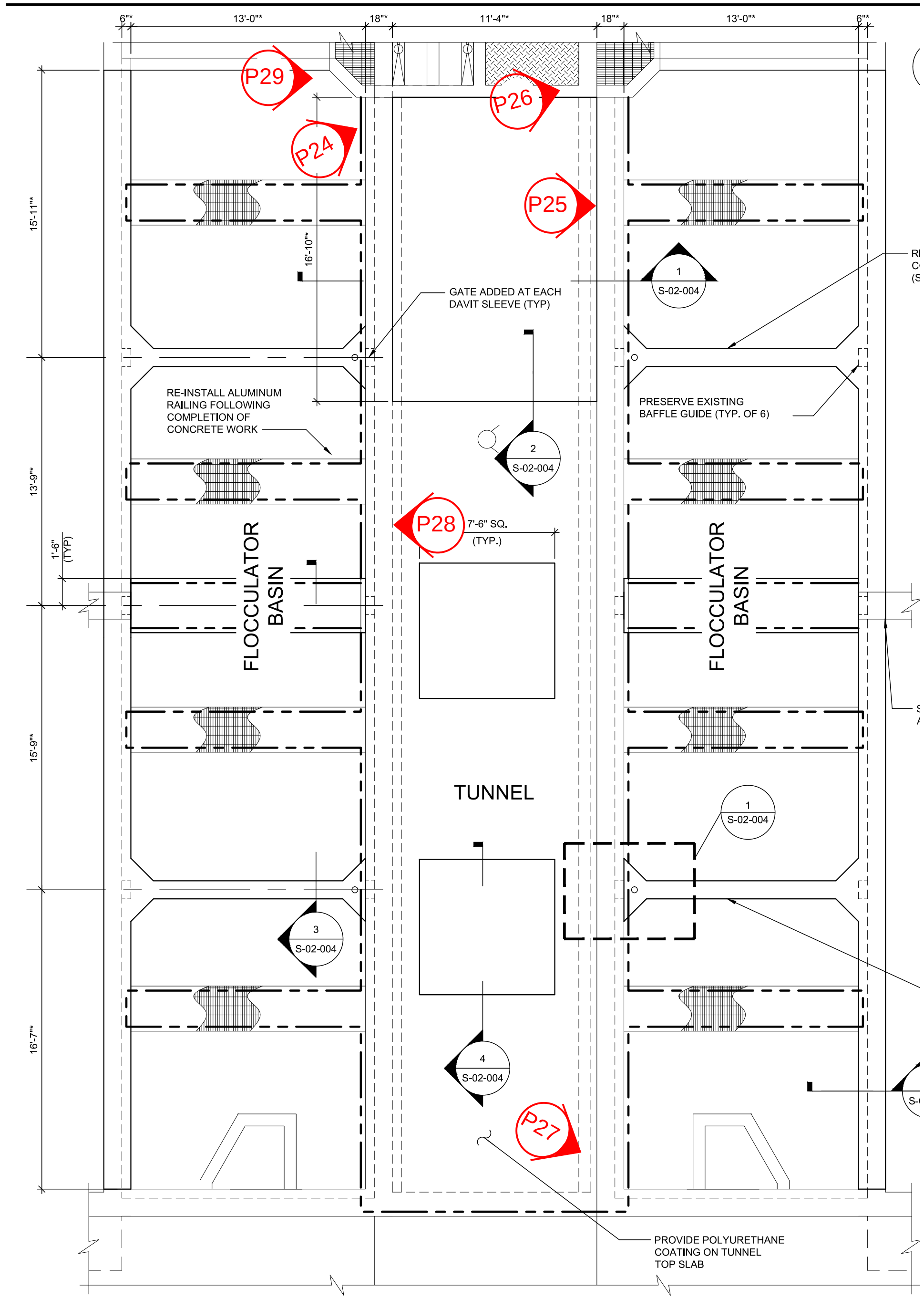
TUNNEL
PHOTOGRAPH LOCATION PLAN



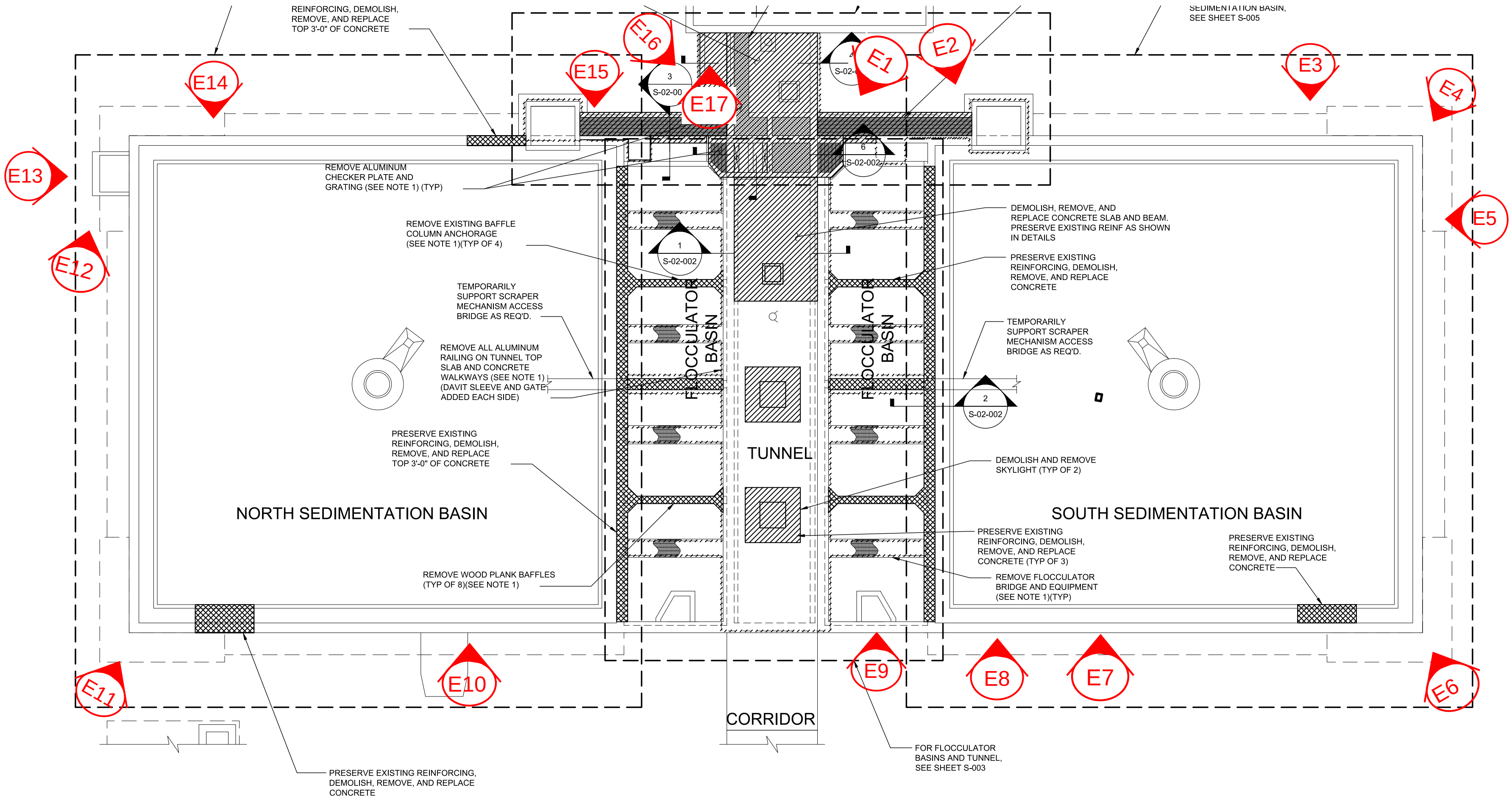
NORTH SEDIMENTATION BASIN
PHOTOGRAPH LOCATION PLAN



SOUTH SEDIMENTATION BASIN PHOTOGRAPH LOCATION PLAN

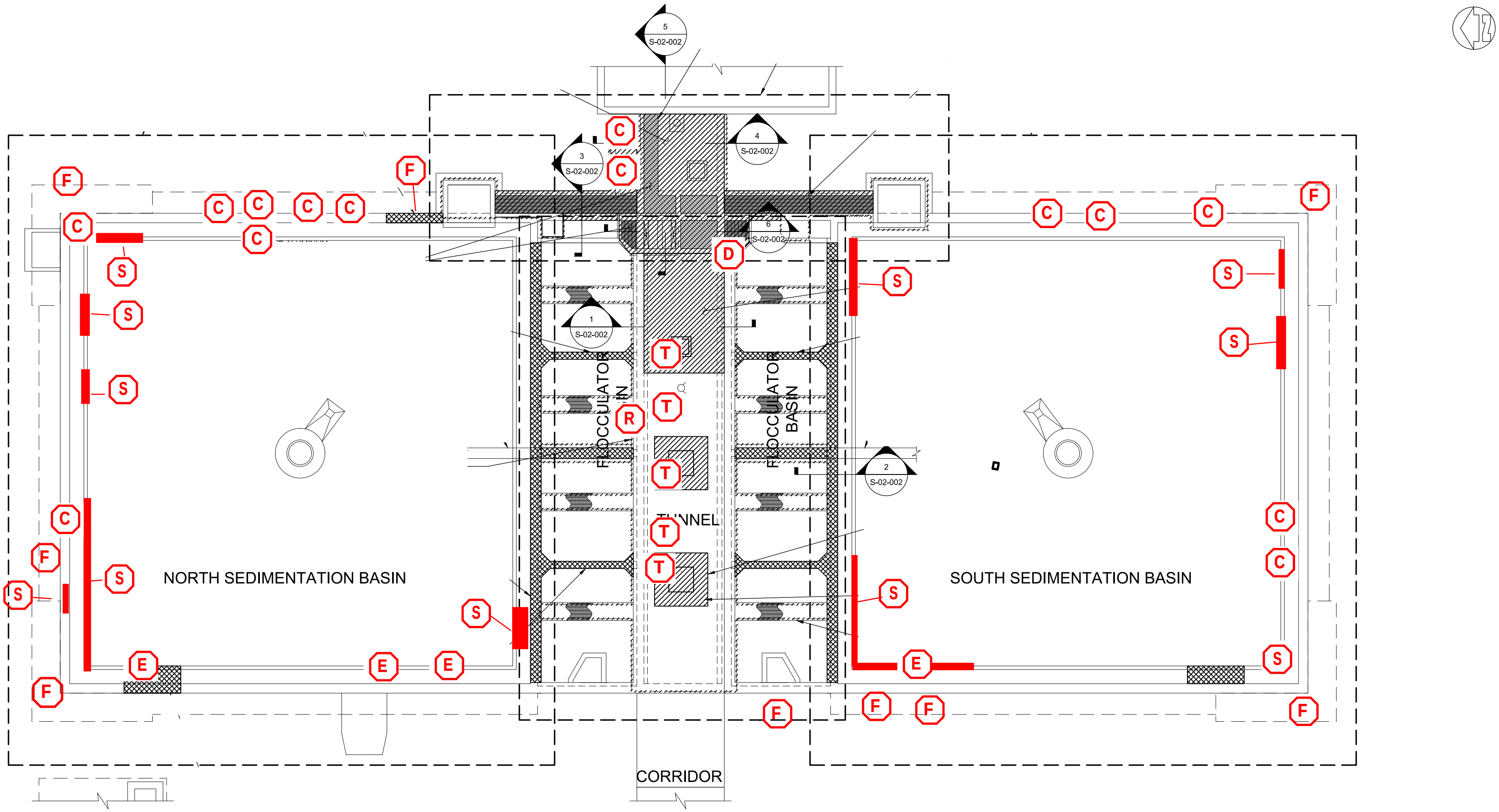


FLOCCULATION BASIN
PHOTOGRAPH LOCATION PLAN



EXTERIOR
PHOTOGRAPH LOCATION PLAN

APPENDIX III



KEY

- S Surface Spalling of Trough wall
- C Crack through wall
- E Exposed Reinforcing Steel
- R Corroded Steel
- F Failed Repair Area
- D Damaged Corbel and Spalling of Trough Wall
- T Crack in Basin Wall at Tunnel Side

