US Army Corps
of Engineers
Louisville District®

2019

Louisville Metro Flood Protection System

Louisville, Kentucky Riverfront

Emergency Supplemental Reconstruction Feasibility Study with Integrated Environmental Assessment

Louisville Metro Flood Protection System
Emergency Supplemental
Volume 1

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1 STUDY INFORMATION AND BACKGROUND

1.1 Overview

This report documents the results of a Feasibility Study initiated in response to Section 216 of the Flood Control Act of 1970 (Public Law 91-611) and Bipartisan Budget Act of 2018 (Public Law 115-123). This study was developed as a cooperative effort by the United States Army Corps of Engineers (Corps) Louisville District and the Louisville/ Jefferson County Metropolitan Sewer District (MSD), the Non-Federal Sponsor. MSD is the local agency responsible for sanitary and storm sewer systems in Jefferson County, Kentucky and assumed responsibility for stormwater and flood risk management in 1987. On October 10, 2018 the Corps and MSD executed a Feasibility Cost Share Agreement (FCSA) to initiate this study to investigate the need and level of federal involvement in the reconstruction of aging facilities in the Louisville Metro Flood Protection System (LMFPS), which serves over 215,000 residents and approximately 86,000 structures in the leveed area (area of the city that would be flooded if the river were as high as the top of levee but the levee was not there).

1.2 Study Authority

The authority to conduct feasibility studies examining the reconstruction of structural flood damage reduction projects and separable elements constructed by the Corps is Section 216 of the Flood Control Act of 1970 (Public Law 91-611) which states:

> *The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to significant changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest.*

Additional authority for this study is contained in the Bipartisan Budget Act of 2018 (Public Law 115-123), Division B, Subdivision 1 Title IV which reads in-part:

> *For an additional amount for "Investigations" for necessary expenses related to the completion, or initiation and completion, of flood and storm damage reduction, including shore protection, studies which are currently authorized or which are authorized after the date of enactment of this subdivision, to reduce risk from future floods and hurricanes, at full Federal expense, $135,000,000, to remain available until expended: Provided, That of such amount, not less than $75,000,000 is available for such studies in States and insular areas that were impacted by Hurricanes Harvey, Irma, and Maria: Provided further, That funds made available under this heading shall be for high-priority studies of projects in States and insular areas with more than one flood-related major disaster declared pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.) in calendar years 2014, 2015, 2016, or 2017: Provided further, That such amount is designated by the Congress as being for an emergency requirement pursuant to section 251 (b)(2)(A)(i) of the Balanced Budget and Emergency Deficit*

Control Act of 1985: Provided further, That the Assistant Secretary of the Army for Civil Works shall provide a monthly report to the Committees on Appropriations of the House of Representatives and the Senate detailing the allocation and obligation of these funds, including new studies selected to be initiated using funds provided under this heading, beginning not later than 60 days after the enactment of this subdivision.

1.2.1 Application of the Section 216 Study Authority

Since completion of the LMFPS, the City of Louisville has experienced significant intensification in development across the city demonstrating both changed physical and economic conditions. One direct result of development is increased impervious surfaces and tree loss in the city's urban core. In a report released in 2014 by the Georgia Institute of Technology, researchers found that since the 1960's the average temperature in urban areas of Louisville has risen more than surrounding areas at a higher rate than any other city in the country due to loss of tree canopy and increased impervious surfaces. Beyond temperature increases, impervious surfaces and tree loss have resulted in a direct impact on the volume and rate that surface water reaches the city's interior drainage system. Upstream from Louisville, the Corps has constructed a total of 60 reservoirs since completion of the first reach of the LMFPS in 1956.

Another aspect of changed conditions, relative to the Section 216 study authority, is the significant expansion in capital investment in Louisville since the time of project construction. Current estimates of structure and content values are over $60 billion (2019 dollars) in the leveed area, which is bolstered by major investments since project construction by companies such as United Parcel Services, General Electric and the Ford Motor Company. Growth has also occurred in other business sectors with a footprint in the leveed area from companies such as Humana, Kindred Healthcare, Norton Healthcare, Brown Forman Corporation and the University of Louisville. As a comparison, the 1937 flood (which generally inundated the same portion of the city as the current leveed area) resulted in approximately $1 billion in damages indexed to current price levels.

1.3 Study Purpose

The purpose of this Feasibility Study is to investigate the need and level of federal involvement in the reconstruction of aging facilities in the LMFPS, which serves over 215,000 residents and approximately 86,000 structures according to the National Structure Inventory 2.0 (NSI2).

In general, the predominant issues with the LMFPS are: (1) the reliability of out-of-date and failing equipment at pump stations where replacement parts are no longer available; and (2) closures, gates and floodwall segments that have exceeded their service life or degraded.

1.4 Study Scope

The procedures to accomplish the LMFPS Feasibility Study are contained in CECW-PB Memorandum, Subject: *Reconstruction of U.S. Army Corps of Engineers Structural Flood Damage Reduction Projects for which Non-Federal Interests are Responsible for Operation, Maintenance, Repair, Rehabilitation, and Replacement*, dated 16 AUG 2005 (August 2005 Reconstruction Guidance). This policy guidance outlines

the decision logic for evaluating the existing project for potential reconstruction, which consists of addressing performance deficiencies caused by a long-term degradation of the foundation, construction materials, and engineering systems that have exceeded their expected service lives and the resulting inability of the project to perform its authorized project functions. Volume 1, Appendix D contains the full text of the memorandum.

The decision logic outlined in the August 2005 Reconstruction Guidance is sequential and informed the overall study progression in assessing project needs, as well as determining which components of the LMFPS qualify for reconstruction. The following categories are summarized below from the August 2005 Reconstruction Guidance:

1. If higher level or expansion of flood damage reduction is pursued, address as a typical flood risk management study and include a full range of alternatives and economic evaluation (see August 2005 Reconstruction Guidance, paragraph 3.g.);
2. If design or construction deficiency, address deficiency under existing authority cost shared (see August 2005 Reconstruction Guidance, paragraph 3.d.);
3. If maintenance deficiencies, address under existing authority cost shared (see August 2005 Reconstruction Guidance, paragraph 3.c.);
4. If long-term degradation and/or exceeded service life, address as reconstruction with new authority with current design and safety standards (see August 2005 Reconstruction Guidance, paragraph 3.e.);
5. If no change to the scope and function of the project, evaluation can be limited to individual project features to establish the justification of reconstruction based on a comparison between the "with" and "without" reconstruction condition.

During the plan formulation process (Section 4) it was determined that this Feasibility Study would be limited to an examination of the reconstruction of features in the LMFPS with no change in their scope or function. According to Paragraph 3.g of the August 2005 Reconstruction Guidance, depending on the interest of the non-federal sponsor, the feasibility study may be limited to examination of the reconstruction of the existing project with no change in its scope or function. Under this limited objective, evaluation would be limited to individual project features to establish the justification of reconstruction based on a comparison between the "with" and "without" reconstruction condition.

The economic evaluation efforts associated with the LMFPS Feasibility Study were conducted primarily around a limited reconstruction objective which produces no change in the original project's scope or function. As such, traditional economic evaluation procedures were not utilized and the Project Delivery Team (PDT) and Vertical Team (VT) decided to evaluate the benefits of the LMFPS on a system wide basis, based on annualized flood damages reduced by the project since its construction. It should be noted that the PDT did, however, engage in a preliminary evaluation of scope changes to the existing project via expanded capacities amongst numerous pump stations and potential changes in condition due to climate change. If in the event that any pump station warranted further evaluation upon the preliminary analysis on capacity increase, the intent of the PDT was to then study each pump station on

an individual risk based examination of incremental benefits, as directed by the expanded scope described in the 2005 Reconstruction Guidance. Ultimately, no such analysis was necessary.

The methodology, interpretation of the 2005 Reconstruction Guidance, and evaluation framework established and used for the LMFPS Feasibility Study was vetted through the VT which included representatives from the Great Lakes and Ohio River Division (LRD), Planning Center of Expertise for Flood Risk Management (FRM-PCX), U.S. Army Corps of Engineers – Headquarters (HQUSACE), and Office of Water Project Review (OWPR). It was also presented and agreed upon after the LMFPS Scoping Charrette (December 12, 2018), In-Progress Review with LRD (February 15, 2019), Alternative Milestone Meeting (February 28, 2019) and the Tentatively Selected Plan (TSP) milestone meeting (September 27, 2019).

1.5 Background on the August 2005 Reconstruction Guidance

The Corps was given authority by Congress to construct flood damage reduction projects with the Flood Control Act of 1936 (Public Law 74-738). Section 3 of that Act contained the stipulation, in part, that no appropriated funds shall be expanded on construction until "…responsible local agencies have given assurances…that they will…maintain and operate all of the works after completion in accordance with regulations prescribed by the Secretary of War." Subsequently, regulations governing the operation and maintenance of local flood protection projects were issued by the Secretary and are contained in the Code of Federal Regulations, Chapter II – Corps of Engineers, Department of the Army, Section 208.10, of Title 33, Local flood protection works; maintenance and operation of structures and facilities. These regulations were incorporated by reference into the required Local Assurances provided by the non-Federal interests responsible for the operation and maintenance of local protection projects constructed under these rules.

Section 103 of the Water Resources Development Act of 1986 (Public Law 99-662), as amended, required that non-federal sponsors agree to pay 100 percent of the "operation, maintenance, and replacement and rehabilitation" costs of projects authorized in the 1986 and subsequent acts. This requirement has been incorporated into Project Partnership Agreements for flood risk management projects constructed subsequent to Public Law 99-662.

In the Water Resources Development Act of 1996 (Public Law 104-303), Section 402(f) directed the Corps to provide non-Federal interests with a "manual describing the maintenance and upkeep responsibilities that the Corps of Engineers requires of a non-Federal interest" for flood protection projects. In that same Section, Congress defines "maintenance and upkeep" as "all maintenance and general upkeep of a levee performed on a regular and consistent basis that is not repair and rehabilitation." The term "repair and rehabilitation" is defined as "repair or rebuilding of a levee or other flood control structure, after the structure has been damaged by a flood, to the level of protection provided by the structure before the flood" but does not include "repair or rebuilding…if, in the normal course of usage the structure becomes structurally unsound and is no longer fit to provide the level of protection for which the structure was designed."

The Corps of Engineers issued its 2005 Reconstruction Guidance providing the framework and describes the process for the studies needed to prepare documentation to justify Federal involvement in the reconstruction of flood projects that have been turned over to non-Federal interests for Operation Maintenance Repair, Rehabilitation and Replacement (OMRR&R).

1.6 Project Sponsor

MSD maintains and operates the levees and floodwalls along with sixteen flood pumping stations (the number of pumping stations now operated has changed over the years, due to the deletion and addition of several pumping stations by MSD). Ten of these pumping stations have been in service for more than sixty years, and for the most part, continue to operate with original equipment. MSD has repaired failed equipment as needed, but replacement parts are beginning to be increasingly more difficult to obtain as the original manufacturers are either no longer in business or stock replacement parts are not available and must be custom built.

The Code of Federal Regulations (CFR), Chapter II, Title 33, Section 208.10 (USACE, 2011), prescribes the regulations covering Operations and Maintenance (O&M) of flood damage reduction for structures and facilities. In general, Section 208.10 provides that structures and facilities constructed by the United States for local flood protection will be continuously maintained in such a manner and operated at such times, and for such periods as may be necessary, to obtain maximum benefits. Section 208.10 also sets the guidelines for the maintenance and operation of said facilities, including: levees, floodwalls, drainage structures, closure structures, pumping plants, channels and floodways, and miscellaneous other facilities.

Once facilities are constructed, local sponsor agreements are used by the Corps to transfer O&M of flood protection facilities to local units of government. The City of Louisville passed two resolutions, dated February 26, 1941, and August 24, 1953, in response to the Flood Control Act and its amendments. These resolutions adopted the plans to construct the original sections (that is, Louisville Reach) of the LMFPS and outlined how Louisville would furnish, without cost to the United States, all lands, easements, and rights-of-way necessary for the construction.

With the exception of the Beargrass Creek Pump Station, the Louisville Reach was transferred to the original Non-Federal Sponsor (City of Louisville) for O&M purposes in two parts between January 1953 and July 1954. The Beargrass Creek Pump Station was transferred to the City of Louisville in February 1957.

On August 17, 1971, the Jefferson County Fiscal Court passed a resolution authorizing the construction of the Southwestern Jefferson County Local Flood Protection project (that is, Southwestern Jefferson County Reach, also referred to as the Southwest Extension). Similarly, the resolution further outlined how Jefferson County would furnish the needed lands, easements, and rights-of-way and handle the relocations of structures, personal property, utilities, and other infrastructure. The Southwestern Jefferson County Reach was transferred to the Jefferson County Fiscal Court for O&M between November 1975 and November 1992 as functional pieces were completed.

In December 1986, MSD assumed responsibility for O&M of the LMFPS via a 50-year renewable lease/sublease and maintenance agreements with the City of Louisville and Jefferson County. MSD added the duties of a stormwater utility to its previous responsibilities as a wastewater utility, including inspections of floodwalls and levees along the Ohio River. As part of the O&M procedure, MSD's employees perform the following tasks:

- Maintain the concrete floodwall
- Maintain and mow the earthen levees
- Maintain, inspect, test, and operate the 15 flood pump stations that existed at that time
- Trial and flood install and dismantle the street closures
- Service the gates and openings along the floodwall
- Perform flood fighting activities when the Ohio River is at flood stage

Proper O&M requires that the Non-Federal Sponsor and its designated agents have a thorough understanding of the LMFPS infrastructure, the preventative maintenance required during normal river stages, and the operational procedures during flood emergencies.

MSD employees run the pumps for short periods of time every month to make sure they are still functioning. These pump stations still rely on most of the original equipment.
The original O&M manual was prepared by the Corps in 1954 for use by the City of Louisville, the Non-Federal Sponsor responsible for the O&M of the LMFPS at that time. The original O&M manual consisted of the following volumes (which have been updated several times since they were first prepared):

- O&M Manual No. 1, General O&M of Levee/Floodwall, Drainage Structures, Pump Plant and Miscellaneous Features;
- O&M Manual No. 2, Closure Structures; and
- O&M Manual No. 3, Beargrass Creek Flood Pump Station.

Updates to the original O&M manuals were developed in 1987 and 1988 (USACE, 1987a, 1987b, and 1988), when the Southwest Extension was completed, to cover the additional flood protection facilities. This O&M manual included a preventive maintenance program to proactively prevent breakdowns and failures of the pump station equipment. This program improved the integrity of pump station operations. An annual service contract is awarded to provide high voltage electrical maintenance on a biannual basis. Also, MSD staff visits each station monthly to run the pumps, motors, and gates to confirm all equipment is functioning. Two to four times a year, the gates are operated through 100 percent of their cycle (that is, full open to full close and back to full open). These exercises are used to identify gates that cannot be completely sealed and need rehabilitation or replacement.

In 2011, MSD initiated an effort to update and consolidate the former O&M manuals and produce digital documents that could be easily updated and modified in the future. The result of this effort was two updated LMFPS O&M manuals issued in January 2013. Volume 1 addresses the 16 pump stations within the LMFPS (USACE, 2013a), while Volume 2 addresses the entire levee and floodwall system including all

closures and flood control gates not associated with the pump stations (USACE, 2013b). These manuals assemble all the details essential for the satisfactory O&M of the LMFPS so that a maximum level of flood protection may be available during its lifetime. The manuals do not contain any information on proposed capital improvement projects as related to the LMFPS.

1.7 Location

1.7.1 Study Area

Jefferson County, Kentucky is situated within the broad floodplain of the south bank of the Ohio River and covers a land area of approximately 386 square miles. The City of Louisville is located within Jefferson County along the banks of the Ohio River and contains numerous smaller streams within its boundaries. In addition to the Ohio River, major streams of Jefferson County include Pond Creek, Beargrass Creek, Mill Creek and Floyds Fork (Figure 1). The floodplains of all streams in the county contain both residential and industrial developments, and a great deal of the residential development occurs in the areas in the vicinity of the expressway systems connecting the northeast and southwest portions of the county. The topography of Louisville-Jefferson County is mostly rolling, and the Ohio River floodplain areas have low relief characterized by a deep covering of Pleistocene outwash deposits of alluvial clay, silt, and gravel. The U.S. Census Bureau lists the 2018 estimated population for the consolidated Louisville-Jefferson County at 770,517.