Observed Damage Summary

8/20/2026

STATE OF KENTUCKY
DAVID A.
CORNWELL
25973
LICENSED
PROFESSIONAL ENGINEER

March 18, 2021

Northern Kentucky Water District
Taylor Mill Treatment Plant
Engineering Memorandum No. 1
UV and PAC System Upgrades and Improvements

Subject: Addendum to the Preliminary Engineering Report (November 25, 2020)

INTRODUCTION

Based on observations from a site visit, an evaluation of available data and information, and discussions with NKWD staff, the Cornwell Engineering Group (Cornwell) prepared and submitted a preliminary engineering report (PER) to the NKWD on November 25, 2020 with findings and recommended improvements for the ultraviolet (UV) disinfection system and the powdered activated carbon (PAC) treatment system as well as for high service pump #3, the filtration system valves and actuators, the Fort Thomas diversion piping modifications, and structural repairs for the clarifier basins, flocculator basins, and the below-ground walkway tunnel. As seen below in Table 1, the estimated budgetary construction cost estimates for all of the recommended options totaled $3,928,500.

Table 1. Budgetary Construction Cost Estimates for Recommended Options

Items	Estimated Cost
UV System Replacement, incl UPS	$1,117,000
PAC Slurry Storage & Feed System	$529,000
Pump No. 3 Motor and Pump Replacement	$450,000
Filter Valves & Actuators Replacement	$875,000
Ft Thomas Diversion Water Modifications	$192,500
Concrete Repairs - Urgent	$480,000
Concrete Repairs - ASAP	$285,000
Total	**$3,928,500**

Subsequent discussions and (virtual) meetings with the NKWD resulted in changes to the design scope of work moving forward. The original design scope of work included UV treatment system improvements and PAC system upgrades and improvements, and these items will continue to remain; however, the NKWD would prefer to have only one of the two UV treatment systems replaced, and a new, detached PAC storage and feed facility was not acceptable, but the NKWD reiterated their desire to have a carbon bulk bag “supersack” and feeder system, similar to the one at the Memorial Parkway Treatment Plant, and located within the existing TMTP facilities.

Although not part of the original design scope of work, the NKWD agrees that the concrete and structural repair work detailed in the PER needs to be done as soon as practicable and should be part of the design scope of work moving forward.

Similarly, the NKWD would like to have Cornwell prepare bidding documents for the Fort Thomas diversion piping modifications work, but as an optional bid item. This would allow the diversion piping work to be done, but only if authorized by the NKWD, and provided sufficient funds for the project are still available.

Subsequent discussions and (virtual) meetings with the NKWD have indicated that the Pump No. 3 replacement work and the filter valves and actuators replacement work would still not be part of the design scope of work moving forward.

From discussions with the NKWD prior to the start of work, Table 2 below shows the total pre-assessment budgetary construction cost estimate was $2,135,000 for the areas of the treatment plant that were to be evaluated and the funds likely to be available for any improvements work.

Table 2. Initial NKWD Budgetary Construction Cost Estimates

Items	Estimated Cost
PAC Replacement	$605,000
Pump No. 3 Motor and Pump Replacement	$550,000
Filter Valve & Actuator and Diversion Valve Replacement	$510,000
UV Replacement and Concrete Repairs	$470,000
Total	**$2,135,000**

With the new direction for the improvements to the UV treatment system, the PAC system, the structural repair work, and the Fort Thomas diversion piping, as an optional bid item, Cornwell will prepare design and bidding documents accordingly. A second site visit in February 2021 also afforded Cornwell the opportunity to confirm existing conditions, further refine the original plans and recommendations, and explore other options and alternatives. As a result, below is a summary of the changes to the recommended improvements and the direction moving forward for preparing the appropriate bidding documents for the UV treatment system, the PAC system, the structural repair work, and the Fort Thomas diversion piping. Following the summary are descriptions and updated budgetary cost estimates for those items.

SUMMARY

The on-going discussions with the NKWD and second site visit afforded Cornwell the opportunity to continue to refine the recommendations for upgrades and improvements, and, more importantly, the budgetary cost estimates for the proposed work as seen below in Table 3. As seen, the current total estimate for the recommended work, including the optional bid item, is slightly less than the preliminary budget set aside for this work. Cornwell will prepare a budgetary cost estimate update with each deliverable as the design work progresses. Subject to approval of the additional design scope of work, Cornwell will prepare bidding documents for:

- Removing the two existing UV disinfection treatment systems, including the UPS system and piping;
- Installing one new UV treatment system in the place of UV Train #2;
- Installing the new UV treatment system control panel on the first floor;
- Removing the PAC and filter aid systems in the Chemical Building and prep for new operations;
- Installing a PAC bulk bag feeder system and enclose the new (former filter aid) area;
- Installing a new filter aid storage and feed system in the new (former PAC) location;
- Performing all recommended structural repair work;
- Installing the Fort Thomas diversion piping modifications as an optional bid item.

Table 3. Updated Budgetary Construction Cost Estimates for Design Work (March 2021)

Items	Estimated Cost
UV System Improvements	$450,000
PAC Bulk Bag Feeder System (incl Filter Aid)	$690,000
Concrete Repairs	$714,000
Ft Thomas Diversion Piping Modifications (Optional Bid Item)	$195,000
Total	**$2,049,000**

CHANGES/MODIFICATIONS TO RECOMMENDED IMPROVEMENTS IN PER

Ultraviolet (UV) Disinfection Treatment System

Cornwell originally recommended removing and replacing both existing UV treatment systems, including control panels and power supplies, as well as the removal of the uninterrupted power supply (UPS) system (in the tunnel area). After subsequent discussions with the NKWD, Cornwell followed-up with Calgon UV representatives for additional data, information, and clarifications. From a virtual meeting in mid-January 2021, the NKWD expressed their preference to move forward with removing both UV treatment systems as well as the UPS system, but replacing only one of the UV disinfection treatment systems.

Cornwell intends to move forward with preparing design documents to replace UV Train #2, which is located in the Filter Pipe Gallery. Although this area is congested with filtration system piping and various other utility conduit and piping, this location affords the new UV reactor unit with sufficient upstream and downstream straight piping. As discussed below as part of the Fort Thomas diversion piping modifications work, an additional advantage of removing UV Train #1 and associated piping from service is it allows for an easier installation of the new diversion piping to discharge into Section 3 of the finished water clearwell, which will turn over the finished water more frequently and maintain the water quality when TMTP is not in regular operation.

The environmental conditions in the basement of the Main Treatment Building have had a negative impact on the Trojan UV systems operations and maintenance, particularly the control panels and power supplies. The distance between the reactor units and the control panels appears to be constrained to be 70 ft or less per Trojan UV recommendations, which likely factored in to where the current panels are located. However, due to utilizing electromagnetic ballasts, Calgon claims their control panels can be up to 500 ft from the UV reactor unit (TrojanUV utilizes electronic ballasts); therefore, Cornwell will prepare bidding documents with Calgon as the basis of design and for the installation of a new control panel and power supply panel(s) on the first floor in the area currently used as a break room and office work space.

The furniture, equipment and materials in the work space area will need to be removed or relocated (per NKWD guidance), and the control panel and power supply panel(s) will be installed in its place. This will minimize the distance between the UV reactor and control panel, and, more importantly, will allow the control panel and power supply panel(s) to be operated and maintained in an area with better environmental conditions.

The UPS system for the UV unit is not recommended for replacement for several reasons:

- The plant is scheduled for a full backup generator system to be installed over the next 18 months.
- NKWD is providing the UV system as a proactive measure for enhanced treatment. Interim temporary loss of power would not create a violation of current treatment regulations.
- Calgon, the proposed supplier, specifically does not recommend either UPS or line conditioning for the proposed unit.

Powdered Activated Carbon (PAC) Storage and Feed Systems

As discussed in the PER, the NKWD expressed a preference to have upgrades and improvements for the PAC system that included a bulk bag (supersack) unloader and feed system similar to that at the Memorial Parkway Treatment Plant, and to remain in the current dedicated space or located within the existing Chemical Building or other facilities. With height limitations in the existing space (approximately 15-ft from floor to ceiling) for PAC storage and feed systems, there did not appear to be adequate space in the Chemical Building without major structural modifications; therefore, Cornwell's recommendation in the PER was to construct a new, detached facility on-site. This would afford the NKWD to construct a dedicated facility with sufficient space and clearances, but came at a cost much higher than budgeted for. With that, the NKWD requested Cornwell explore alternatives consistent with the original intent – a bulk bag loading and feed system located within existing facilities.

All rooms and spaces within the Chemical Building are utilized for, or in support of, the water treatment chemical storage and feed systems. Upon further review, Cornwell determined the footprint of the current PAC room is similar to the space used for the filter aid storage and feed systems, but this area has a floor level lower than the main floor level by approximately 4-ft. The Memorial Parkway Treatment Plant has an Acrison bulk bag unloader system (Model 820), which has an overall height of approximately 18-ft. Within the sunken floor area for the filter aid systems, there is a floor-to-ceiling height of about 20-ft. Cornwell's proposal to switch the locations of the PAC and filter aid systems was acceptable to the NKWD with the understanding that structural, mechanical, and electrical modifications would need to be done within the Chemical Building to accommodate the new PAC storage and feed systems. In particular, the new area would need to be fully enclosed and constructed to comply with current code requirements and appropriate equipment as well as safety and health provisions. This approach appears to offer many advantages since a majority of the existing infrastructure should be able to remain in place and remains within the Chemical Building, including for the new filter aid storage and feed systems.

As discussed in further detail within the PER, the PAC system for TMTP will be flow paced with the raw water influent and capable of feeding PAC at rate of 2.3 cu ft/hr to 15.8 cu ft/hr. With the intermittent usage of the PAC system at the TMTP, the 90^{th} percentile monthly usage is approximately 2,500 lbs/month based on recent historical operating and maintenance data (2017-2020). A bulk bag of PAC is roughly 900 lbs, so the TMTP would have one active bag with two to three spare bags on hand.

Filter Aid Storage and Feed Systems

With switching the locations of the PAC and filter aid systems, the existing filter aid storage and feed equipment will not be relocated. The equipment has been in service for quite some time and, more importantly, oversized for its current usage and needs, particularly the solution mixing tank (approx. 800-gal). The original system utilized a dry polymer product, and the plant transitioned at some time later to a hybrid coagulant solution, which is the same product used as the primary coagulant aid for the water treatment. As part of the transition to the hybrid coagulant for filter aid, plant staff constructed a transfer line to the current filter aid storage and feed area utilizing the hybrid coagulant transfer pumps.

The trade name of the hybrid coagulant product utilized by the Taylor Mill Treatment Plant is ACS 2000 (from Aluminum Chemical Specialties, LLC), which is an aluminum chlorohydrate solution. The ACS 2000 solution is 50% aluminum chlorohydrate and 50% water, and has a density of 1.34 g/mL. The stored product for filter aid is further diluted with water to a 50/50 product-to-water ratio prior to feeding. The diluted product is fed a dose rate of approximately 1.0 mg/L. The Taylor Mill Treatment Plant will use the diluted filter aid product at the beginning of start-up if the plant has been out of service for some time, and feed for typically 15-20 mins (30 mins is used for sizing new storage and feed systems). Based on recent historical plant operating data, it is not uncommon for the Taylor Mill Treatment Plant to be out of service for several days, weeks, and even months during the year.

The new filter aid storage and feed equipment will be housed in the old PAC Room, and has supporting infrastructure and equipment in place – water service, emergency eyewash and shower, electrical, mechanical/HVAC, fire suppression, etc. Once the old PAC equipment has been removed and the room thoroughly cleaned, the new filter aid systems will be installed along with a small containment curb and equipment can be quickly connected to existing utilities.

Hose connections will be integrated with the piping to allow for occasional flushing to mitigate concerns with the product crystalizing and clogging the lines.

The new filter aid storage system will continue to utilize the hybrid coagulant transfer pumping system, and new transfer piping will be extended in the overhead chemical containment tray to the new storage and feed area (i.e., old PAC Room). With an average plant flow rate of 6 mgd and dosage of 1.0 mg/L, around 0.4 gal/day of solution is used, or approximately 12 gal for a 30 day minimum storage. With that, a 50-gal FRP tank with a cone bottom will be set on an elevated stand, and neat ACS 2000 will be fed directly into the top of the tank along with a (cold) water supply to allow plant staff to manually dilute the product to a 50% concentration. A tank mixer with a continuous duty rated motor will keep the solution suspended to prevent it from crystalizing.