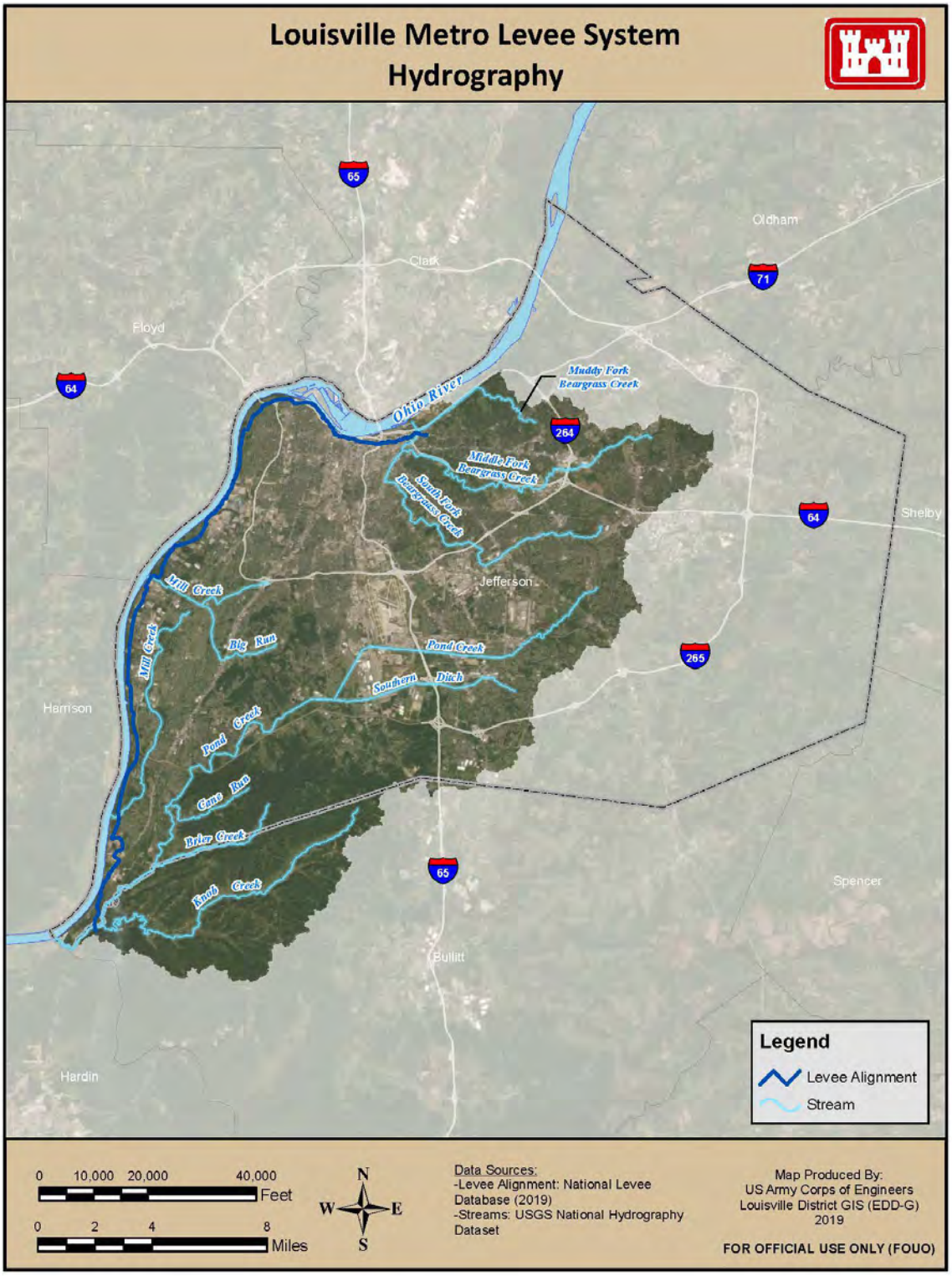


Figure 1: Ohio River Tributaries in Jefferson County, Kentucky

The Louisville levee system, which was built by the Corps, extends on the south bank of the Ohio River at Mile 602 to Mile 628.6 below Pittsburgh, Pennsylvania. Of importance, the system of 60 upstream Corps reservoirs (Figure 2) completed in 1997 would have reduced the 1937 flood at Louisville by about 3 to 5

feet. Major tributaries to the Ohio River, above Louisville include the Kentucky, Kanawha, Monongahela and Allegheny rivers which drain large portions of Pennsylvania, Ohio, West Virginia and Kentucky.

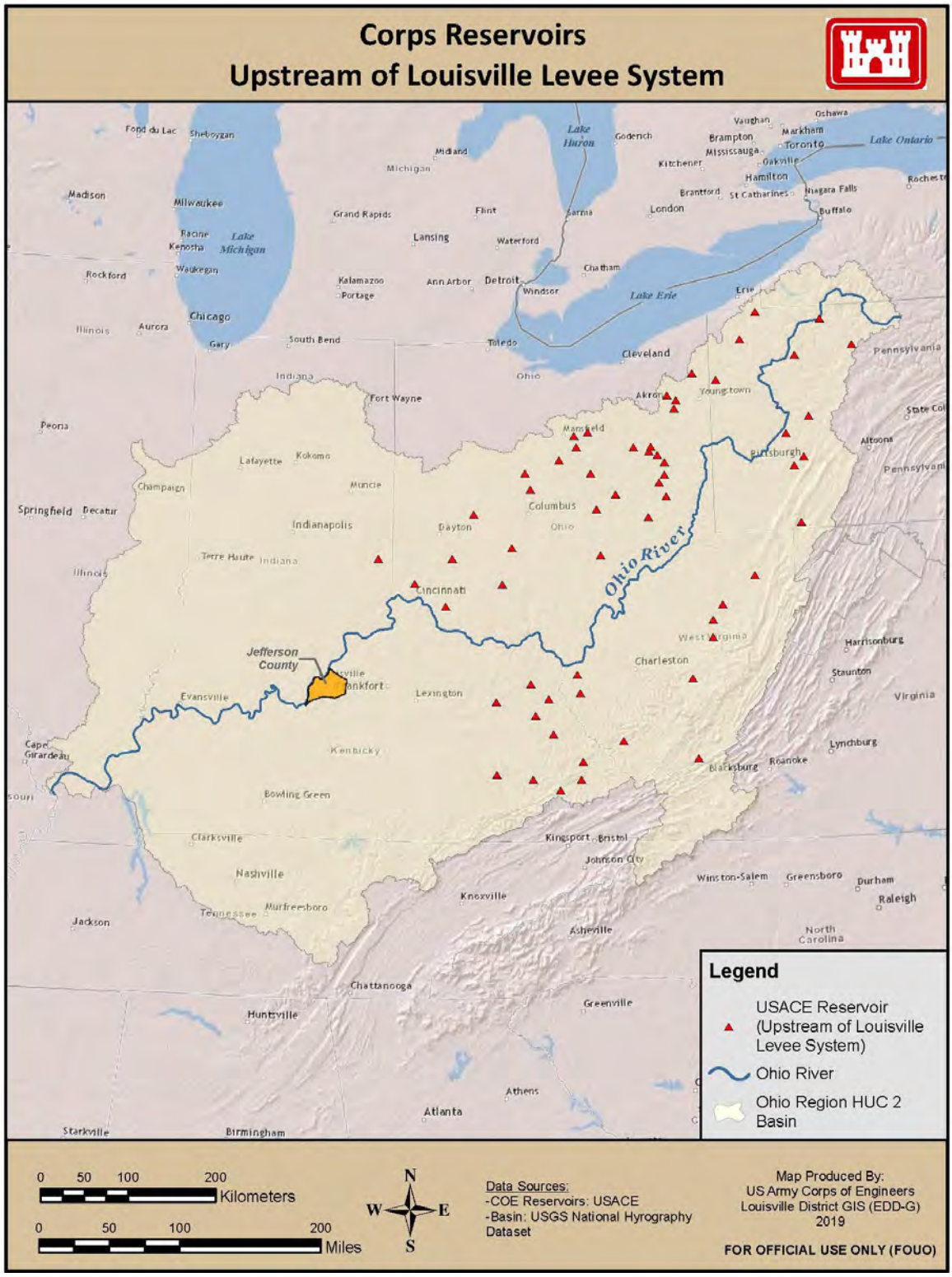


Figure 2: Corps of Engineer Reservoirs Upstream of Louisville, Kentucky

1.7.2 Project Area

The leveed area is heavily developed. The portion of the city east of downtown and in the Beargrass Creek drainage basin consists of mixed one to two story commercial and residential structures as well as a few historic religious buildings (Figure 3).

Figure 3: Beargrass Creek and Surrounding Neighborhood

The downtown central business area, which extends from Baxter Avenue in the east to 18th Street in the west, is densely developed with multi-story commercial structures and multi-family homes (Figure 4). From 18th Street west to the river, older, mostly single family homes comprise the majority of the development (Figure 5). The population in this section tends to consist of lower-income residents. South of Algonquin Parkway along the levee, there is significant chemical, industrial, and commercial development mixed with neighborhoods of one-story, single-family homes (Figure 6).

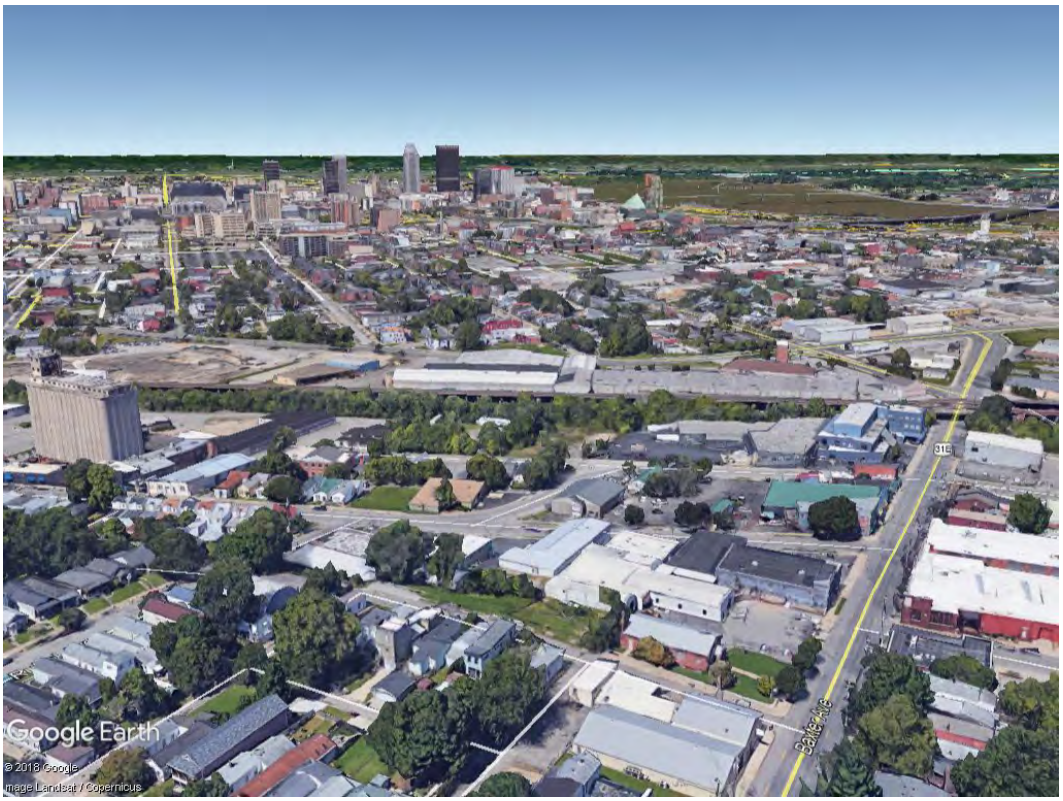


Figure 4: Looking West from Baxter Avenue

Figure 5: Typical Housing in West Louisville

Figure 6: Residential Adjacent to River Industry

Throughout the leveed area, there are also several pieces of infrastructure of regional significance that could be flooded in the event of a levee breach, including several local governmental headquarters and emergency management facilities. Regional power plants, the University of Louisville, and Louisville Muhammad Ali International Airport (including UPS Worldport) may also experience severe impacts in the event of a levee system breach.

1.8 Original Project Authorization and Construction

After devastating floods on the Ohio River in 1937, numerous flood damage reduction projects were planned and implemented by the Corps in the Ohio River Basin. Specifically, the LMFPS was constructed to reduce the risk of flooding from the Ohio River equal to the maximum flood of record (January 1937), plus an additional three feet of freeboard. The LMFPS is comprised of two distinct reaches which were authorized by two separate actions by Congress:

1) Louisville Reach: Flood Control Act approved June 28, 1938, as amended (PL 75-795)
2) Southwestern Jefferson County Reach: Flood Control Act approved August 13, 1968, as amended (PL 90-483)

Construction of the Louisville Reach occurred between 1947 and 1956. Assurance of local cooperation was given by the City of Louisville on February 28, 1941, acting by and through the Director of Public Works of the City of Louisville. A second assurance for local cooperation was signed by the City of

Louisville in August 1971 and construction of the Southwestern County Jefferson Reach occurred between 1973 and 1989.

Upon completion of the Louisville and Southwestern Jefferson County Reaches (1956 & 1989) the Non-Federal Sponsor assumed responsibility for Operation & Maintenance (O&M) of the LMFPS from the federal government. The original project assurances between the Non-Federal Sponsor and federal government in the 1950s and 1970s make no mention of Repair, Rehabilitation, and Replacement (RR&R). The term, RR&R was first introduced in the Water Resources Development Act of 1986 (WRDA 1986), Section 103(j), and was instituted by USACE through ER1165-2-131 "Local Cooperation Agreements for New Start Construction Projects" (April 15, 1989). Following reconstruction of this current project, the Non-Federal Sponsor (MSD) will have full legal responsibility for Operating, Maintaining, as well as Replacing, Repairing, and Rehabilitating the project.

1.9 Existing Authorized Project Overview

The total levee system (Figure 7) has a current length of 26.5 miles and consists of approximately 22.2 miles of earthen levee, 3.9 miles of concrete wall, 15 federally constructed pump stations (73 pumps), 152 gates, and other necessary appurtenances. The total project also incorporates a total of 97 closures; 21 of which have been permanently sealed and 19 of which are relatively small sandbag closures. Table 1 provides a full description of levee system features. The leveed area is estimated at approximately 76 square miles and reduces flood risk from Ohio River floods equal to the maximum on record, elevation 460.15 feet (North American Vertical Datum 1988) in January 1937, with a freeboard of three feet. Note that all elevations that appear in the report unless otherwise noted, are based on the North American Vertical Datum of 1988.

The Louisville Reach was transferred to local interests for operation and maintenance in two parts, with the first portion transferred on January 2, 1953 and the second portion transferred on July 1, 1954. The Beargrass Creek Pumping Station was transferred to the Non-Federal Sponsor in February 1957. Design top of levee elevations along this reach vary from 458.3 to 463.7 feet.

The Southwestern Jefferson County Reach (which extends into a small portion of Bullitt County) was completed in 1989. Design top of levee elevations vary from 457.2 to 459.0 feet. Upon completion of the Southwestern Jefferson County Reach, and due to redundancy, approximately 4.7 miles of levee embankment stretching from the original downstream terminus of the Louisville Reach to high ground and a pumping station located along the Mill Creek Cutoff were abandoned (Figure 8).

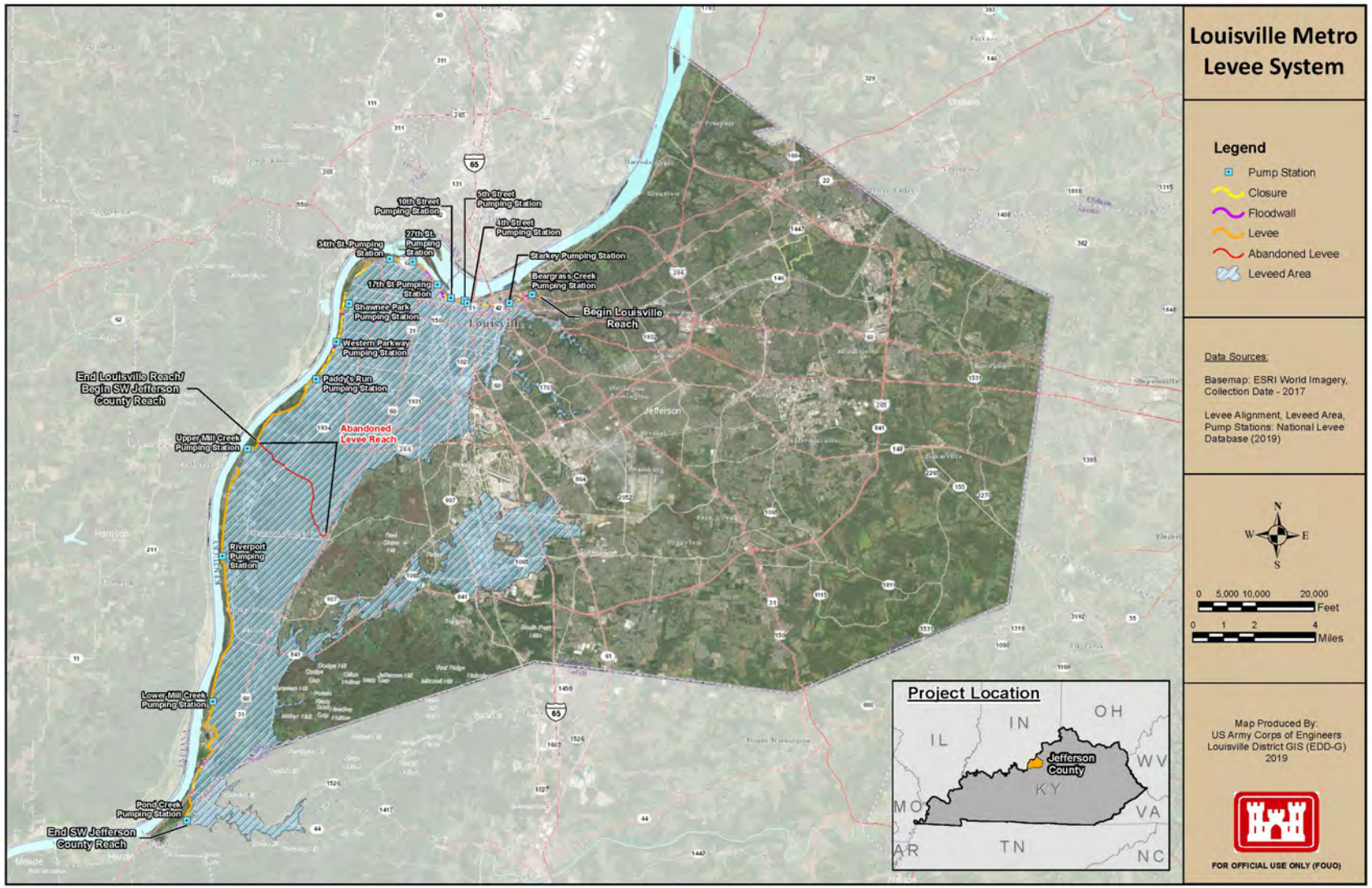


Figure 7: Levee System Overview

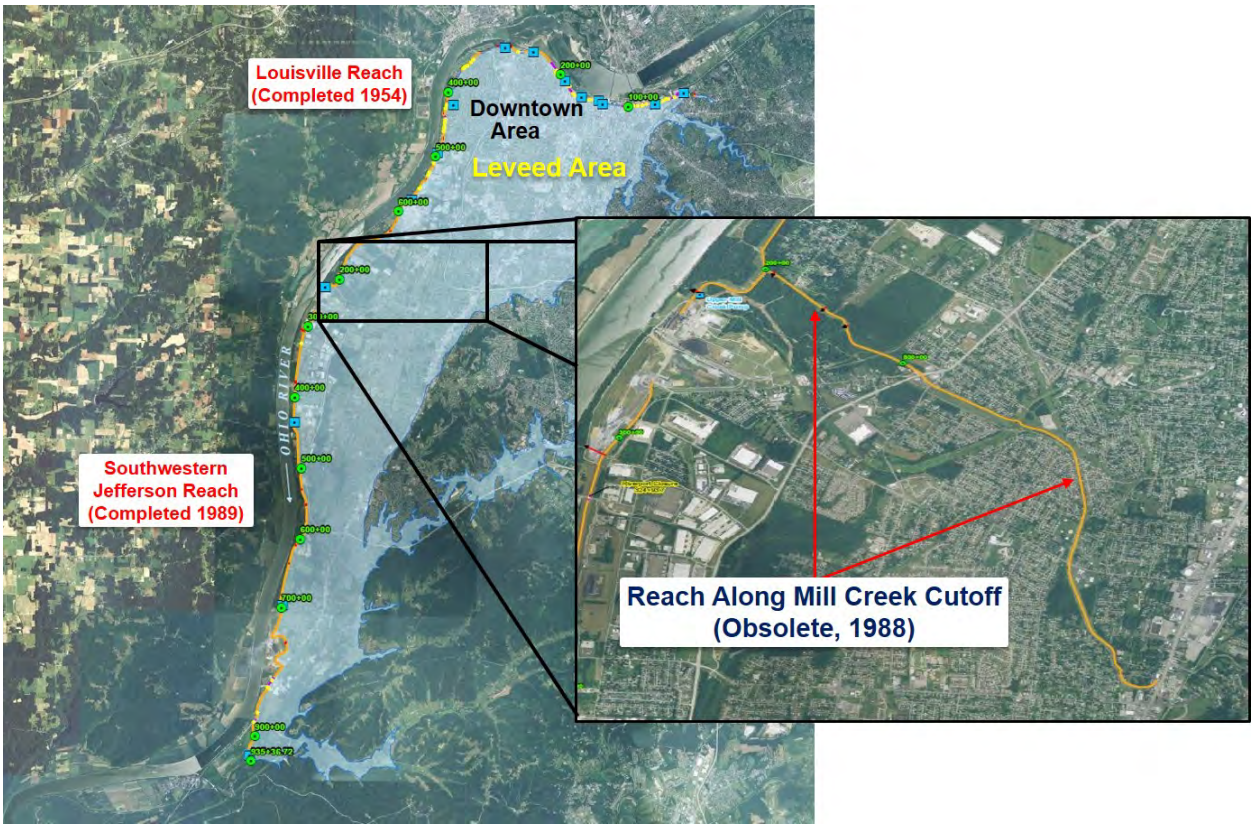


Figure 8: Mill Creek Cutoff

The LMFPS is generally comprised of five types of features:

Earthen Levees: A soil embankment with the primary purpose of furnishing flood risk reduction from seasonal high water loading periods lasting from days to weeks.