With a minimum plant flow of 3 mgd and a plant capacity flow of 10 mgd, the metering pumps should be capable of feeding within a range of 29 mL/min to 98 mL/min (at 1.0 mg/L feed dosage). There are currently two separate filter aid injection points when the filter aid is utilized due to the construction and configuration of the settled water effluent flows from the clarifier basins, and filter aid polymer is typically fed at both injection points when in service. A peristaltic metering pump will be installed for each feed point location and a pipe/valve manifold will allow staff to direct the product to the desired location or to one location if necessary (e.g., a clarifier basin is out of service). A third peristaltic metering pump will be furnished and available to back up/replace one of the installed pumps. If one of the installed pumps cannot be easily repaired, the backup pump can be easily installed and plugged in to immediately be placed into service.

Summary and Recommendations – PAC Storage and Feed Systems

Within the existing Chemical Building, the PAC and filter aid systems will switch locations, which will allow a bulk bag unloader and feed system to be installed with sufficient space and clearances. The new PAC area will need to be enclosed and equipment and materials will be designed to be suitable for a hazardous (explosive dust) environment, including structural materials, electrical, and mechanical/HVAC. Existing infrastructure and utilities in this area will be repurposed and easily connected to for continued use and support for PAC operations and maintenance. The PAC room will utilize the active bulk bag and up to three additional bulk bags will be maintained in the old PAC room until needed. With the removal of the equipment and stairs, new filter aid storage and feed equipment will be installed in the old PAC room. Existing infrastructure and utilities will be repurposed and easily connected to for continued use and support for filter aid operations and maintenance.

Concrete and Structural Repairs

The original scope of work requested Cornwell assess and provide recommendations for existing structural and concrete elements related to the clarifier basins, flocculation basins, and the below-ground walkway tunnel between the Chemical Building and the Main Treatment Building. In the PER, Cornwell presented the findings and recommendations in two categories – Type A for urgent work or repairs and Type B for work or repairs to be addressed at the earliest opportunity. In Table 4 below, budgetary cost estimates for the recommended work or repairs was included with the PER. Note, a larger than normal contingency was utilized since the clarifier basins were only drained down a few feet during this site visit and Cornwell was only able to visually observe the concrete surfaces above the water line.

Table 4. Structural Repairs at the Taylor Mill Treatment Plant (Nov 2020)

Item	Cost	Comment
A – Urgent Structural Work		
Repair Corbel and Expansion Joint	$20,000	
Repair Cracks in Launders Troughs and in Tunnel and Clarifier Basins	$60,000	
Repair Surface Spalls in Launder Troughs with Epoxy-Modified Repair Mortars	$240,000	
Subtotal – A	$320,000	
Contingency – A	$160,000	50%
Total – A	**$480,000**	
B – Structural Items to be Addressed at the Earliest Opportunity		
Removed Failed Concrete Repairs/Repairs with Epoxy-Modified Repair Mortars	$120,000	
Epoxy-Modified Repair Mortar to Cover Exposed Reinforcing Steel (Launder Troughs)	$10,000	
Repair Corroded Steel for Metal Platforms (Flocculators)	$2,000	
Prepare/Recoat Exposed Metal Platforms/Walkways (Flocculators)	$25,000	
Apply Epoxy Coating to Interior Surface of Launder Troughs	$68,000	
Repair Foundation at North Side of North Sedimentation Clarifier Basin	$3,000	
Subtotal – B	$228,000	
Contingency – B	$57,000	25%
Total – B	**$285,000**	
TOTAL, ALL STRUCTURAL WORK (A+B)	**$765,000**	

Subsequent discussions with the NKWD indicated the assessment revealed the structural work was quite extensive and costly, but also agreed all the work recommended was necessary to complete and should be part of the current design scope of work. As the clarifier and flocculation basins were not able to be fully drained during the original site visit in August 2020, Cornwell, as authorized by the NKWD, was able to conduct another site visit in February 2021 to inspect the fully drained basins to confirm the extent of the structural work and repairs, as well as further refine the budgetary cost estimates for structural repair work. The updated recommendations and budgetary cost estimates for structural repair work is provided below in Table 5. As seen, there were additional repair items discovered during the second site visit, but, overall, there was a reduction in the total budgetary cost for structural repair work due to the crack repair work for the troughs and tunnel not being in as a deteriorated state as assumed, and the contingency for all work was reduced (to 20%). A trip report for the structural inspection and recommended repairs, including updated cost estimates are enclosed with this engineering memorandum.

Table 5. Updated Structural Repairs at the Taylor Mill Treatment Plant (March 2021)

Item	Cost	Comment
Repair Corbel and Expansion Joint	$20,000	
Repair Cracks in Launders Troughs and in Tunnel and Clarifier Basins	$42,000	
Repair Surface Spalls in Launder Troughs with Epoxy-Modified Repair Mortars	$240,000	
Removed Failed Concrete Repairs/Repairs with Epoxy-Modified Repair Mortars	$120,000	
Epoxy-Modified Repair Mortar to Cover Exposed Reinforcing Steel (Launder Troughs)	$10,000	
Repair Corroded Steel for Metal Platforms (Flocculators)	$2,000	
Prepare/Recoat Exposed Metal Platforms/Walkways (Flocculators)	$25,000	
Apply Epoxy Coating to Interior Surface of Launder Troughs	$68,000	
Repair Foundation at North Side of North Sedimentation Clarifier Basin	$3,000	
Repair Cracks in Clarifier Basin Floors	$18,000	
Remove/Replace Coating on Clarifier Basin Floors	$42,000	
Patch Coating on Clarifier Basin Walls	$5,000	
Subtotal	$595,000	
Contingency	$119,000	20%
TOTAL, ALL STRUCTURAL WORK	**$714,000**	

Alternatives Assessment – Stainless Steel and Fiberglass Clarifier Troughs

The subsequent site conducted in February 2021, Cornwell was able to inspect the clarifier basins fully-drained as well as visually inspect the flocculation basins fully drained. In the updated budgetary cost estimates above in Table 4, the total budgetary estimated cost for the recommended clarifier effluent trough concrete repair work is $381,600. Bear in mind, these costs include all materials, equipment, and labor as well as a 20% contingency for the repair work.

As discussed with the NKWD and an alternative to repairing the existing concrete clarifier troughs, Cornwell requested budgetary material cost estimates for comparable sized troughs constructed of stainless steel and fiberglass reinforced plastic (FRP) from two different manufacturer representatives. The existing concrete troughs are roughly 24-in wide by 36-in deep, and there is a total of approximately 512 lin. ft of troughs between the two basins (256 lin. ft. each). For FRP, the NKWD could expect the material cost range for the size and quantity of troughs needed to be between $159,000 and $296,000. Similarly, for stainless steel (Type 304), the NKWD could expect the material cost range for the size and quantity of troughs needed to be between $120,000 and $365,000. Based on these material cost estimates alone, the alternative materials of construction did not appear to provide an economical advantage over the concrete repair work, and could result in higher overall costs once equipment costs, labor costs, and other typical mark-ups are included.

Additionally, it is understood that the long-term plan for the Taylor Mill Treatment Plant to make significant plant upgrades and improvements in approximately 10-years highlighted with the construction of granular activated carbon GAC) treatment facilities, which will impact the existing clarifier and flocculation basins. With these future plans in mind, there does not appear to be a compelling argument or advantage to removing the existing concrete troughs and replacing with stainless steel or FRP. Unless otherwise advised, Cornwell will prepare bidding documents for the concrete repair work as recommended in the PER.

Summary and Recommendations – Structural Repair Work

A second site visit and inspection of the drained clarifier basins revealed the concrete cracking associated with the clarifier troughs was not as severe as initially estimated. The additional visit did expose concrete cracking and coating deterioration in need of repair on the clarifier basin floors and walls, which resulted in additional costs in the updated budgetary cost estimates. With the second site visit, nearly all exposed concrete surfaces were able to be visibly inspected, and, as a result, the contingency cost, or estimated percentage, was reduced to 20% for all recommended items.

Cornwell also looked into removing and replacing the clarifier effluent troughs with alternative materials of construction, particularly stainless steel and FRP. However, the material costs alone for both alternative options indicate the cost benefits of stainless steel or FRP should not be considered. Quotes Cornwell received from vendors showed material costs for equivalent sized stainless steel (Type 304) troughs ranged from $120,000 to $365,000, and FRP troughs ranged from $159,000 to $296,090. Due to the high material costs, Cornwell did not evaluate the alternative trough options further plus the costs, particularly for the stainless steel, has been steadily increasing over the past year or so and is expected to continue with that trend for the foreseeable future. With that, Cornwell intends to prepare bidding documents for all recommended structural repair items noted above in Table 4.

Fort Thomas Diversion Piping Modifications

Cornwell considered several options in the PER and presented a few options for the TMTP to discharge Fort Thomas finished water to Section 3 of the finished water clearwell, which is the first section of the clearwell. The NKWD preferred the option to modify the Fort Thomas piping in the basement of the Main Treatment Building to allow for the Fort Thomas water to be directed to Section 3 as well as maintain the existing diversion piping, fittings, and valves to Section 1, which is the clearwell under High Service Pump Nos. 1, 2, and 3 (and the backwash supply pump). This option was also the least expensive.

The NKWD is concerned about funding constraints for the work to be done with all the proposed upgrades and improvements to be done with this project. The NKWD would like Cornwell to prepare bidding documents for the Fort Thomas diversion piping modifications, but as an option bid item with the optimistic expectations of being able to approve and authorize the Contractor to execute the diversion piping work as part of this project. From earlier, another advantage of removing UV Train #1 and associated piping is that should allow for an easier installation of Fort Thomas diversion piping to Section 3 of the clearwell and downstream of UV Train #2, which will allow for maximum flushing and turnover of the clearwell, and especially when the Fort Thomas water is the only supply in operation.

CONCLUSIONS

The on-going discussions with the NKWD and second site visit afforded Cornwell the opportunity to continue to refine the recommendations for upgrades and improvements, and, more importantly, the budgetary cost estimates for the proposed work as seen below in Table 3, repeated below. As seen, the current total estimate for the recommended work, including the optional bid item, is slightly less than the preliminary budget set aside for this work. Cornwell will prepare a budgetary cost estimate update with each deliverable as the design work progresses, Subject to approval of the additional design scope of work, Cornwell will prepare bidding documents for:

- Removing the two existing UV disinfection treatment systems, including the UPS system and piping;
- Installing one new UV treatment system in the place of UV Train #2;
- Installing the new UV treatment system control panel on the first floor;
- Removing the PAC and filter aid systems in the Chemical Building and prep for new operations;
- Installing a PAC bulk bag feeder system and enclose the new (former filter aid) area;
- Installing a new filter aid storage and feed system in the new (former PAC) location;
- Performing all recommended structural repair work;
- Installing the Fort Thomas diversion piping modifications as an optional bid item.

Table 3. (REPEATED) Updated Budgetary Construction Cost Estimates for Design Work (March 2021)

Items	Estimated Cost
UV System Improvements	$450,000
PAC Bulk Bag Feeder System (incl Filter Aid)	$690,000
Concrete Repairs	$714,000
Ft Thomas Diversion Piping Modifications (Optional Bid Item)	$195,000
Total	**$2,049,000**

3/1/21

Gerald Wright
Cornwell Engineering Group
712 Gum Rock Court
Newport News, VA 23606

Re: Northern Kentucky Water District Taylor Mill
LM Project No: G20.092

Dear Mr. Wright

Lynch Mykins Structural Engineers. PC visited the Northern Kentucky Water District's Taylor Mill Water Treatment Plant on February 4, 2021. The purpose of the visit was to perform visual observations of sediment basin after the water was drained.

The Structural sheets of the "The Taylor Mill Water Treatment Plant Electrical and Basin Improvements" drawings dated January 2014 with a Record Drawing stamped 08/24/16 were made available for use during the investigation.

This report is an addendum to the report prepared by Lynch Mykins Structural Engineers for this project dated 11/11/20 and must be used in conjunction with this referenced report.