Concrete Floodwalls: A floodwall is an engineered structure made of reinforced concrete. Floodwalls in the LMFPS consist of T, I (Type I and Type II), and L-walls.

Traffic/Pedestrian Closures: A gap in the levee system that remains open for pedestrian or vehicular traffic but can be closed in the event of high water. Closure storage vaults are typically integral with the closure abutments and are located on the landside of the levee system, providing secure storage for the removable closure parts.

Interior Drainage Structures: Drainage structures function by allowing interior runoff to exit during normal river stages, by gravity flow through a system of collector sewers, gated manholes, diversion channels, and drainage pipes generally equipped with flap gates on concrete headwalls.

Pump Stations: A structure used to pump interior drainage water from the interior side (leveed area) of a levee system to the riverside.

Table 1: Levee System Overview

Reaches	
Louisville Reach (LOU)	13.9 miles
Southwestern Jefferson County Reach (SWJ)	12.6 miles
Embankment	
Type	Rolled earth embankment
Length	22.2 miles
Typical Crest width	LOU – 12 feet; SWJ – 12 to 15 feet
Typical Height	LOU – 12 feet; SWJ – 20 feet
Maximum height	LOU – 58 feet; SWJ - 72 feet
Floodwall	
Type	I-Wall, T-Wall, L-Wall
Length	3.9 miles
I-Wall	
Length	0.6 miles
Typical Height	9 feet
Maximum Height	12 feet
T-Wall	
Length	3.3 miles
Typical Height	18 feet
Maximum Height	29 feet
L-Wall	
Length	0.01 miles
Typical Height	11 feet
Maximum Height	17 feet
Pump Stations	
Total Number	16 (15 were federally constructed)
Control	Flap Gate and Manually Operated Sluice Gate
Range of Max. Discharge Capacity	Approximately 79 cubic feet per second (cfs) to 5469 cfs
Closures	
Total Number	97
Abandoned	21
Active	46 (roadway/railroad); 19 (sandbag); 11 (pedestrian)

1.10 Project Performance

1.10.1 Project Loading History

The 1964 Flood was the largest event experienced; however, it was prior to construction of the Southwestern Jefferson County Reach. The 1964 Flood resulted in a loading of about 45% of the height of the levee system, or approximately 15 feet from the top of the levee.

After the Southwestern Jefferson County Reach was constructed, the flood of record occurred in 1997. During this flood, the river was approximately 16 feet above flood stage (or about 3 feet lower than the 1964 Flood) and no performance issues were reported.

Of importance, the system of upstream Corps reservoirs completed post construction of the LMFPS would have reduced the 1937 Flood at Louisville by approximately 3 to 5 feet.

Many high water events have occurred since the completion of the Louisville Reach (1956) and the Southwestern Jefferson County Reach (1989). Table 2 shows the ten largest historical floods and their associated peak elevations and frequencies for the Jefferson County area at the McAlpine Locks and Dam lower gage, river mile 606.7. As shown on Table 2, the March 1964 Flood was the greatest of these events with an Ohio River elevation of 446.1 feet, which was about equal to a 0.69% annual chance exceedance (145-year) flood. According to MSD officials, they were not aware of any flood problems that occurred during these historic events with the exception of not installing a gate closure gate during the March 1964 Flood. That problem has been corrected with no other occurrences to date.

Table 2: Peak Historic Floods Since Project Completion

DATE	Elevation (feet)	Estimated % Loading
3/13/1964	446.2	45%
3/7/1997	443.2	34%
2/26/2018	439.8	21%
3/5/1962	437.9	14%
12/14/1978	436.3	8%
3/12/1967	436.0	7%
4/27/2011	435.6	6%
3/22/1963	435.4	5%
5/10/1961	434.7	2%
3/16/2015	434.0	0%

1.10.2 Project Incidents and Failures

There are no loading events which have caused performance problems other than a failure by the Non-Federal Sponsor to install a few downtown closures during the 1964 Flood (which occurred shortly after

construction of the Louisville Reach). Resultant damages were on the order of $150,000, occurring only to a few nearby buildings.

Recent floods (February 2019, February 2018, March 2015, April 2011, March 2008, January 2005, and March 1997) have required that many of the pump stations be operated to remove interior water. There have been several instances with individual pumps failing or deemed inoperable at multiple pump stations during these flood events. There have not been any life loss or significant economic consequences associated with loss of pumping capacity during these events.

In October of 2016 the Pond Creek Closure was struck by a Louisville & Nashville (L&N) train during a trial installation of the closure due to a breakdown in communication between MSD and the railroad operator. The closure was partially installed when the collision happened. No one was hurt and the damaged closure parts were replaced. MSD put a new standard operating procedure in place to prevent a similar future incident.

There have also been two other historical collisions both at the 16th Street Closure as the result of train derailments. After the incidents, inspections found no damage to the closure structure.

1.11 Relevant Studies, Reports and Existing Projects

1.11.1 Studies and Reports

Periodic Inspection (2019)

A Periodic Inspection (PI) of the LMFPS was performed in 2019 and was used to characterize the existing condition of the system during the Feasibility Study. The 2019 PI is located in Volume 3. The inspection rated the overall system as 'minimally acceptable', the same rating as approximately 90% of the levees within the Corps portfolio, a list of critical issues identified during the inspection specific to this Feasibility Study, which are directly related to degradation or exceedance of the features expected service life include:

- Inoperable pumps at Beargrass Creek, Starkey, Upper Mill Creek, Pond Creek and Paddy's Run Pump Stations;
- 40 gates were identified as inoperable or poorly functioning;
- Outdated electrical equipment at Paddy's Run Pumping Station; and
- The Johnsontown Road closure vault exhibited significant ongoing deterioration that needs to be addressed.

Semi-Quantitative Risk Assessment (2019)

Concurrent to this Feasibility study, the Louisville District with the Risk Management Center performed a Semi-Quantitative Risk Assessment (SQRA) on the LMFPS. Results from the 2019 SQRA were utilized to identify problems and assist with formulation of study measures. The 2019 SQRA primarily examined the levee system for risk of incremental life loss from failure. It considered the likelihood of failure for all flood loadings of which the failure modes were plausible and estimated their likelihood as well as the

life loss consequences of such a failure. Economic incremental impacts are also estimated. This produced an analysis of the probability of a feature not performing, and the physical and fiscal consequences of the failure of that feature to perform. Features identified which have a potential performance issue were considered for measures in the study associated with lessening the likelihood or consequences of the failure to a level in order to meet the Tolerable Risk Guidelines (TRG's). Primary measures associated with addressing risk reduction from the 2019 SQRA are listed in order of achieving the greatest risk reduction as follows:

- Reinforcing the Pond Creek Pump Station floodwalls;
- Adding capacity to the Beargrass Creek roller gates hoist mechanism and a secondary access to the Hoist;
- Repair/replacement of pump station equipment in the pump stations with potential life loss consequences;
- Buttressing or replacement of Butchertown I-walls (a type of concrete floodwall); and
- Adding to the Operations Manual the indication to 'open' certain gravity gates when interior flooding exceeds the exterior elevation.

MSD 20-Year Comprehensive Facility Plan – Critical and Reinvestment Plan (2017)

This Facility Plan identified an estimated $4.3 billion in financial needs for future facility rehabilitation, renewal, replacement, upgrade, and expansion over the next 20 years for both sanitary and storm water systems. The Facility Plan includes projected rainfall intensity, duration, and frequency (IDF) curves for year 2035. These projections consider both statistical trends going back 60 years, along with state-of-the art global circulation models that project future precipitation conditions. These models reflect the observed increased frequency of extreme storm events that we have experienced, related to the impacts of global climate change. To assure the reliability and adequacy of the flood pumping systems, all pump stations were subjected to a facility condition assessment and hydraulic and hydrologic modeling using storm IDFs projected for 2035.

The recommended 20-year investment plan includes rehabilitating and/or expanding 15 of the 16 flood aging pumping stations in the Louisville Metro Levee system to future capacity requirements forecasted through 2065. MSD outlined a preferred level of service of 10-percent annual chance of exceedance (10-year event), 24-hour storm and identified seven pump stations that do not meet that criteria with their current pumping capacity. Additional evaluation on pump station capacity increases is located in Section 4.6.4 and Volume 2, Appendix B.

National Flood Insurance Program - Levee System Evaluation (LSE) (2015)

The National Flood Insurance Program (NFIP) Levee System Evaluation (LSE) examined the operations, maintenance, and condition of the entire LMFPS. The LSE concluded that the LMFPS met all applicable standards and provides reasonable assurance the LMFPS will exclude the 1-percent annual exceedance flood (100-year flood event) from the leveed area based on the condition of the system at the time of the evaluation . The LSE noted the floodwall and levee features are in an acceptable condition and

should not need expansion (raise in levee and floodwall height) in the foreseeable future. However, continued maintenance at appropriate levels is necessary to keep the floodwall and levee system operable to meet the community's needs. The 2015 LSE resulted in positive evaluation by the Corps and accreditation of the LMFPS by FEMA on the Flood Insurance Rate Maps (FIRM). Reference Volume 4 for the complete LSE report.

Levee Screening Tool (2014)

A screening level risk assessment of the Louisville Metro Levee System using the Levee Screening Tool (LST) was performed in 2014. Based on the findings of the levee screening assessment, the Levee Safety Action Classification (LSAC) for the Louisville Metro Levee System was given a LSAC-2 due to the combination of life, economic, and environmental consequences. The three primary risk drivers for breach prior to overtopping, all designated as "moderate likelihood", are listed below:

- Floodwall Stability;
- Embankment and Foundation Seepage and Piping; and
- Embankment Stability.

This action classification led to the levee system being placed high in the queue for completion of a SQRA. The recent SQRA is a higher level update to the project risk, and should be seen as replacing the system's risk estimate completed through the 2014 LST.

Metro Operations Flood Gate Evaluation (2011)

In 2011, MSD had engineering firms inspect, operate, and evaluate gates associated with the levee system. In all, fourteen gates were considered in need of improvement with two that were being repaired at the time. The inspection results and initial evaluation were used to necessitate the need for further structural evaluation by MSD. The structural evaluations typically listed a maximum recommended head based on the condition of the gate. MSD subsequently performed several gate repairs and modifications following the recommendations of this study with Corps approval.

Metro Louisville, Kentucky – Pumping Station Reconstruction Study Initial Assessment Report (2007)

The purpose of this study was to conduct a preliminary investigation to determine if there is a need for and local interest in federal involvement in the reconstruction of the ten aging pumping stations in the Louisville flood protection system. This study was limited to the reconstruction of these facilities with no change in their scope or function. Under this limited perspective, the evaluation was limited to the individual pumping stations and appurtenant features to establish the need and rationale for reconstruction and the level of interest and support from the local sponsor, MSD. This study contains preliminary costs for any required work, and recommends a future course of action.

Investigations Related to the Construction of the Louisville Reach (1941-1969)

Supplemental Report: Definite Project for Local Flood Protection, Interior Drainage Facilities, and Louisville, Kentucky (USACE, 1946). A proposed plan for the disposal of runoff from an area of approximately 49,000 acres that is drained by sewers and creek channels crossing the proposed alignment was presented in a second report. Included in this proposed plan are preliminary designs for the major items involved in the disposal of interior runoff, including the preliminary design for 12 pump stations and several large sewer lines.

Supplement to Definite Project Report on Local Flood Protection, Louisville, Kentucky, Protection of Additional County Area (USACE, 1948). The report was prepared to present the proposed alignment in the area downstream of the former corporate limits of the City of Louisville. This portion is referred to as Section E of the Louisville Reach.

Supplemental Report: Definite Project for Local Flood Protection, Louisville, Kentucky, Interior Drainage Facilities, and County Area (USACE, 1948). The report presented a proposed plan for the disposal of runoff through Section E of the Louisville Reach. This report details a plan for the disposal of runoff from approximately 11,500 acres.

Supplemental Report: Definite Project for Local Flood Protection, Louisville, Kentucky, Interior Drainage Facilities, and Sewer Runoff Investigation (USACE, 1969). The report presented the results of a sewer runoff investigation and unit hydrograph study for six major sewers. The total area drained by these sewers is approximately 13,300 acres. This study was prepared as a follow-up to previous studies in order to provide better estimates of required pump station capacities.

General Design Memorandum: Local Flood Protection, Section A-A, Louisville, Kentucky, Design Memorandum No. 1 (USACE, 1954). The report detailed the foundation conditions and outlined the method of analysis to be used in the design of floodwalls and related structures.

General Design Memorandum: Local Flood Protection, Section A-A, Louisville, Kentucky, Design Memorandum No. 2 (USACE, 1954) provided supplemental information to the general design analysis methods presented in *General Design Memorandum: Local Flood Protection, Section A-A, Louisville, Kentucky, Design Memorandum No. 1.*

Investigations Related to the Southwestern Jefferson County Reach (1971 -1975)

The size and scope of the proposed Southwestern Jefferson County Reach flood risk reduction project was presented in a report titled *Southwestern Jefferson County, Kentucky, Design Memorandum No. 1*. (USACE, 1971). The report presented the size and scope of the proposed SWJ flood risk reduction project Recommendations for modifications to the plan initially authorized were included in order to achieve a reasonable balance between structural works, floodplain regulations, and floodplain management.

Southwestern Jefferson County, Kentucky, Design Memorandum No. 1, Volume 1, Plates 1-61 (USACE, 1971). The report presented Plans, profiles, and maps for the Southwestern Jefferson County Reach. Information on soils and hydraulics were presented in *Southwestern Jefferson County, Kentucky, Design Memorandum No. 1, Volume 2, Plates 62-163* (USACE, 1971).

Southwestern Jefferson County, Kentucky, Local Flood Protection Project, Supplement No. 1 to Design Memorandum No. 1 (USACE, 1973). Changes to the proposed alignment between Sta. 200+00 and Sta. 236+94.82 in the vicinity of Upper Mill Creek were presented in the report. The report also included in this report were additional investigations completed since the publication of *Southwestern Jefferson County, Kentucky, Design Memorandum No. 1* in 1971.

Southwestern Jefferson County, Kentucky, Local Flood Protection Project, and *Supplement No. 2 to Design Memorandum No. 1* (USACE, 1974). The report presented stability analyses for the Southwestern Jefferson County Reach.

Southwestern Jefferson County, Kentucky, Local Flood Protection Project, Design Memorandum No. 2, Major Ponding Area Determination (USACE, 1973). The report presented analyses to determine the most economical balance between pump station capacities and ponding areas.

Southwestern Jefferson County, Kentucky, Local Flood Protection Project, Design Memorandum No. 3, Land Requirements Plan – Public Use (USACE, 1971). The report includes a preliminary land use plan for recreational areas associated with construction of the Southwestern Jefferson County Reach was presented in Further analyses of recreational and public use areas was presented in *Southwestern Jefferson County, Kentucky, Local Flood Protection Project, and Design Memorandum No. 1 Recreation Resource Appendix*. This report analyzed the amount, cost, and location of lands to be acquired for public use and for the preservation of environmental resources.

Southwestern Jefferson County, Kentucky, Local Flood Protection Project, Design Memorandum No. 3, and Pumping Stations for Sections 1 & 2 (USACE, 1975). The report includes detailed designs of the Riverport and Lower Mill Creek pump stations. The report also includes the proposed pump station configurations, mechanical and electrical computations, equipment selection, structural analyses, and cost estimates.

1.11.2 Existing Projects

The following highlights federal and local water resource projects within the general study area.

<u>Beargrass Creek Basin</u>

The Beargrass Creek feasibility study was completed in 1998. The study focused primarily on the watershed of the South Fork of Beargrass Creek, which drains about 25 square miles of urbanized land east of Interstate 65. The report recommended construction of various components to reduce flood-related damages along Beargrass Creek, including eight detention basins, a short floodwall-levee

section, and a minor modification of part of the creek. Congress authorized construction of the $11 million project in WRDA 1999, and construction was completed in 2009 in partnership with the MSD.

Cannelton Locks and Dam

The Cannelton Locks and Dam is located on the Ohio River at mile 720.7. It is three miles upstream from Cannelton, Indiana. The upper pool maintained above the dam extends upstream for a distance of 114 miles to the McAlpine Locks and Dam (downtown Louisville) at mile 606.8 and for a short distance up Salt River.

Concrete Channel - South Fork of Beargrass Creek

Commissioners of Sewage of Louisville and the Board of Public Works made channel improvements on Beargrass Creek in three major stages between 1906 and 1943. The channel improvement occurred on the lower end of the South Fork of Beargrass Creek and resulted in a concrete channel from about mile 1.5 (just below Main Street) to mile 4.26 (approximately 400 feet upstream of Eastern Parkway) in a highly urbanized reach. The channel reduces the chance of flooding in the lower reaches of the South Fork by keeping the stream within its banks; however, damages still occur upstream of the concrete lined channel. MSD is responsible for maintaining the concrete channel.