OBSERVATIONS

Observations were made of visible structural members. No Testing of Material was performed. No finishes, standing water or earth was removed to expose the structure.

Photographs of observed damage are included in Appendix I of this report. The locations the photos were taken are indicated in the Photograph Location Plans Included in Appendix II of this report.

<u>Basins</u>

The interior of the sediment basins were drained observed from inside the basin. The flocculator basin were drained and the flocculator basin walls were observed from the upper deck. The basin walls and floors were not cleaned from sediment.

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South Basin

The south basin is exhibiting cracking through the basin floor. These cracks have been previously repaired with an epoxy injection repair. Refer to photographs P7-S, P8-S and P10-S.

The cracks in the basin floor primarily align with expansion joints in the basin walls. Refer to photograph P-9S and attached Photo Location Diagram and Crack Location Sketch in Appendix II.

Additional cracks were noted, the observed cracks were previously repaired with epoxy injection. Refer to Photograph P12-S.

Basins walls were covered with a layer of sediment. No major cracks were observed through the sediment layers. Refer to photographs P1-S, P2-S, P3-S.

Some minor erosion of the concrete wall surface was observed, refer to photograph P4-S and P5-S.

Minor corrosion noted on the trough screens, refer to photograph P13-S.

North Basin

Parts of the basin floor was covered with ice a layer of sediment at the time of observations. Refer to photographs P1-N and P3-N.

The North Basin is exhibiting cracking through the basin floor. Refer to photographs P2-N, P4-N, P6-N, P7-N.

Basins walls were covered with a layer of sediment. No major cracks were observed through the sediment layers. Refer to photograph P2-N.

Several cracks were previously repaired with what appears to an epoxy patch. Refer to photographs P2-N, P5-N, P11-N and P12-N. These patches appear to be failing.

The coating on the basin floor is coming loose. Refer to photograph P13-N.

Flocculator basins

Surface erosion of the concrete walls were noted in all the flocculator basins.

RECOMMENDATIONS

For both sediment basins, all loose repair materials and the coating should be removed from the basins' floor. This is typically performed with hydro-demolition equipment. Once removed the cracks shall be repaired as described below. Once all cracks have been repaired it is recommended to install a new sealant on the basin floors such as a BASF MastersSeal 581.

For the sediment basin walls, areas of failed coating should be removed and recoated. The failure of the wall coating does not appear to be widespread and can be done at failed areas only with the BASF MasterSeal 581.

<u>South Basin</u>

The cracks that run between the expansion joints were previously repaired with an injected epoxy. These repairs are failing in several locations. These cracks are subject to movement therefore a flexible joint should be installed in lieu of another epoxy repair. The repair requires the joint to be opening up with a router and filled with a flexible silicone caulk. Since these repairs will be subject to the sediment arm continuously crossing the repair the caulking used should be traffic rated.

For the cracks that are not aligned with an expansion joints the cracks should be repaired with a gravity fed high modulus, low viscosity high strength epoxy. This will involve widening the surface of the crack and filling the crack with epoxy in accordance with the epoxy manufacturers installation instructions.

<u>North Basin</u>

It should be assumed that all existing epoxy repairs have failed. All observed cracks in this basin should be repaired with a gravity fed high modulus, low viscosity high strength epoxy. This will involve widening the surface of the crack and filling the crack with epoxy in accordance with the epoxy manufacturers installation instructions.

<u>Flocculator Basins</u>

The surface of the concrete walls was observed to be pitted from erosion. The current conditions do not appear to be affecting the structural integrity of the system. No repairs are recommended to the flocculator basins at this time

Updated Opinion of Probable Cost

The opinion of probable cost for the structural repairs for the entire scope of the project was updated to consider observations included in this report.

The opinion of probable cost for urgent structural repairs includes the following:

1. Repair of the Corbel and re-working the expansion joint at the corbel location. $20,000.00
2. Repair cracks in the troughs, tunnel and basins by pressure injection. $42,000.00
3. Repair surface spalls in troughs with epoxy modified repair mortars. $240,000.00

The opinion of probable cost for structural repair to be addressed in the near future includes the following:

1. Remove failed concrete repairs and replace with epoxy modified repair mortar. $120,000.00
2. Provide cover over exposed reinforcing with epoxy modified repair mortar. $10,000.00
3. Repair of corroded steel at walkways. $2,000.00
4. Recoating exposed structural steel with zinc rich paint. $25,000.00
5. Application of an epoxy coating to the surface of the troughs. $68,000.00
6. Install foundation under exterior basin stairs and fill voids. $3,000.00
7. Repair cracks in the sediment basin floors. $18,000.00.
8. Remove and replace coating on sediment basin floors. $42,000.00.
9. Patch failed coating on basin walls. $5,000.00.

The total Opinion of Probable Cost for structural repairs is Seven Hundred Fourteen Thousand Dollars ($714,000.00). This total allows for a 20% contingency for unforeseen conditions.

Conclusion

This report represents a professional opinion of the condition of specific structural elements identified above and is based upon the results of our limited observations. This letter is not intended to be a complete or comprehensive study of the structure.

Work has been performed in accordance with generally accepted principles and practices of structural engineering. Lynch Mykins cannot be responsible for any future changes in the condition of the structure. No other warranty is provided, either expressed or implied. If new conditions are observed, this office should be contacted so that the findings and conclusions can be reviewed and revised, if necessary.

We appreciate the opportunity to be of service to you. If you have any questions, or need additional information, please do not hesitate to call.