Dry Bed Reservoir -South Fork of Beargrass Creek

A dry bed reservoir is located just upstream of Hunsinger Lane on the South Fork of Beargrass Creek in Jefferson County, Kentucky. The reservoir controls a 2.4 square-mile drainage area. The project was completed in 1980 and flooding frequencies have been reduced since that time. MSD is responsible for maintaining the reservoir. The reservoir reduces the chance of flooding in the upper reaches of the South Fork by regulating the amount of water going downstream during intense rainfalls. Damages occur downstream of the reservoir in the middle reaches.

McAlpine Locks and Dam

The McAlpine Locks and Dam is located on the Ohio River at Mile 604.5 in Jefferson County, Kentucky. The U.S. Army Corps of Engineers, Louisville District is responsible for operating and maintaining the structures which provide navigation through the Metropolitan Louisville area. A number of improvements have been made at the site over the years to provide greater navigation efficiency including replacement of the existing 360-foot and 600-foot lock chambers with a new 1,200-foot by 110-foot single lift lock. The result of this modernization effort is two parallel 1,200-foot locks along with some navigation channel improvements. Two river gages are maintained at the project and track river elevations among other variables: McAlpine Upper Gage (UG) and McAlpine Lower Gage (LG).

MSD Integrated Overflow Abatement Plan

The Integrated Overflow Abatement Plan (IOAP) is a response to a Consent Decree negotiated with the U.S. Environmental Protection Agency (EPA) and Kentucky Department of Environmental and Public Protection (KDEP). As such, the IOAP is a federally enforceable action plan for sewer overflow abatement. MSD's IOAP is a long term plan to control combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) in the community. Projects identified in the IOAP are in various phases of

construction and are scheduled for completion in 2025, at an estimated cost of $850 million. These projects include large storage basins, pipelines, and sewage treatment facilities. The major CSO storage basins are all scheduled to be completed by the end of FY2021 and were considered in modeling work completed for this Feasibility Study.

New Albany, Indiana Local Protection Project (LPP)

The New Albany LPP is located on the right bank of the Ohio River at New Albany in Floyd County, Indiana. It comprises a system of earth levees, concrete walls, and pumping plants to dispose of drainage during floods. The levee system reduces flood risk to about 1,500 acres.

Pond Creek Basin

The feasibility study for Pond Creek Basin, which drains the southern-most portions of Metro Louisville, was completed in 1994. The report recommended construction of various components to reduce flood-related damages, including detention basins and minor modifications of part of the stream channel. The recommended $16 million project was authorized for construction by Congress in the Water Resources Development Act of (WRDA) 1996. Construction was completed in 2008 in partnership with the MSD. MSD is responsible for maintaining the components of the project.

Up-Stream Corps Reservoirs

The flood of January, 1937 was the most disastrous flood ever in the Ohio River Basin, with a peak flow at Louisville of 1,110,000 cfs. Excessive and almost continuous rainfall from January 6-25 caused maximum recorded stages in a 705-mile reach of the Ohio River. In Louisville, there were only eight days in the month of January, 1937 where no rain was recorded. This flood interrupted virtually all communication and transportation between the north and south banks for periods of a week to a month. In Louisville, about three-quarters of the city was flooded, 175,000 residents were evacuated, and 90 flood related deaths occurred. Because of the widespread catastrophic damages that occurred along the Ohio River and tributaries, a series of levees and floodwalls were constructed along the flooded communities including the LMFPS, with top of levee/wall designed to at least three feet greater than the peak of this 1937 flood. In addition to these flood risk damage reduction measures, 60 Corps flood control reservoirs (Figure 2) were constructed upstream of Louisville. There are a total of 80 Corps reservoirs throughout the Ohio River basin designed to reduce the impact of flooding on the receiving streams of these reservoirs as well as along the Ohio River. Based on curves from the 1976 Ohio River Basin Comprehensive Survey, this extensive system of reservoirs would have reduced the 1937 peak flow at Louisville from 1,110,000 cfs to 954,000 cfs. It is estimated that these reservoirs would have reduced the 1937 flood in Louisville by approximately 3 to 5 feet. Based on this information, the current levee system is capable of accommodating a hydrologic event similar to the 1937 flood with approximately 6 to 8 feet of freeboard.

2 EXISTING CONDITIONS

2.1 Environmental

The National Environmental Policy Act (NEPA) and the Council on Environmental Quality's NEPA Implementing Regulations require that an Environmental Assessment identify the likely environmental effects of a proposed project and that the agency determine whether those impacts may be significant. The determination of whether an impact significantly affects the quality of the human environment must consider the context of an action and the intensity of the impacts (40 CFR 1508.27).

The term 'context' refers to the affected environment in which the proposed action would take place and is based on the specific location of the proposed action, taking into account the entire affected region, the affected interests, and the locality. The term 'intensity' refers to the magnitude of change that would result if the proposed action were implemented.

Determining whether an effect significantly affects the quality of the human environment also requires an examination of the relationship between context and intensity. In general, the more sensitive the context (i.e., the specific resource in the proposed action's affected area), the less intense an impact needs to be in order for the action to be considered significant. Conversely, the less intense of an impact, the less scrutiny even sensitive resources need because of the overt inability of an action to effect change to the physical environment. The consideration of context and intensity also must account for the indirect and cumulative effects from a proposed action. This section describes the existing environmental conditions in the project area (affected environment), providing a baseline for measuring expected changes that would result from implementation of the proposed alternatives.

2.1.1 Climate

Climate in Louisville, KY is humid subtropical with four distinct seasons. Spring-like conditions typically begin in mid-to-late March, summer from mid-to-late-May to late September, with fall in the October-November period. Seasonal extremes in both temperature and precipitation are not uncommon during early spring and late fall.

Records from the National Climatic Data Center for Louisville show an average annual rainfall of 44.91 inches and an average daily temperature of 58.2°F. These average values are based on a 29 year period from 1981 - 2010. Extreme temperatures from the entire period of record include a maximum observed temperature of 107°F in 1901, 1930, and 1936, as well as a minimum observed temperature of -22°F in 1994. Of the top ten wettest days in Louisville, KY; four have occurred in March and two in October. The highest precipitation amount occurred on 1 March 1997, with 10.48 inches of rain in a single day. Figure 9 displays historic average monthly temperature and precipitation totals for the Bluegrass Region according to the Kentucky Climate Center for a period of record of 1895 – 2016.

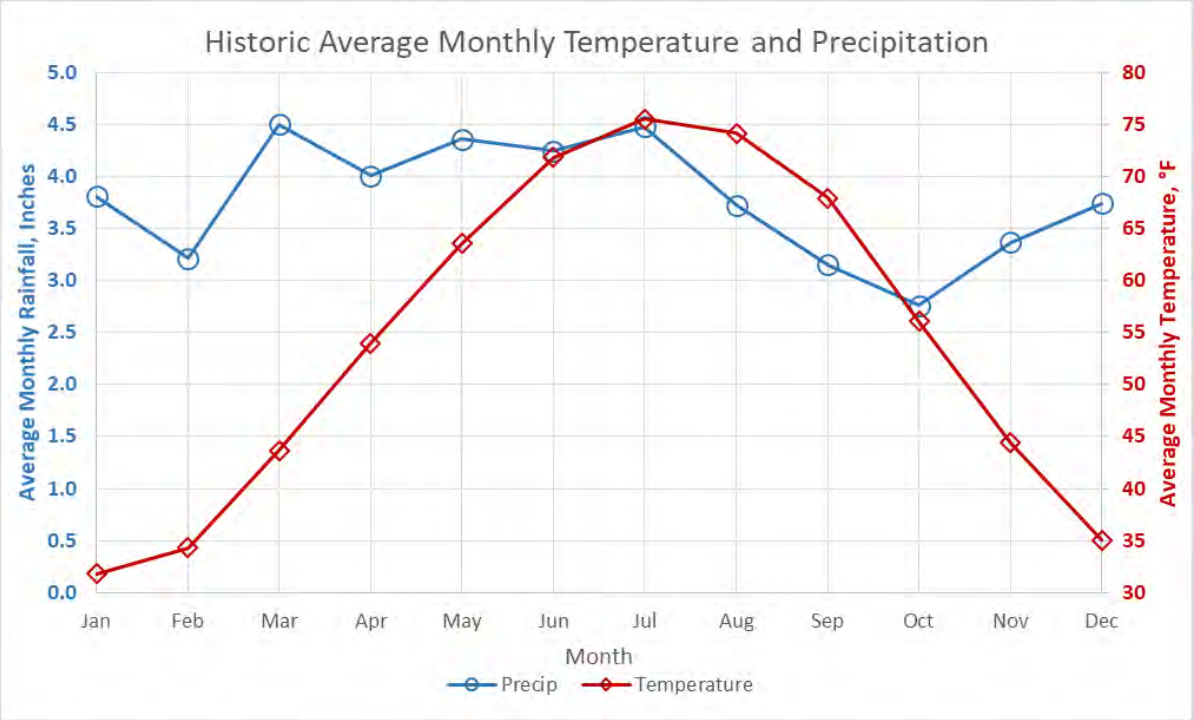


Figure 9: Historic Average Monthly Temperature and Precipitation

Based on a review of pertinent literature, there is consistent consensus among the available sources supporting trends of increasing temperatures within the project area. Observed changes in precipitation have more uncertainty associated with them; however, there are substantial indications that increasing trends in rainfall have been observed. Recently, L-moment analysis indicates that rainfall occurrence and intensity has increased since 2004; however, precipitation frequency estimates from this timeframe have not been incorporated into this study. Rather, the increases in rainfall over the historic norm have been incorporated using the upper confidence limit of NOAA's Atlas 14. Significant changes in urban streamflow have also been observed but are largely attributed to changes in land use and urbanization and cannot be attributed solely to the impact of climate change.

A comprehensive, qualitative assessment of climate change impacts on the hydrology of the Louisville Metro area, as required by USACE Engineering and Construction Bulletin (ECB) 2018-14, is included in Volume 2, Appendix I.

2.1.2 Air Quality

The U.S. Environmental Protection Agency (USEPA) Office of Air Quality Planning and Standards has set National Ambient Air Quality Standards (NAAQS) for six principal pollutants, called "criteria" pollutants. They are carbon monoxide, nitrogen dioxide, ozone, lead, particulates of 10 microns or less in size (PM-10 and PM-2.5), and sulfur dioxide. Ozone is the only parameter not directly emitted into the air but forms in the atmosphere when three atoms of oxygen (O_3) are combined by a chemical reaction between oxides of nitrogen (NO_x) and volatile organic compounds (VOC) in the presence of sunlight. Motor vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents are some of the

major sources of NO_x and VOC, also known as ozone precursors. Strong sunlight and hot weather can cause ground-level ozone to form in harmful concentrations in the air.

At the time of this report, portions of Jefferson County in Kentucky had nonattainment status for sulfur dioxide and 8-hour ozone. The EPA has approved State Implementation Plans for attaining NAAQS for these areas. The county was in attainment for all other criteria pollutants (USEPA, 2019). The City of Louisville's 8-hour ozone (2015 standard) classification was "marginal"- the least severe classification.

2.1.3 Topography, Geology and Soils

The project area is located in the Outer Bluegrass Region, which is generally characterized by underlying fossiliferous limestone, dolomite, and shale of the Ordovician geological age. The study area lies within the Ohio River Alluvium physiographic region of Kentucky. Deposits in the county include limestone, shale, dolomite, lacustrine, and alluvial deposits. The Ohio River Alluvium is primarily made up of Pleistocene glacial outwash material and unconsolidated alluvium, which consists of sand, gravel, clay, and silt. Regionally, the lithology is comprised of a 5 to 45-feet thick layer of clay, silt, and fine sand that overlays sand and gravel containing discontinuous lenses of clay. Beneath the aquifer are relatively tight shale and limestone bedrock.

The topography of the project area can be obscured by the extensive urban and suburban development, appearing flat. However, it is essentially a gently southwestward sloping surface from a high elevation of 790 feet on the east to 500 feet at the foot of the knobs in the southwest part of the Jefferson County. Floyds Fork and Harrods Creek have cut valleys as much as 150 to 200 feet below this surface in the east-central part of the county. Some sinkholes are present, but these karst features do not constitute an important part of the landscape.

The lowest elevations in the project area are found along the Ohio River. Upstream from downtown Louisville, the floodplain is relatively narrow but widens substantially to the south and southwest. Elevations along the floodplain are 430 to 440 feet. The lowest point in Jefferson County is 383 feet along the Ohio River just north of West Point. The highest elevations are in the Muldraugh Hill area. Here the escarpment rises abruptly 300 to 400 feet above the lowland to the north and east. South Park Hills is a complex of hills and ridges separated by erosion from the main upland to the west. The highest point in South Park Hills, and the highest point in Jefferson County, is 902 feet (McGrain and Currens, 1978).

As the project area is mostly developed land, the majority of soils in the project area are classified as urban land, with varying amounts of Udorthents and Udarents soil complexes with between zero and 12 percent slope. A Natural Resources Conservation Service (NRCS) soil map, and associated tables are located in Appendix A.

2.1.4 Surface Water Hydrology and Groundwater

The dominant feature of the hydrologic system in the Louisville area is the Ohio River and its floodplain, underlain by about 100 feet of permeable sand and gravel deposits. At Louisville the river carries the drainage from an area of over 91,000 square miles.

The leveed area of metro Louisville includes portions of nine HUC 12 watershed basins (Figure 10), which form tributary streams of the Ohio River. Beargrass Creek and its tributaries drain generally to the northwest, Mill Creek drains to the west, and Pond and Knob Creeks flow southwesterly into the Ohio River (Figure 1). The surface water hydrology in Louisville has been highly modified to urban development. These changes associated with urban development, such as channel modifications, storm-sewer construction, and paving of pervious areas, have generally led to increased rates and volumes of surface runoff in the project area.

The vast amount of impervious surfaces in the city like roads, parking lots, and rooftops prevent rain and snowmelt from infiltrating into the ground. Most of the rainfall and snowmelt remains above the surface, where it runs off rapidly in large amounts.

Storm sewer systems concentrate runoff into smooth, straight conduits, which increases velocity and erosional power of the water as it travels underground. When this runoff leaves the storm drains and empties into a stream if the outlet is not properly designed, its excessive volume and power can scour the streambed leading to channel instability and potential bank failure, damaging streamside vegetation and wiping out aquatic habitat. These increased storm flows carry sediment loads from construction sites and other denuded surfaces and eroded streambanks. They often carry higher water temperatures from streets, roof tops, and parking lots, which are harmful to the health and reproduction of aquatic life. The loss of infiltration from urbanization may also cause profound groundwater changes. Although urbanization leads to increases in flooding during and immediately after wet weather, in many instances it results in lower stream flows during dry weather.

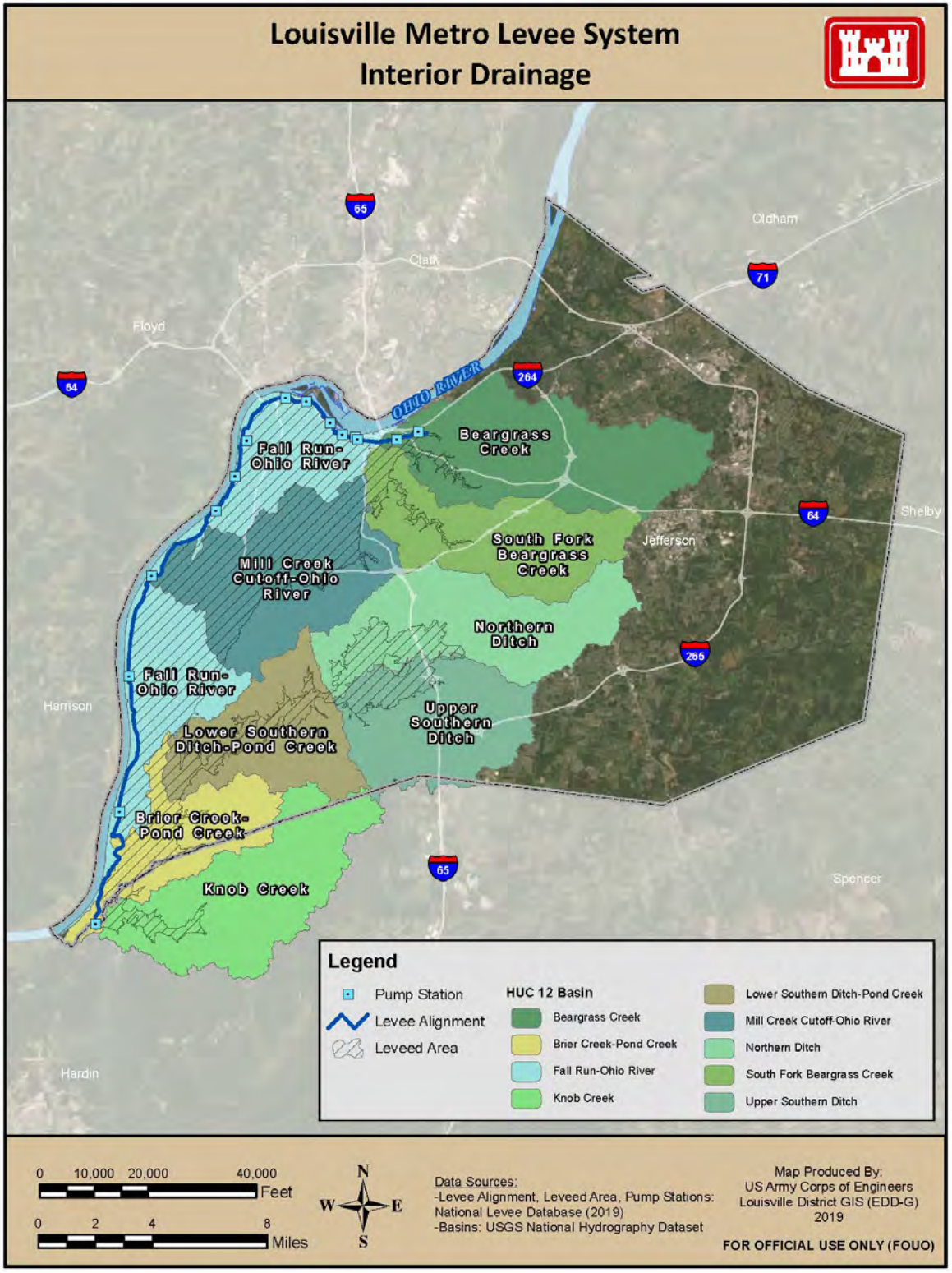


Figure 10: HUC-12 Watersheds Located in Interior Drainage of Jefferson County

The Ohio River alluvium aquifer is the most dependable source of groundwater in Louisville. Domestic wells drilled in the alluvium are generally drilled to a depth of 100 feet below ground surface and can produce approximately 1,000 gallons of water per minute. In the upland areas of Jefferson County, which comprises 30 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply unless they are drilled along drainage lines, in which case they may produce enough water except during dry weather.