Sincerely,
LYNCH MYKINS STRUCTURAL ENGINEERS, PC

Michael Behm, EIT
Structural Investigator

Zachary J. Miller, P.E.
Project Engineer

Enclosure: Appendix I - Photographs
Appendix II – Photo Location Sketch

APPENDIX I

P1-N

P2-N

P3-N

P4-N

P5-N

P6-N

P7-N

P8-N

P9-N

P10-N

P11-N

P12-N

P13-N

O 

P1-S

P2-S

P3-S

P4-S

P5-S

P6-S

P7-S

P8-S

P9-S

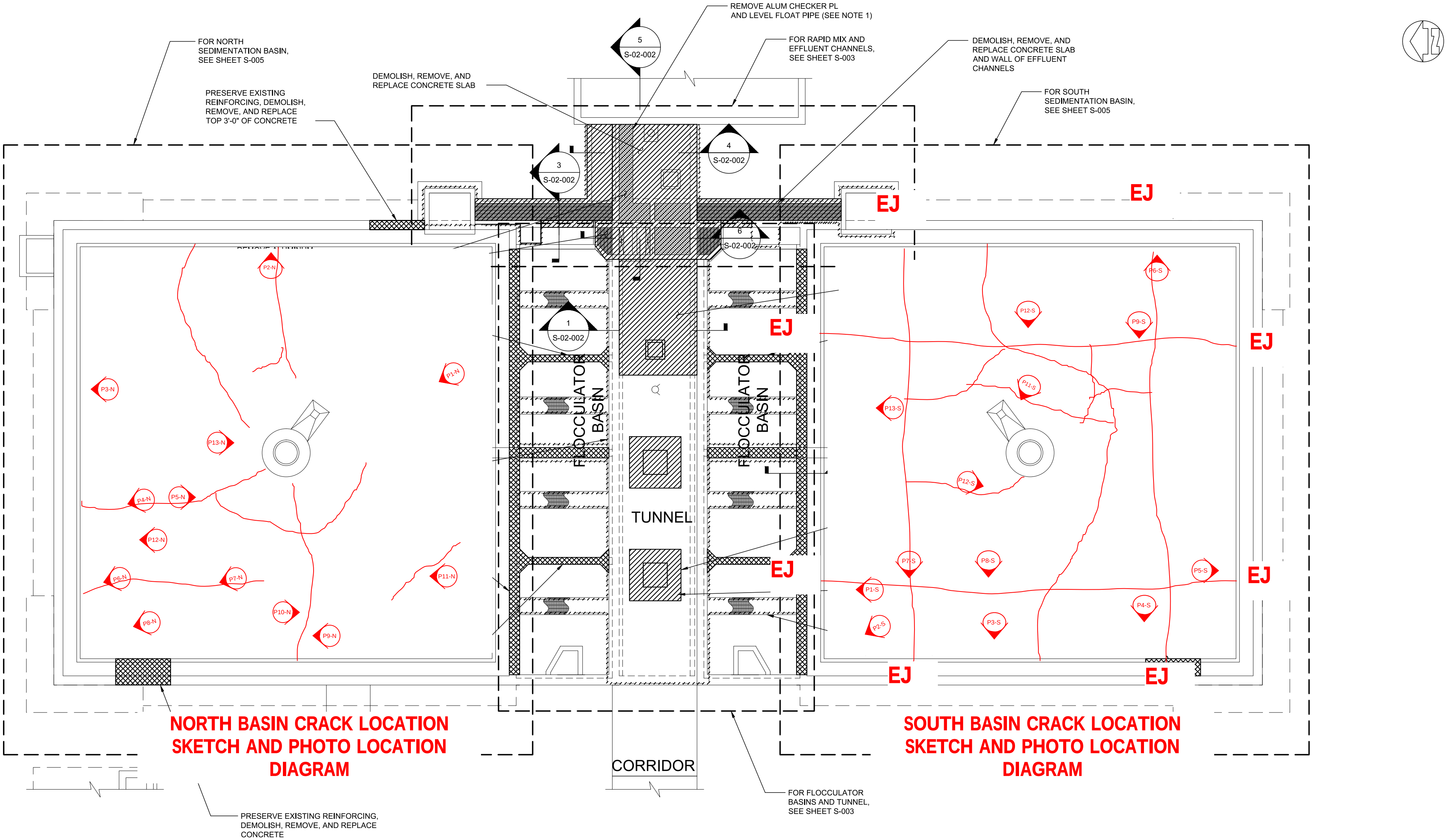
P10-S

P11-S

P12-S

P13-S

APPENDIX II



NORTH BASIN CRACK LOCATION SKETCH AND PHOTO LOCATION DIAGRAM

SOUTH BASIN CRACK LOCATION SKETCH AND PHOTO LOCATION DIAGRAM

Northern Kentucky Water District

EXHIBIT A-4

ENGINEER'S OPINION OF PROBABLE TOTAL CONSTRUCTION COST

		$ 3,770,000	**matches amount NKWD put in request for SRF funds**		
General Construction					
	Concrete Construction	$ 850,000		$ 10,000	pac
			$ 827,000	$ 817,000	basin repair
	Demolition	$ 275,000		$ 30,000	pac (& filt aid)
				$ 50,000	uv
				$ 180,000	basin repair
			$ 272,000	$ 12,000	diverter
	General Consruction	$ 294,000	$ 294,000		
Building Construction					
	Electrical Contractors	$ 170,000		$ 128,000	pac
				$ 25,000	uv
			$ 173,000	$ 20,000	diverter
	HVAC	$ 110,000		$ 110,000	pac (& filt aid)
	Masonry	$ 100,000		$ 100,000	pac
	Plumbing	$ 50,000		$ 50,000	pac
	Roofing	$ 20,000		$ 20,000	pac
	Wiring	$ 152,000		$ 100,000	pac (& filt aid)
				$ 32,000	uv
			$ 152,000	$ 20,000	diverter
Roadway Construction	NONE				
Water Line Construction					
	PVC, DIP Supplier	$ 240,000		$ 60,000	pac (& filt aid)
				$ 30,000	uv
			$ 240,000	$ 150,000	diverter
	Water Line Work	$ 200,000		$ 50,000	pac (& filt aid)
				$ 40,000	uv
			$ 190,000	$ 100,000	diverter
	Water Valve Supplier	$ 139,000		$ 60,000	pac (& filt aid)
			$ 139,000	$ 79,000	diverter
Sewer Construction	NONE				
Specialized Construction					

	Safety Equipment Installation	$ 20,000	$ 20,000		
Supplier					
	Water Treatment Chemicals & Equipment	$ 1,150,000		$ 600,000	pac (& filt aid)
				$ 550,000	uv
			$ 1,150,000	$ -	diverter

PAC	$ 1,318,000	
UV	$ 727,000	
Structural	$ 997,000	
Diverter	$ 381,000	
misc	$ 314,000	$ 3,737,000

6/5/2026