All sizable wetland complexes that once existed in the study area have been drained and/or filled during the urban development. Some small, isolated wetlands do exist within the leveed area, but most are of moderate to poor quality. Figure 11 shows existing wetlands within the bounds of the leveed area, according to the USFWS National Wetland Inventory (NWI).

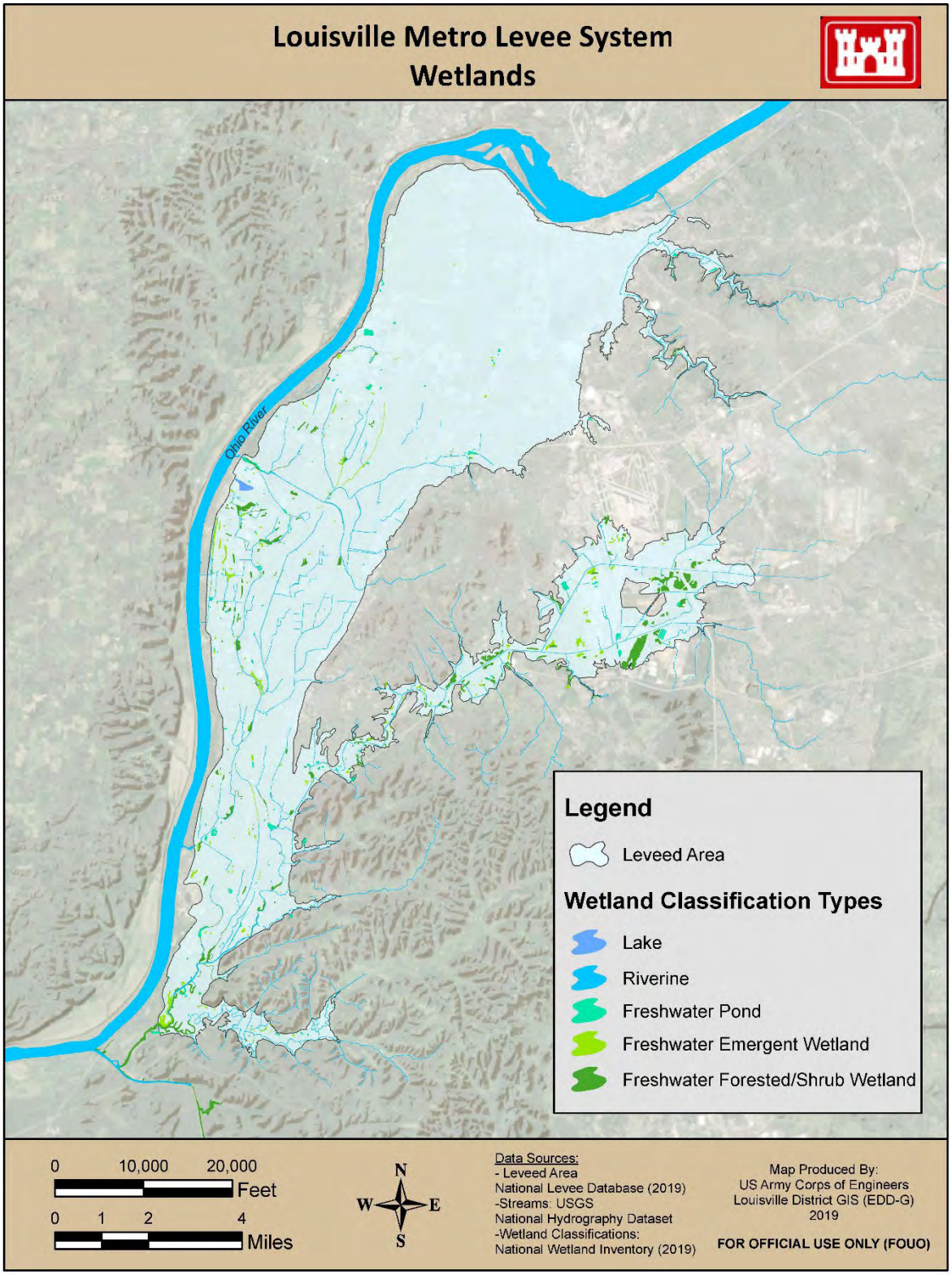


Figure 11: Wetlands Within the Leveed Area

2.1.5 Water Quality

Water quality in the urban streams of Louisville has been highly impacted from several factors including channelization, increases in impervious area, loss of riparian vegetation, and inputs from combined and sanitary sewer overflows and non-point source pollution. According to the USEPA 303(d) List of Impaired Waters, every major stream in the project area contains segments that are considered to be impaired due to nutrient and organic enrichment and other causes. Urbanization has increased the variety and amount of pollutants carried into the streams. These pollutants can include, but are not limited to sediment, oil, grease, pesticides, nutrients, road salts, organic compounds from pet wastes and septic systems, and heavy metals.

The water in Louisville is predominantly of calcium magnesium bicarbonate type and contains appreciable concentrations of sulfate. As in most areas, the ground water is generally harder than surface water and contains more dissolved solids.

2.1.6 Biological Environment

Greater than 60% of Louisville has been developed to some extent, which has greatly modified the existing natural resources of the area (Figure 12). The proposed alternatives would occur on previously disturbed and/or developed lands, mostly in the existing footprint of the levee and its associated pump stations. The earthen levees, which are maintained in mowed grass, support little to no biological diversity. The T-wall and I-wall sections of the levee system also run through developed areas with little biological diversity. Construction laydown areas for the proposed alternatives would also be confined to road easements and/or paved lots.

Oxygen depletion from elevated nutrient levels in area's streams, such as Pond Creek, have negatively impacted aquatic biological communities, and often results in fish kills. Due to the impacts from the channelization of streams, removal of riparian vegetation, and increase of impervious surfaces in the project area, aquatic habitat quality has been severely degraded.

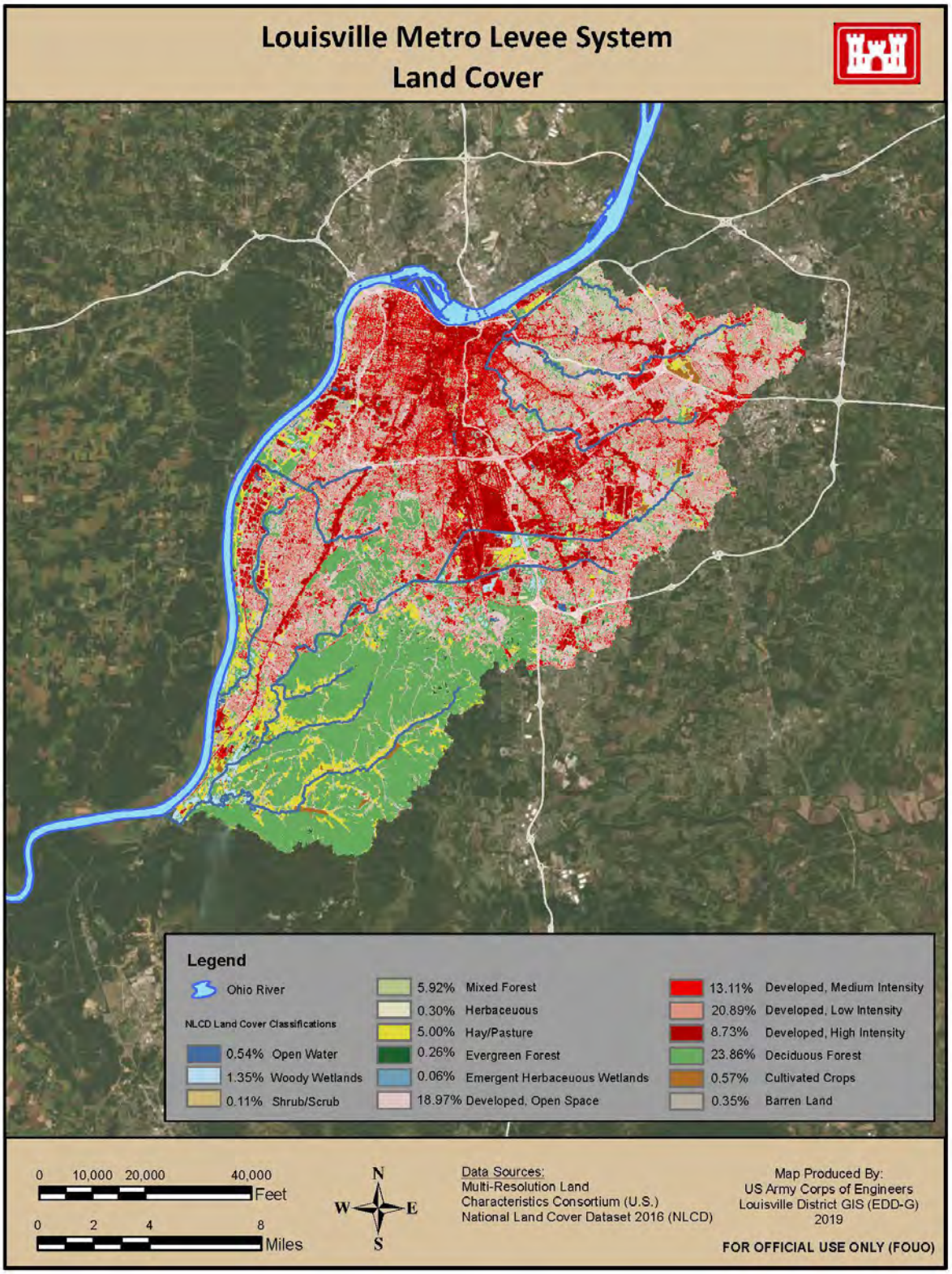


Figure 12: Land Cover of Metropolitan Louisville.

2.1.7 Threatened and Endangered Species

Lists of threatened, endangered and species of special concern are maintained by the USFWS and the State of Kentucky. Under the Endangered Species Act (ESA) of 1973 (16 U.S.C. §§ 1531-1544), endangered species are defined as any species in danger of extinction throughout all or portions of its range. A threatened species is any species likely to become endangered in the foreseeable future. The ESA defines critical habitat of the above species as a geographic area occupied by the species that contains the physical or biological features that are essential to the conservation of a particular species and that may need special management or protection.

An official list of federally protected species was generated using the USFWS automated IPaC (Information for Planning and Consultation) website. The list from the Kentucky Ecological Field Office is included in Appendix B. Table 3 includes 15 species that could potentially be affected by activities within the project area. The occurrence of a species on the list does not necessarily indicate their presence within the project area.

Table 3: Federally Listed Species that Could be Potentially Affected by Activities Near the Project Area (USFWS)

Taxonomy	Common Name	Scientific Name	Status
Mammals	gray bat	*Myotis grisescens*	Endangered
	Indiana bat	*Myotis sodalis*	Endangered
	northern long-eared bat	*Myotis septentrionalis*	Threatened
Birds	least tern	*Sterna antillarum*	Endangered
Mussels	clubshell	*Pleurobema clava*	Endangered
	fanshell	*Cyprogenia stegaria*	Endangered
	Northern riffleshell	*Epioblasma torulosa rangiana*	Endangered
	orangefoot pimpleback	*Plethobasus cooperianus*	Endangered
	pink mucket	*Lampsilis abrupta*	Endangered
	purple cat's paw	*Epioblasma obliquata obliquata*	Endangered
	rabbitsfoot	*Quadrula cylindrica cylindrica*	Threatened
	ring pink	*Obovaria retusa*	Endangered
	rough pigtoe	*Pleurobema plenum*	Endangered
	sheepnose mussel	*Plethobasus cyphyus*	Endangered
	spectaclecase	*Cumberlandia monodonta*	Endangered

2.1.8 Demographics and Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Population and Low-Income Populations (Executive Order, 1994), directs federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority population and low-income populations. When conducting NEPA evaluations, the Corps of Engineers incorporates Environmental Justice (EJ) considerations into both the technical analyses and the public involvement in accordance with the EPA and the Council on Environmental Quality guidance (CEQ, 1997). The CEQ guidance defines “minority” as individual(s) who

are members of the following population groups: American Indian or Alaskan native, Asian or Pacific Islander, Black, not of Hispanic origin, and Hispanic. The Council defines these groups as minority populations when either the minority population of the affected area exceeds 50% of the total population, or the percentage of minority population in the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis.

The EPA online EJScreen environmental justice mapping tool was used to assess the environmental and demographic indicators within the leveed area of the LMFPS. The full EJScreen Report is located in Appendix A. Figures 13 and 14 compares environmental and demographic indicators of the project area with averages in the United States. Compared to the rest of the U.S., the assessed area ranked highest for exposure to traffic proximity (88th percentile), lead paint indicator (85th percentile), risk management plan (RMP) facilities proximity (93rd percentile), and hazardous waste proximity (89th percentile). The EPA considers an RMP facility as those that have a potential chemical accident management plan.

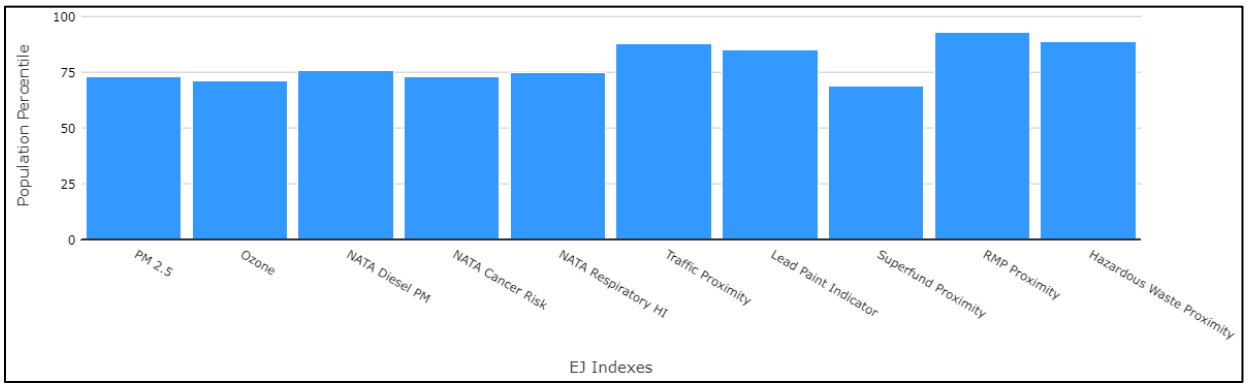


Figure 13: Environmental Justice (EJ) Indexes for the Leveed Area Compared to All Block Groups in the U.S.

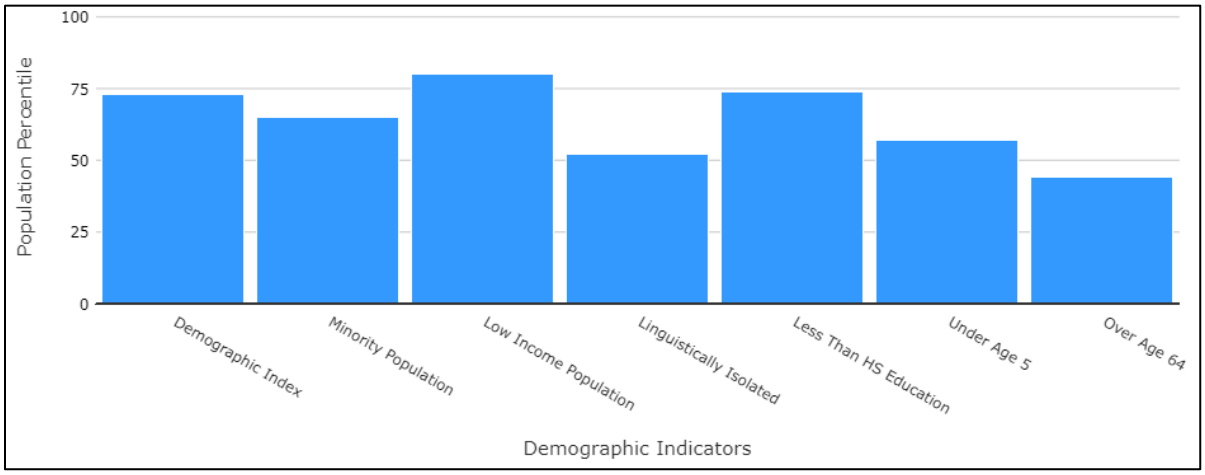


Figure 14: Demographic Indicators for the Leveed Area Compared to All Block Groups in the U.S.

According to the 2012-2016 American Community Survey (ACS) estimates, the approximate population of the leveed area is 242,000 and is comprised of 47% minority population. Per capita income of that

same area was $18,836 per year. Figure 15 shows median household income data in Jefferson County, Kentucky. Approximately 31% of the population in the leveed area is under the age of 18 years old. Appendix A contains the EJScreen ACS summary report generated for the leveed area.

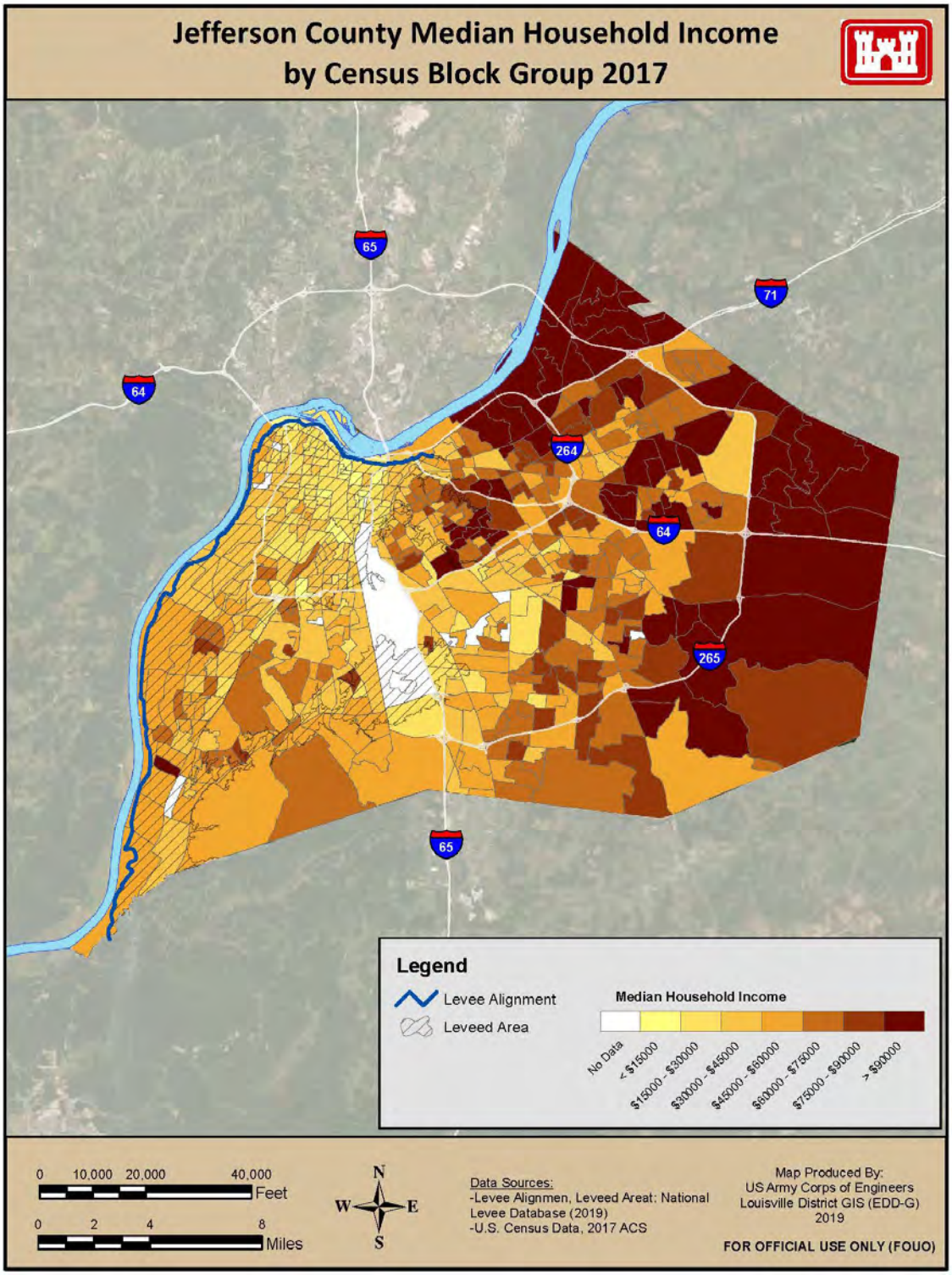


Figure 15: Median Household Income for Jefferson County, Kentucky, Including Leveed Area

2.1.9 Recreation

Louisville and the surrounding areas afford visitors and residents many choices for outdoor recreation, including excellent recreational paddling opportunities on the Ohio River, at the Falls of the Ohio National Wildlife Conservation Area and an extensive city parks system featuring 118 public parks.

The Louisville Loop (Figure 16) is an estimated 100-mile trail system that will eventually encircle Louisville and link existing and new parks and neighborhoods. The LMFPS is an important component of the Loop, as a large portion of the trail runs along the top of the levee.

Figure 16: Louisville Loop Trail System

2.1.10 Hazardous, Toxic, and Radioactive Waste Materials (HTRW)

A search of the EPA's Envirofacts Database was completed on August 22, 2019 for each of the sites that would require ground disturbance outside the footprint of the existing levee system. This includes three sites: Canal Street T-wall, Butchertown I-wall stabilization, and the access road at McAlpine Locks and

Dam. The Envirofacts search included multiple environmental databases for facility information, including toxic chemical releases, water discharge permit compliance, hazardous waste handling processes, Superfund status, and air emission estimates. The databases revealed no permitted hazardous waste disposal facilities or known sites of hazardous, toxic, or radioactive materials within the project work limits. Lists of EPA-regulated facilities in close proximity to each of these sites are located in Appendix A.

2.1.11 Noise

Changes in noise are typically measured and reported in units of A-weighted decibels (dBA), a weighted measure of sound level. The primary sources of noise within the project area would include everyday vehicular traffic along the adjacent highways (typically between 50 and 60 dBA at 100 feet) and human-generated recreational activities at the project area. Noise ranging from about 10 dBA for the rustling of leaves to as much as 115 dBA (the upper limit for unprotected hearing exposure established by the Occupational Safety and Health Administration) is common in areas where there are sources of recreational activities, construction activities, and vehicular traffic. Primary sources of noise at the project area include traffic on nearby streets and highways, boating traffic on the Ohio River, maintenance equipment such as mowers, and air traffic. Noise levels vary along the levee system. Levels are generally lower along stretches of the levee that are farther away from the highways and development of downtown Louisville.

2.2 Cultural Resources

A number of steps were taken to identify any cultural resources within the proposed project area. Most of the proposed project area has not been archaeologically surveyed. A check of the online database provided by the Kentucky Office of State Archaeology (OSA) on February 19, 2019 shows there are two archaeological sites located within the project area. A portion of site 15JF2 is located within the proposed access road for McAlpine Lock and Dam. A portion of site 15BU160 is located within the existing footprint of the floodwall at the Pond Creek Pumping Station. There are three other archaeological sites (15JF69, 15JF107, and 15JF766) that have been previously recorded within 150 feet of the project area.

According to the online-National Register of Historic Places (NRHP) database and a GIS request of the KHC GIS data on February 19, 2019, there are NRHP-listed buildings, structures, and historic districts within 150 feet of the project area. A review of the project area found that there are two NRHP listed properties and three NRHP historic districts within 150 feet of its location. In addition to these listed properties and districts, several other properties have been either recommended eligible for listing to the NRHP or are pending listing to the NRHP. Table 4 presents the individual project locations along with the individual NHRP listed properties and districts located in the project area.

Table 4: NRHP Listed Properties and Historic Districts Within or Adjacent to (within 150 feet) of the LMFPS

Location within / adjacent to Project Area	Historic Resource Name	Site Type	National Register of Historic Places (NRHP)
Shawnee Park Pumping Station	Shawnee Park (Part of Olmstead Park System Historic District)	Park	Listed
Shawnee Park Pump Station	Olmstead Park System Historic District	Park System	Listed
34th Street Pump Station	JFWP 18 (Contributing Site to Portland Historic District)	Commercial Building	Listed
34th Street Pump Station	JFWP 413 (Contributing Site to Portland Historic District)	House	Listed
34th Street Pump Station	Portland Historic District	Neighborhood / City	Listed
Canal Street T – Wall	Louisville Railway Co High Street Power Station	Power Station	Determined Eligible
10th Street Pump Station	New Enterprise Tobacco Warehouse	Commercial	Listed
10th Street Pump Station	Tobacco Realty Company Building	Commercial	Listed
5th Street Pump Station	American Life & Accident Insurance Company Building	Commercial	Pending National Register Listing
Butchertown I – Wall Stabilization	JFCB 4 (Contributing Site to Butchertown Historic District)	House	Listed
Butchertown I – Wall Stabilization	JFCB 5 (Contributing Site to Butchertown Historic District)	Commercial / Residential	Listed

Location within / adjacent to Project Area	Historic Resource Name	Site Type	National Register of Historic Places (NRHP)
Butchertown I – Wall Stabilization	JFCB 18 (Contributing Site to Butchertown Historic District)	House (Duplex)	Listed
Butchertown I – Wall Stabilization	JFCB 40 (Contributing Site to Butchertown Historic District)	Duplex	Listed
Butchertown I – Wall Stabilization	JFCB 41 (Contributing Site to Butchertown Historic District)	House	Listed
Butchertown I – Wall Stabilization	JFCB 42 (Contributing Site to Butchertown Historic District)	House	Listed
Butchertown I – Wall Stabilization	JFCB 43 (Contributing Site to Butchertown Historic District)	Duplex	Listed
Butchertown I – Wall Stabilization	JFCB 613 (Contributing Site to Butchertown Historic District)	Commercial Building	Listed
Butchertown I – Wall Stabilization	JFCB 614 (Contributing Site to Butchertown Historic District)	Commercial / Warehouse	Listed
Butchertown I – Wall Stabilization	JFCB 685 (Contributing Site to Butchertown Historic District)	Commercial / Warehouse	Listed
Butchertown I – Wall Stabilization	Wesley House Gymnasium (Contributing Site to Butchertown Historic District)	House	Listed
Butchertown I – Wall Stabilization	William Ray House	House	Listed

Location within / adjacent to Project Area	Historic Resource Name	Site Type	National Register of Historic Places (NRHP)
Butchertown I – Wall Stabilization	Butchertown Historic District	Neighborhood / City	Listed
Starkey Pump Station	JFCB 250 (Contributing Site to Butchertown Historic District)	House	Listed
Starkey Pump Station	JFCB 258 (Contributing Site to Butchertown Historic District)	Manufacturing / Industrial Building	Listed
Starkey Pump Station	Butchertown Historic District	Neighborhood / City	Listed
Beargrass Creek Station	Beargrass Creek Station (Contributing Site to Butchertown Historic District)	Pump Station	Unassessed
Beargrass Creek Station	Butchertown Historic District	Neighborhood / City	Listed

A search of the OSA GIS database found that several archaeological surveys have been conducted within project area. In 2006, David Breetzke surveyed a portion of the APE that makes up the proposed McAlpine access road during an archaeological survey of the proposed McAlpine cell tower (Breetzke 2006). No archaeological sites were identified within the project area during the 2006 survey. In 2016, Brian DelCastello carried out an archaeological survey for the proposed Paddy's Run flood pump station rehabilitation project (DelCastello 2016). No archaeological sites were identified within the project area during the 2016 survey. In 2016, several areas within the Portland neighborhood were selected for areas of deep core testing as part of the CSO basin and included the 34th Street Pump Station (Sullivan 2016). No archaeological sites were identified within the project area during the 2016 survey. In 2016, Anne Bader and Tim Sullivan with Corn Island surveyed 28.12 acres for the proposed downtown CSO Interceptor project (Bader and Sullivan 2016). Portions of this survey covered the 10th Street Pump Station and 10th Street Gate Closure and the 5th Street Pump Station. No archaeological sites were identified within the project area during the 2016 survey. In 2016, 33.6 acres of the Southwestern Parkway CSO basin at the Shawnee Park Pump Station was surveyed by David Schatz and Kathryn McGrath (Schatz and McGrath 2016). Part of this survey covered portions of the project area and no archaeological sites were identified during the 2016 survey. In 2017, Anne Bader and David Schatz

conducted an archaeological survey of the Phase 2 portion of the Southwestern Parkway CSO basin project. Portions of the 2017 survey covered the Shawnee Park Pump Station and no archaeological sites were identified within the project area during the 2017 survey.

Portions of the Louisville Reach are included as part of project area. The Louisville Reach was constructed between 1947 and 1956 and is over 50 years old. Given the age of the Louisville Reach, and previous correspondence with the Kentucky Heritage Council (KHC) on April 4, 2019, the Corps has agreed to evaluate the Louisville Reach for its eligibility for listing in the NRHP. The NRHP eligibility evaluation of the Louisville Reach is in progress and is scheduled to be completed by December 2019.

The Southwestern Jefferson County Reach was constructed between 1973 and 1989 and is less than 50 years old. The Corps consulted with the Kentucky State Historic Preservation Office (SHPO) in both phone call and follow up email on April 4, 2019 regarding the recent age of the Southwestern Jefferson County Reach. SHPO agreed that the Southwestern Jefferson County Reach and Louisville Reach are considered two separate systems. The SHPO also agreed with the Corps that given its recent age (less than 50 years of age) that the Southwestern Jefferson County Reach did not need to be evaluated for the NRHP. The SHPO concurred with this statement in an email dated April 4, 2019.

An archaeological survey was conducted on August 7, 2019 within all anticipated areas of ground disturbance within the project area. The area was examined by both visual inspection in areas of prior ground disturbance and on sloped terrain. The survey also included shovel testing in areas where soils appear to be undisturbed. The portion of site 15JF2 that overlap with the proposed access road at McAlpine Lock and Dam is located in an area of prior disturbance and construction activity. Site 15JF766 is located adjacent to the existing Canal Station Floodwall in an area of prior disturbance and construction activity. Site 15BU160 is located within the existing footprint of the floodwall and the Pond Creek Pump Station. The site was destroyed during the construction of the Southwestern Jefferson County Reach and Pond Creek Pump Station. Most of the project area is previously disturbed due to the construction of the Louisville Reach and Southwestern Jefferson County Reach floodwalls, nearby roads, commercial, industrial, and residential development, and utilities. No undisturbed soils or archaeological sites were identified within the project area during the archaeological survey. The results of the archaeological survey (Volume 1, Appendix F) will be coordinated with both the SHPO and THPOs.

Currently, a Cultural Historic Survey of the project area is in progress to evaluate the effects of the project on above ground structures, NRHP listed properties, and to evaluate the Louisville Reach to determine its eligibility for listing to the NRHP. In addition, the Corps is in the process of developing a determination of effects document for the overall project and will work with the SHPO, other consulting parties, and Tribes to evaluate alternatives or modifications to the project to avoid, minimize or mitigate the adverse effects to any historic properties or archaeological sites that have either been recommended eligible or are already listed to the NRHP through a Memorandum of Agreement (MOA).

2.3 Hydrology & Hydraulics

The Ohio River Basin lies in the middle eastern portion of the United States, east of the Mississippi River. Of the six natural divisions of the Mississippi River Watershed, the Ohio River Basin is the largest in volume of flow and second largest in area with 203,910 square miles of contributing area. The drainage area at Louisville, Kentucky is 91,170 square miles. The main stem of the Ohio River falls 429 feet in its 981-mile course from Pittsburgh to Cairo, Illinois (confluence with the Ohio River and Mississippi River). It ranges in average width from less than a half mile in the Pittsburgh to Wheeling reach to more than a mile at downtown Louisville. At Louisville, it widens out to about one mile.

Several types of storms occur in the basin. One is characterized by long duration, relatively low intensity and wide extent, during which an enormous amount of rainfall. The weather systems which result in these widespread flood-producing storms originate by the opposing action of two large stationary anticyclones – "highs" – one located off the Atlantic coast and the other entrenched over the upper portions of the Mississippi and Missouri Basins, or possibly north of the Canadian Border. These produce a more or less stationary front which lies northeast to southwest across the basin. Along this front a succession of "moist waves" may move northeastward, resulting in bursts of copious warm rains for prolonged periods. The condition continues to exist until there is a displacement of one or both of the anticyclones. Meteorological conditions such as these are confined to the winter or early spring months. The floods of January, 1913 and March, 1964, as well as the January, 1937 flood of record were produced by this type of storm.

Another storm type typical to the basin causes moderate to fairly heavy, and sometimes intense, precipitation for a period generally not exceeding five days, over broad but smaller areas. These involve one or more closely related cyclones – "lows" – and occur most frequently from December to April when soils are generally saturated. Such storms produced the floods of February, 1884; March, 1913; and March, 1936. Occasionally, these storms occur during the summer months, but since the soil is able to absorb a great quantity of rainfall, runoff is less.

Storms covering areas from 50,000 to 200,000 square miles may result in up to 15 inches of rainfall during a two- to five-day period within this area and storm period. Areas as large as 20,000 square miles may experience 24-hour rainfalls in excess of six inches. The basin may experience several of these two- to five-day storms in succession, separated by only three or four days of clear weather.

Thunderstorms often yield intense local rainfall and may cause flash flooding on small streams. The Ohio River Basin averages 30 to 50 days of thunderstorms each year, with a few storms being severe. It is extremely difficult to give advance warning of this type of event for a specific area.

The flow and stage frequency curves for the Ohio River at the LMFPS were also updated for the 2019 SQRA and account for unregulated flows (prior to most upstream dams being constructed) to regulated flows. The current frequency curve has the lowest point of the levee overtopping at an event with a return period of once in 8500 years. The lowest point in the levee is referred to as the Levee Control

Location (LCL). The LCL is located in southwest Jefferson County at Ohio River Mile 622.5. The LCL is the location where a flood event would first overtop the levee crest and is identified by comparing the Top of Levee (TOL) profile with the water surface profiles. The LCL is within an approximate 8 mile stretch that overtops at a similar frequency. MMC modeling for the 2019 SQRA modeled a breach at this location as well as two others; Potential Highest Consequences (PHC), and Maximum Hydraulic Loading (MHL). All three locations (Figure 17) were evaluated under various loading scenarios to estimate consequences from failure prior to and overtopping.

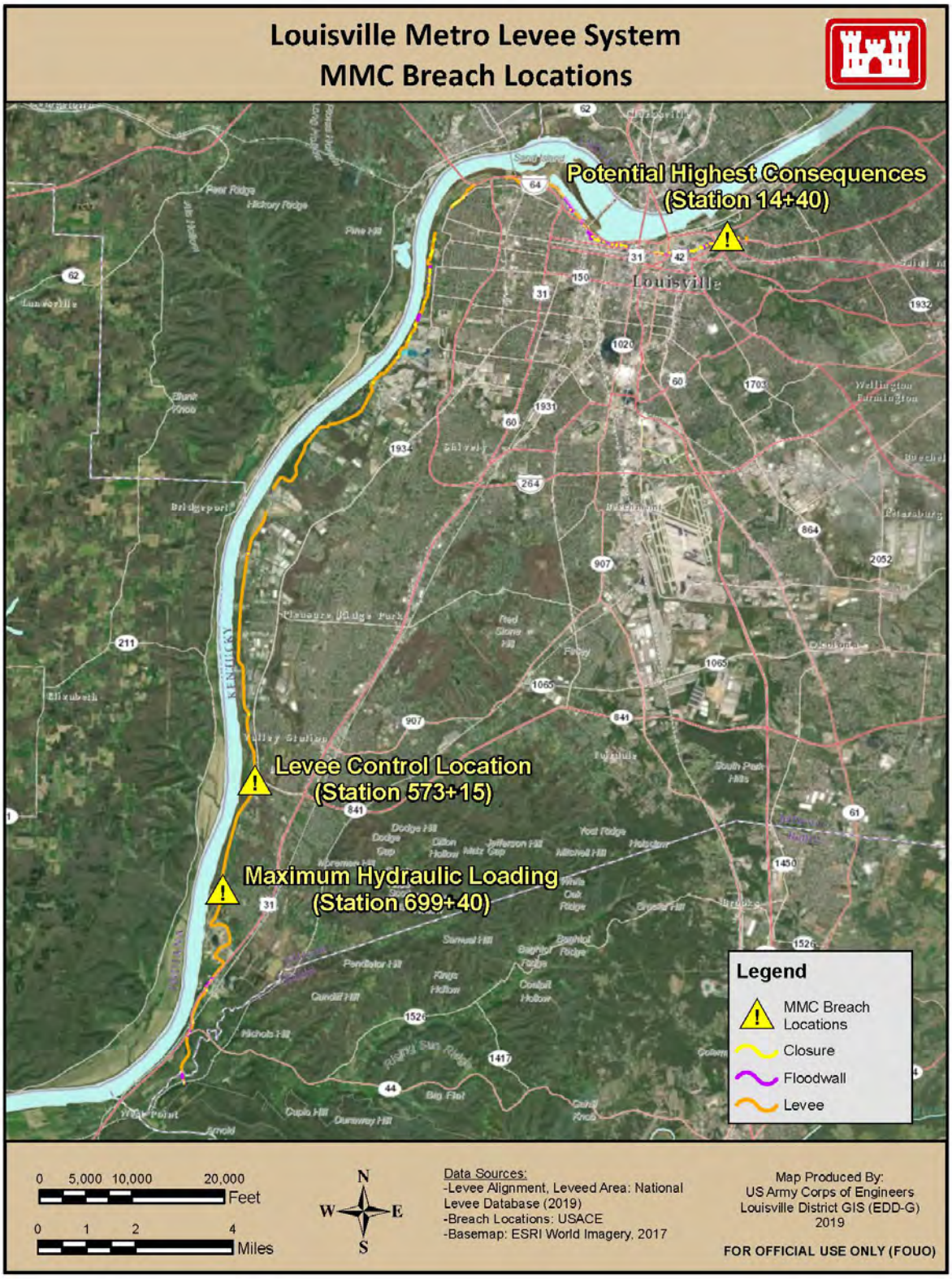


Figure 17: MCC Levee Breach Locations

In addition to an updated probability of overtopping, the revised stage-frequency curve, using an additional 50 years of rainfall and flows from original design to present time, indicate that flood events that load the levee system are less likely than previously expected. Table 5 was developed in support of the 2019 SQRA and shows a summary of key locations along the levee profile with estimated frequencies for varying elevations of the levee up to and beyond the top of levee height.

Table 5: Levee Loading Summary

Levee Loading Summary					
Loading Scenario (At the LCL)	Peak Flow (cfs)	Annual Exceedance Probability (AEP)	Peak Water Surface Elevation (feet NAV88)		
			PHC (STATION 23+64)	LCL (STATION 1142+29)	MHL (STATION 1269+32)
50%	1,043,400	1/2,900	457.24	451.35	450.53
75%	1,087,800	1/5,100	459.84	454.09	453.29
Top of Levee	1,143,300	1/8,500	462.44	456.83	456.06
1ft Overtopping	1,176,600	1/11,500	463.64	457.80	457.04
Incremental Flood Limit	1,243,200	1/21,000	464.38	458.71	458.02
Max	1,298,700	1/31,000	465.72	461.17	460.62

2.4 Levee Risk

The term levee risk is also referred to as "incremental risk" and is used to describe the risk (likelihood and consequences) posed by the levee system itself. Levees are designed to provide a specific level of risk reduction, and larger flood events can cause them to be overtopped or breach (fail) resulting in higher consequences than if the levee was not in place during a flood event. Note that the estimated overtopping frequency for the LMFPS is an average of a 1 in 8,500 year event. For perspective, the 1937 was approximately a 1 in 2,000 year event.

From the 2019 SQRA, the best estimate of the average annual incremental life loss is less than 1 life per year (0.03), which considers the average annual probability of various levee failure scenarios and the estimated life loss that could result from that failure. Average annual life loss does not represent an actual fatality every year, rather it is used to communicate the levee risk on an annual basis.

The levee risk associated with a breach is considered high mainly because of the large population living behind the levee. The overall levee risk is mostly driven by a breach due to an overtopping of the levee embankment by a depth of 1.5 feet of water. This means that during a 1 in 15,400 year event (6.5E-05 AEP), flood water from the Ohio River would be 1.5 feet higher than the top of the levee and possibly

cause the levee to breach. A breach during this 1 in 15,400 year event would lead to an extensive inundated area (46.4 square miles) that contains widespread development and potential significant consequences. Additionally, the potential for partial pump station failure at the Beargrass Creek Pump Station and I-wall instability provided limited contribution to the total risk.

The primary consequence center from overtopping failure is the western and southwestern portions of Jefferson County, KY. Incremental life loss is primarily driven by the large incremental Population at Risk (PAR), which is approximately 50,000 people during the day and 51,000 at night. Average depths on structures is relatively low, but incremental life loss is still high due the large PAR and those that choose not to evacuate and shelter in place.

In general terms, loss of life is computed by estimating PAR, who are those people caught in a structure (home or business) when the flood hazard arrives and are unable to elevate themselves above the maximum water elevation by climbing to second or third stories or onto the roof. It also includes those attempting to evacuate by car but are caught by the flood hazard before they are able to reach the evacuation destination.

The critical factors in determining fatalities are the following:

- Hazard Communication Delay and Warning Communication Delay
- Warning Diffusion Time
- Mobilization Time
- Evacuation Destinations
- Characteristics of the flood hazard (arrival times and depth of water)
- Characteristics of structures (number of occupants, 1st floor elevations and number of stories)

PAR is comprised of the people within the inundated area for a given flood hazard scenario and is divided into two general exposure categories, day and night. Daytime population represents the expected number of people in a given structure during an average working day; hence day populations will typically be higher than night for commercial structures, and lower in residential structures. PAR is a function of both inundation extents (spatial) and warning issuance time (temporal).

The total Incremental economic loss is driven by the large number of inundated structures (approximately 22,000), which includes a significant number of commercial structures. The estimated weighted average incremental life loss is between 100 and 1000 lives per failure, and estimated weighted average incremental economic loss between $1 Billion and $10 Billion.

2.5 Non-Breach Flood Risk

Non-breach flood risk is defined as the risk if the levee simply gets overtopped and the economic and life loss consequences that would occur.

The levee is estimated to overtop at a 1 in 8,500 year event (1.18E-04 AEP). During this rare event, life loss is expected to occur at minimal depths of overtopping due to the extensive length (approximately 8 miles) of the overtopping area; therefore, the likelihood of flooding was estimated to be between a 1 in 3,000 and 30,000 (3E-05 and 3E-04) floods per year. The non-breach inundation area is extensive at approximately 27.4 square miles for floods producing 0.5 feet or greater of overtopping. The weighted average non-breach life loss was estimated to be between 1000 and 10,000 lives per flood. Therefore, the best estimate of average annual non-breach life loss is 0.3 (3E-01) lives per year.

Due to the large number of inundated structures, the weighted average non-breach economic loss was estimated to be between $3 Billion and $30 Billion. Therefore, the best estimate of the average annual non-breach economic loss is $1,000,000 per year.

2.6 Existing Project Accomplishments

Each year, the Louisville District produces Annual Project Accomplishments for every urban and agricultural flood damage reduction project, and multipurpose reservoirs within its Civil Works boundary. This memorandum provides information on storm events and associated flood damages in the Louisville District in support of the U.S. Army Corps of Engineers annual flood damage reduction report submitted to Congress. The report is prepared in response to House Committee Report 98-217, Energy and Water Development Appropriation Act of 1984.

This report includes data on flood damages reduced by projects controlled by the Corps. The report represents preliminary estimates available at the end of the fiscal year from a variety of sources. These estimates are generated by applying real rainfall, stream, and gauge data to established depth-damage curves for each project within the Louisville District Civil Works boundary.

The data is intended to provide an overall assessment of storm events and the extent of beneficial flood damages prevented by the Louisville District Civil Works Projects. The Project Accomplishments are used in the annual Report of the Secretary of the Army on Civil Works Activities. Upward reporting of flood damage reduction outcomes is also required by the Office of Management and Budget (OMB) to assess the Corps via the Performance Assessment Rating Tool (PART).

The process for developing the annual flood damages reports is fairly straightforward. Each year, typically around December or January, the district Hydrology and Hydraulics Section will review available data (gages, etc.) around completed flood risk management projects. The data is then condensed to a set of flows, stages, or frequencies representing reductions in the area of, or as a result of, an existing project. For example, storage projects typically provide information for (1) what level the river would have reached, had the project not been operated and (2) what level the river did reach. Levee projects typically only require the actual river levels. This information is then passed to a district economist, who compares the hydrology and hydraulics (H&H) information with a set of project-specific stage-damage functions. These functions, combined with the H&H information, produce the economic value of the damages prevented. These values are then passed back to the Hydrology and Hydraulics Section, then

progress through the MSC, and Headquarters before ultimately being combined in an annual report to Congress.

The stage-damage curves used for the LMFPS date back to 1962. While the price levels are typically updated by the economist each year, the population centers and surrounding areas have seen significant change over the past 60+ years, particularly in growth of residential, commercial, and industrial structures. This means it is nearly certain that the District is systematically underestimating the value of existing flood risk management projects, including LMFPS, by failing to capture the intensification of benefits that has occurred. Table 6 displays the actual LMFPS Annual Flood Damage Reductions in the year in which they transpired, with each occurrence also indexed to current FY19 price levels using the Engineering News-Record's Construction Cost Index.

Table 6: Louisville Metro Flood Protection System Annual Flood Damage Reduction

Flood Damages Prevented Calculator

Year	Base Year Index	Current Year: 2019	Index Factor (ENR CCI)	Flood Damage Prevented (observed year)	Damages Prevented 2019 Price Level
1955	660	11183.53	16.9447	$ 1,430,000	$ 24,230,982
1956	692	11183.53	16.1612	$ -	$ -
1957	724	11183.53	15.4469	$ -	$ -
1958	759	11183.53	14.7346	$ 410,200	$ 6,044,116
1959	797	11183.53	14.0320	$ -	$ -
1960	824	11183.53	13.5722	$ -	$ -
1961	847	11183.53	13.2037	$ 919,100	$ 12,135,516
1962	872	11183.53	12.8251	$ 1,887,300	$ 24,204,904
1963	901	11183.53	12.4124	$ 1,350,000	$ 16,756,676
1964	936	11183.53	11.9482	$ 6,136,000	$ 73,314,252
1965	971	11183.53	11.5175	$ -	$ -
1966	1019	11183.53	10.9750	$ -	$ -
1967	1074	11183.53	10.4130	$ 1,617,300	$ 16,840,897
1968	1155	11183.53	9.6827	$ 484,000	$ 4,686,432
1969	1269	11183.53	8.8129	$ -	$ -
1970	1381	11183.53	8.0981	$ -	$ -
1971	1581	11183.53	7.0737	$ 100	$ 707
1972	1753	11183.53	6.3797	$ 230,000	$ 1,467,320
1973	1895	11183.53	5.9016	$ -	$ -
1974	2020	11183.53	5.5364	$ -	$ -
1975	2212	11183.53	5.0558	$ -	$ -
1976	2401	11183.53	4.6579	$ -	$ -
1977	2576	11183.53	4.3414	$ -	$ -
1978	2776	11183.53	4.0286	$ -	$ -
1979	3003	11183.53	3.7241	$ 14,146,000	$ 52,681,390
1980	3237	11183.53	3.4549	$ -	$ -
1981	3535	11183.53	3.1637	$ -	$ -
1982	3825	11183.53	2.9238	$ -	$ -
1983	4066	11183.53	2.7505	$ 89,000	$ 244,794
1984	4146	11183.53	2.6974	$ -	$ -
1985	4195	11183.53	2.6659	$ -	$ -
1986	4295	11183.53	2.6038	$ -	$ -
1987	4406	11183.53	2.5383	$ -	$ -
1988	4519	11183.53	2.4748	$ -	$ -
1989	4615	11183.53	2.4233	$ 1,499,000	$ 3,632,527
1990	4732	11183.53	2.3634	$ -	$ -
1991	4835	11183.53	2.3130	$ -	$ -
1992	4985	11183.53	2.2434	$ -	$ -
1993	5210	11183.53	2.1466	$ -	$ -
1994	5408	11183.53	2.0680	$ -	$ -
1995	5471	11183.53	2.0441	$ -	$ -
1996	5620	11183.53	1.9900	$ -	$ -
1997	5826	11183.53	1.9196	$ 61,353,000	$ 117,772,591
1998	5920	11183.53	1.8891	$ -	$ -
1999	6059	11183.53	1.8458	$ -	$ -
2000	6221	11183.53	1.7977	$ -	$ -
2001	6334	11183.53	1.7656	$ -	$ -
2002	6538	11183.53	1.7105	$ -	$ -
2003	6694.64	11183.53	1.6705	$ -	$ -
2004	7114.89	11183.53	1.5718	$ 1,786,000	$ 2,807,322
2005	7445.98	11183.53	1.5020	$ 13,280,000	$ 19,945,968
2006	7749.36583	11183.53	1.4432	$ -	$ -
2007	7970.52083	11183.53	1.4031	$ -	$ -
2008	8311.14083	11183.53	1.3456	$ 2,146,000	$ 2,887,673
2009	8570	11183.53	1.3050	$ 2,101,000	$ 2,741,727
2010	8799	11183.53	1.2710	$ -	$ -
2011	9070	11183.53	1.2330	$ 18,836,000	$ 23,225,245
2012	9308	11183.53	1.2015	$ -	$ -
2013	9547	11183.53	1.1714	$ -	$ -
2014	9806	11183.53	1.1405	$ -	$ -
2015	10035	11183.53	1.1145	$ 9,525,000	$ 10,615,159
2016	10338	11183.53	1.0818	$ -	$ -
2017	10737	11183.53	1.0416	$ 218,000	$ 227,066
2018	10870.06	11183.53	1.0288	$ 30,630,000	$ 31,513,306
2019	11183.53	11183.53	1.0000	$ -	$ -

Number of Years	$ 64	
Unindexed Cumulative	$ 170,073,000	
Unindexed Annual Average	$ 2,657,391	
	Indexed Cumulative	$ 447,976,570
	Indexed Annual Average	$ 6,999,634
	Present Value	$184,452,884.17

2.7 Existing Project Accomplishments Comparison to LifeSim Model Runs

It is understood that the Louisville District has certainly underestimated annual project accomplishments associated with the LMFPS by using the 1962 stage-damage curves. To account for this underestimation, a comparison between expected flood damages using the 1962 stage-damage curves and expected flood damages observed using a HEC-LifeSim model with an up-to-date structure inventory was conducted.

The Louisville District's Engineering Division provided hydraulic models that demonstrated the inundation of the Louisville Metro leveed area during 1-, 2-, 5-, 10-, 25-, 50-, 100-, and 500- year flood events in a simulation wherein the city is vulnerable without the levee system. Those flood scenarios were imported into HEC-LifeSim 1.0.1 along with a structure inventory based on the National Structure Inventory (NSI) 2.0. Structure placement in the NSI 2.0 is based on 2017 parcel data, and structure, content and vehicle values are in 2018 prices. The resulting property damage expected from those flood events is shown in Table 7.

Table 7: Estimated Property Damage Using LifeSim

Flood event	Estimated property damage per event
1-year	$279,202
2-year	$7,771,261
5-year	$12,508,673
10-year	$27,691,290
25-year	$66,677,426
50-year	$202,267,170
100-year	$483,377,680
500-year	$1,634,487,200

To estimate damage from the same events using the 1962 state-damage curves, Engineering Division provided corresponding river elevations and stages at the Upper and Lower Gages at Louisville's McAlpine Locks and Dam, which were used to calculate benefits for the system. The estimated property damage from the 1962 stage-damage curves are shown in Table 8.

Table 8: Estimated Property Damage Using 1962 Stage-Damage Curves

Flood event	McAlpine Upper Gage (UG)*		McAlpine Lower Gage (LG)*		Total expected damage per event
	Stage	Damage	Stage	Damage	
1-year	17.47 feet	$0	46.33 feet	$0	$0
2-year	23.64 feet	$0	55.04 feet	$0	$0
5-year	27.43 feet	$1,572,000	59.97 feet	$0	$1,572,000
10-year	31.12 feet	$11,845,000	63.99 feet	$116,000	$11,961,000
25-year	34.80 feet	$22,974,000	67.58 feet	$1,218,000	$24,192,000
50-year	37.79 feet	$35,128,000	70.65 feet	$8,755,000	$43,883,000
100-year	40.17 feet	$48,433,000	73.03 feet	$26,929,000	$75,362,000
500-year	44.95 feet	$203,908,000	77.62 feet	$139,766,000	$343,674,000

* North American vertical datum of 1988.

The difference in these two methods of estimation demonstrates vividly the failure of the 1962 stage-damage curves to capture the intensification of benefits that has occurred from increased development in the leveed area since the origin of the curves. Expected annual damages were estimated based upon the flood events simulated in LifeSim, shown in Table 9.

Table 9: Expected Annual Damages Computation

Louisville Metro Flood Protection System
Emergency Supplemental Feasibility Study
Annual Damage Computation
LifeSim Model Results

Recurrence Interval	Probability	Probability Interval	Damages	Interval Average Damages	Interval Damage Calculation	Summary of Expected Annual Damages
1	0.999		$249,202			
		0.499		$4,010,232	$2,001,106	$2,001,106
2	0.5		$7,771,261			
		0.3		$10,139,967	$3,041,990	$5,043,096
5	0.2		$12,508,673			
		0.1		$20,099,982	$2,009,998	$7,053,094
10	0.1		$27,691,290			
		0.06		$47,184,358	$2,831,061	$9,884,155
25	0.04		$66,677,426			
		0.02		$134,472,298	$2,689,446	$12,573,601
50	0.02		$202,267,170			
		0.01		$342,822,425	$3,428,224	$16,001,825
100	0.01		$483,377,680			
		0.008		$1,058,932,440	$8,471,460	$24,473,285
500	0.002		$1,634,487,200			

Applying the LifeSim-based expected annual damages ($24,473,285) to the project's total average annual costs of $6,729,000 results in a benefit-cost ratio of 3.6:1.

Prior to submission of the Draft Final Feasibility Study, HEC-FIA version 2.2 will be used to estimate damages produced by 1-, 2-, 5-, 10-, 25-, 50-, 100-, and 500- year flood events in a simulation wherein the city is vulnerable without the levee system. The River Analysis System (RAS) output provided by H&H for the similar modeling that was done in HEC-LifeSim will be used to produce maximum depth grids for each event. Those depths will be applied to the NSI 2.0 to calculate damages. The damages for each frequency event will be used to calculate the expected annual damages that would occur to the up-to-date inventory in the absence of the levee system.

2.8 Existing Project Conditions

Overall, the levee system is well maintained and has not had any significant performance issues during high water events, but no event has significantly loaded the levee system. The Non-Federal Sponsor has demonstrated adherence to the O&M program ($10.5M estimated in annual expenditures), often going above and beyond by conducting supplemental inspections of project components. The Non-Federal Sponsor is highly engaged with 13 full time employees who operate and maintain the levee system. Additional resources of up to 150 personnel are available during flood response operations.

However, the system is aging, and mechanical/electrical components of the system are requiring regular and often significant maintenance each year. There are areas of known concern discovered during the 2019 PI, 2015 LSE and 2019 SQRA that are summarized below. A full account of the system conditions is contained in Volume 2.

2.8.1 Pump Stations - General

The Louisville Levee System has a total of 15 federally constructed pump stations (73 pumps) that were federally constructed for the purpose of pumping surface drainage from the leveed area into the Ohio River during flood periods (closed outlet conditions). The System has substantial streams that flow through the levee system (e.g. Beargrass Creek, Mill Creek and Pond Creek) and conveyance of water through the system when river gates are closed is essential to maintain the overall system function and performance.

Table 10 displays the population and number of structures which experience flood risk reduction from the various Louisville Flood Pump Stations. The 4th column also displays the stormwater drainage area in acres which drain to the pump stations. The table was adapted from the 2017 MSD Comprehensive Facility Plan.

Table 10: Federally Constructed Pump Stations. Population, Buildings and Drainage Served.

Flood Pump Station	Population	Buildings	Drainage (Acres)
Beargrass Creek Pump Station	17,660	6,640	38,682*
Robert J. Starkey Pump Station	17,660	6,640	38,682*
4th Street Pump Station	1,640	440	350
5th Street Pump Station	1,710	180	171
10th Street Pump Station	3,280	290	258
17th Street Pump Station	1,010	510	142
27th Street Pump Station	10,510	5,610	910
34th Street Pump Station	12,580	6,660	1,205
Shawnee Park Pump Station	30,650	15,960	3,008
Western Parkway Pump Station	93,540	41,770	11,144
Paddy's Run Pump Station	36,540	23,500	5,699
Upper Mill Creek Pump Station	39,600	27,380	8,682
Riverport Pump Station	30	250	789
Lower Mill Creek Pump Station	70,480	51,320	17,432
Pond Creek Pump Station	33,950	22,600	15,473

* The Beargrass Creek and Robert J Starkey Pump Station have overlapping contributing areas. The Beargrass Creek Pump Station serves the area's watershed, and the Robert J Starkey Pump Station serves the area's sewershed.

There are numerous pump stations at the project that play an essential role in preventing consequences due to interior flooding. The majority of the equipment, including the pumps, are original to the project with decreasing reliability due to age and deterioration. Although the Non-Federal Sponsor has a good history of maintenance, pump station reliability has become a consistent problem, especially in recent years, sometimes affecting the ability of the pump stations to operate at full capacity. In addition, a number of the pump stations have small or non-existent ponding areas associated with them. This leads to a potential for both incremental life loss and economic loss, if the pump station fails to operate as designed. This is especially true at the Beargrass Creek Pump Station where incremental life loss due to a partial loss of the pump station is significant.

Pump stations have three basic components: the pumps, the electrical motors that turn the pumps, and the electrical supply equipment and switchgear that provide the power for the motors. The pumps themselves have not been upgraded nor had any major rehabilitation since their original installation. The pumps in the stations are exercised by MSD staff for short periods of time to check that they are functioning.

Nearly all the pump motors in these stations are the originals. The pump motors have been kept in good condition from an exterior standpoint. They are painted, clean, and kept reasonably dry. The pump motor insulation is given its age, is expected to be cotton, asbestos, or a combination thereof. This insulation has exceeded its predictable useful life (its ability to prevent electrical shorts). The insulation of the windings is rarely exposed to the heat of a fully loaded motor for extended periods of time. The monthly testing of pumps does not stress the winding insulation and bearings adequately to reveal how the pump motors will respond during a sustained high flow event.

In a majority of stations in the Louisville Reach, the motor control switchgear is the original, 1950's vintage switchgear. Included are oil circuit breakers, protective relaying, potential transformers, current transformers, meters, and wiring. The switchgear appears to be in good shape from visual inspection; however, this equipment has exceeded its life expectancy. Though it is rarely used, it is becoming increasingly difficult to service due to a scarcity of parts. The existing switchgear operation relies on a multitude of mechanical movements of numerous parts to perform its functions. Due to its age, replacement of broken or worn out parts sometimes results in nationwide searches for expensive, rare, used parts.

The high expense and downtime of total replacement of switchgear in general has given rise to several companies that deal in reconditioned parts acquired from demolished equipment. Chances of locating a specific part or a replacement breaker in their inventory are random and generally decreasing. Switchgear manufacturers ceased production of oil circuit breakers; since 1983, sulfur hexafluoride circuit breakers have replaced oil circuit breakers in new installations. The potential transformers used for protective relaying may contain polychlorinated biphenyl (PCB) oil. Their failure would negate a portion of the protective relaying and metering and a non-PCB replacement could be difficult if not impossible to find. As years pass, obsolescence will progressively get worse as chances of equipment failure increase, especially when placed under rare heavy load that cannot be easily simulated.

2.8.2 Beargrass Creek Pump Station

The Beargrass Creek Pump Station (Figure 18) is located at the corner of Brownsboro Road and Story Avenue and spans Beargrass Creek. During Ohio River flood events, the station pumps Beargrass Creek flow from the landside to the riverside of the levee system. The Beargrass Creek Pump Station is the fourth station of the McAlpine upper gauge (UG) to go on line should a flood occur on the Ohio River. On average, the pump station operates about once every 3 to 4 years. The pump station was designed by the Corps and put into service in 1952.

Figure 18: Beargrass Creek Pump Station

The original pumps, motors, and ancillary systems are still in service, most of which have not had a major rebuild since installed in 1952. The control system is rudimentary by today's standards, requiring the station to be staffed at all times during flood pumping operations.

All eight of the existing pumps and motors are recommended for removal, inspection, and rehabilitation or replacement. The 2015 LSE recommended the voltage meters be recalibrated, motors retested and motor currents further investigated, and corrective actions be performed on the motor winding insulation. Some of these items were addressed under an electrical modifications project by MSD in 2017 and included the following: new medium voltage motor control center (MCC) and substation upgrades (not including transformers); replacement of old wiring to low voltage equipment; roof replacement; and improvements to the supervisory control and data acquisition (SCADA) system.

The 2015 LSE noted the east river gate did not close properly and needed further investigation and repair. The coupling on the west gate had excessive movement and needs further investigation and possible repair. Both gates needed to be cleaned and painted. Gate actuators, gearboxes, and stems needed to be repaired or replaced as appropriate. The two bypass gates, one in the east bay and one in

the west bay, used to equalize the inside and outside pressures against the intake gates both leak with no way to inspect since they are continuously submerged. These bypass gates needed to be investigated to determine options for inspection and repair.

The inability to open river gates with a differential head were identified as a risk driver during the 2019 SQRA. In the past 65 years there have been two documented occurrences of the pumps losing power while the gates were closed and the leveed area ponding elevation was higher than the Ohio River elevation. If gates could have been opened during these events, interior flooding could have been less. It was determined that being able to open the gates under a differential head would lower the overall risk; however, the existing hoist machinery was not designed for differential head operation.

2.8.3 Starkey Pump Station

The Robert J. Starkey Pump Station (Figure 19), located at the corner of Buchanan and Franklin Streets, is the first station upstream of the McAlpine UG to go online should a flood occur on the Ohio River. On average, the pump station operates in flood mode about once every year. The pump station, formerly the Buchanan Street Pump Station, was reconstructed as a completely new pump station in 2005. The station is operated as a sanitary pumping station during periods of normal river stage and as a combined storm and sanitary pumping station during periods of high water. The frequency of use reduces the expected lifespan of pumps and motors.

Figure 19: Robert J. Starkey Pump Station

The biggest concern inside the pump station is the check valves, which are closed using variable-frequency drives (VFDs) since they do not have mechanical arms. When VFDs fault, the check valves slam shut resulting in a water hammer effect. Other concerns include issues with the DeviceNet system,

which operates the electrical breakers. These breakers need to be replaced and the system needs to be converted to the Modbus serial communications protocol.

2.8.4 4th Street Pump Station

The 4th Street Pump Station (Figure 20), located at the southeastern corner of 4th Street and Main Street in downtown Louisville, is the second station upstream of the McAlpine UG to go online should a flood occur on the Ohio River. On average, the pump station is operated in flood mode about once every 5 years. However, recent real-time control modifications implemented as part of MSD's Dry Weather Overflow Elimination Project now results in the station operating in minor flood mode between 1 and 2 times a year. The pump station was designed by the Corps and put into service in 1952. The 4th Street Pump Station Improvement Project, completed by MSD in 2018, addressed the identified needs for this station including pumps, motors, and electrical equipment to match its current capacity.

Figure 20: 4th Street Pump Station

2.8.5 5th Street Pump Station

The 5th Street Pump Station (Figure 21) is located at the north end of 5th Street and is confined to a small space between the Kentucky Center for the Arts and the Riverfront Parking Garage. The 5th Street Pump Station is the fifth station upstream of the McAlpine UG to go online should a flood occur on the Ohio River. On average, the pump station operates about once every 5 years. The pump station was designed by the Corps and put into service in 1952. The original pumps, motors, and ancillary systems are still in service and have not had a major rebuild since they were originally installed. The electrical system is original equipment, which cannot be repaired with currently available components. The control system is rudimentary by today's standards, requiring the station to be fully staffed at all times during flood pumping operations.

Figure 21: 5th Street Pump Station

2.8.6 10th Street Pump Station

The 10th Street Pump Station (Figure 22), located at the northwest corner of 10th and Rowan Streets, is the sixth station upstream of the McAlpine UG to go online should a flood occur on the Ohio River. On average, the pump station operates about once every 5 years. The pump station was designed by the Corps and put into service in 1952. The original pumps, motors, and ancillary systems are still in service and have not had a major rebuild since they were originally installed. The electrical system is original equipment, which cannot be repaired with currently available components. The control system is rudimentary by today's standards, requiring the station to be fully staffed at all times during flood pumping operations.

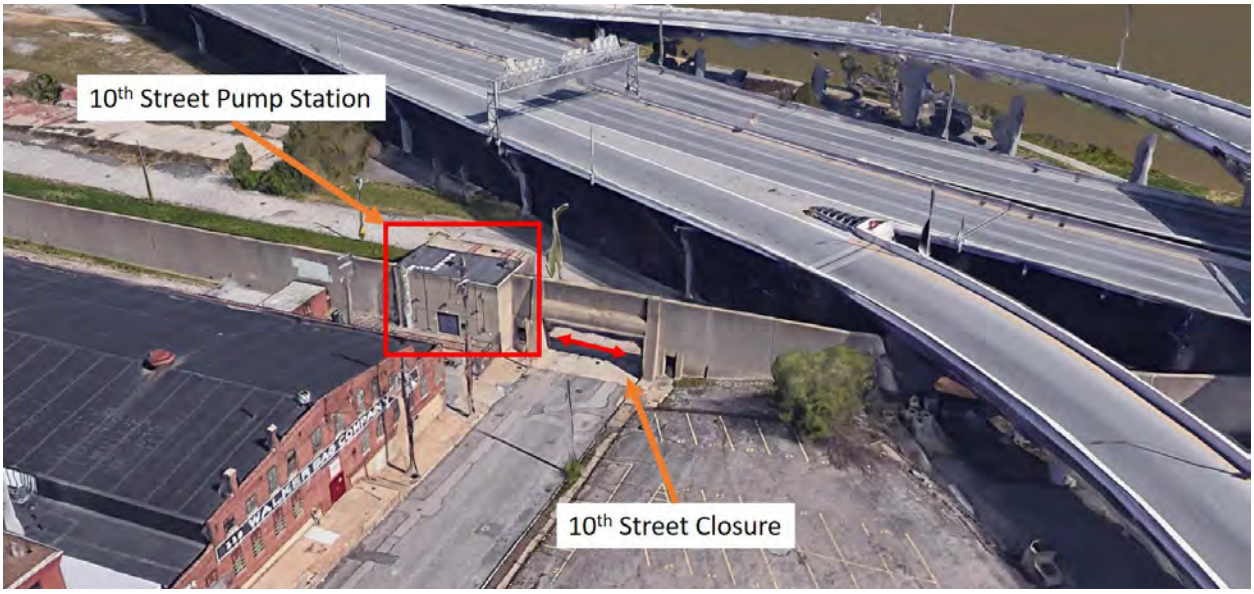


Figure 22: 10th Street Pump Station and 10th Street Road Closure

2.8.7 17th Street Pump Station

The 17th Street Pump Station (Figure 23), located at the north end of 17th Street immediately north of the Northwestern Parkway, is the eighth and final station upstream of the McAlpine UG to go online should a flood occur on the Ohio River. On average, the pump station operates about once every 5 years. The pump station was designed by the Corps and put into service in 1952. The original pumps, motors, and ancillary systems are still in service and have not had a major rebuild since they were originally installed. The electrical system was recently upgraded along with gate actuators and controls. The station is still staffed at all times during flood pumping operations.

Figure 23: 17th Street Pump Station

2.8.8 27th Street Pump Station

The 27th Street FPS (Figure 24), located on the landside of the levee with access from 27th Street, is the third station upstream of the McAlpine UG to go online should a flood occur on the Ohio River. On average, the pump station operates about once every 5 years. The pump station was designed by the Corps and put into service in 1952. The original pumps, motors, and ancillary systems are still in service and have not had a major rebuild since they were originally installed. The electrical system was recently upgraded along with gate actuators and controls. The station is still staffed at all times during flood pumping operations.

Figure 24: 27th Street Pump Station and 27th Street Road Closure

2.8.9 34th Street Pump Station

The 34th Street Pump Station (Figure 25), located just landside of the levee on 34th Street, is the second station downstream of the McAlpine lower gage (LG) to go online should a flood occur on the Ohio River. On average, the pump station operates about once every year. The pump station was designed by the Corps and put into service in 1951. The original pumps, motors, and ancillary systems are still in service and have not had a major rebuild since they were originally installed. The electrical system was recently upgraded along with gate actuators and controls. The station is still staffed at all times during flood pumping operations.

Figure 25: 34th Street Pump Station

2.8.10 Shawnee Park Pump Station

The Shawnee Park Pump Station (Figure 26), located within a Louisville Metro park at the west end of Broadway, is the fourth station downstream of the McAlpine LG to go online should a flood occur on the Ohio River. On average, the pump station operates about once every 5 years. The pump station was designed by the Corps and put into service in 1951. The original pumps, motors, and ancillary systems are still in service and have not had a major rebuild since they were originally installed. The electrical system is original equipment, which cannot be repaired with currently available components. The control system is rudimentary by today's standards, requiring the station to be fully staffed at all times during flood pumping operations.

Figure 26: Shawnee Park Pump Station

2.8.11 Western Parkway Pump Station

The Western Parkway Pump Station (Figure 27), located near Chickasaw Park off of Southwestern Parkway and just north of the Morris Forman Water Quality Treatment Center (WQTC). On average, the pump station operates about once or twice every year. The pump station was designed by the Corps and put into service in 1952. The pump station was recently reconstructed with new pumps, motors, an electrical substation and switchgear. The controls are still original to the pump station. In 2013 MSD completed a project at the pump station that included a new trash removal system, plumbing, HVAC, roofing membrane, and aesthetic improvements. Louisville Gas and Electric (LG&E) also provided a redundant power feed from their system as part of this project; however, the current service transformers are unable to provide full power to the pump station. The station is still staffed at all times during flood pumping operations.

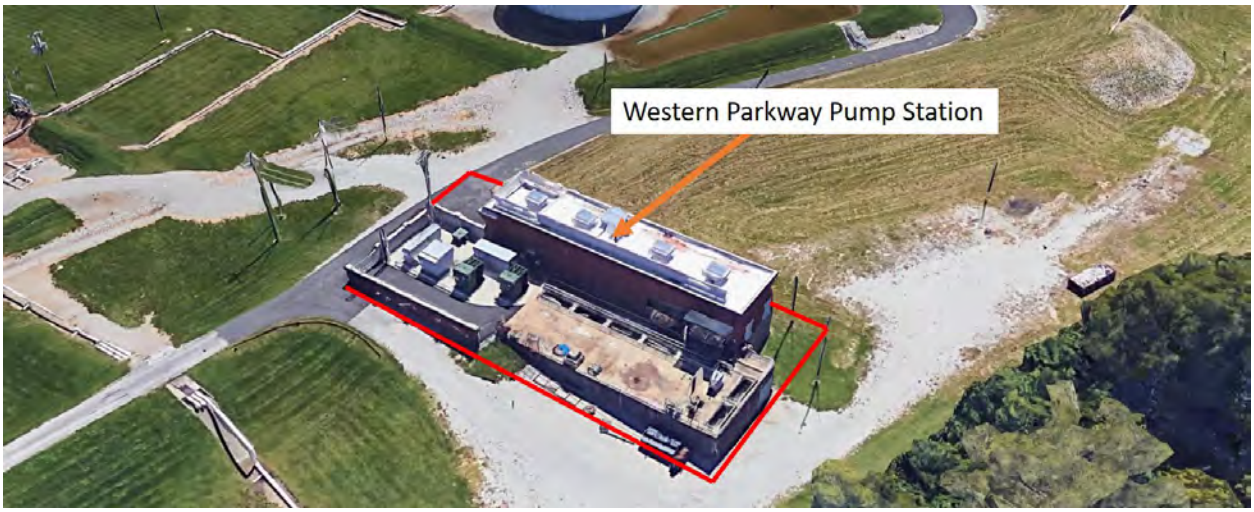


Figure 27: Western Parkway Pump Station

2.8.12 Paddy's Run Pump Station

The Paddy's Run Pump Station (Figure 28), located on the northern bank of Paddy's Run Creek, adjacent to the LG&E facility. Paddy's Run is the first station downstream of the McAlpine LG to go online should a flood occur on the Ohio River. Historically, this pump station had been online twice in 17 years, but is now being operated in minor flood mode earlier and more frequently when flooding occurs to improve hydraulics elsewhere in the leveed area as MSD implements its real-time control initiative. The pump station was designed by the Corps and put into service in 1953. The original pumps, motors, and ancillary systems are still in service and have not had a major rebuild since they were originally installed. The electrical system is original equipment, which cannot be repaired with currently available components. The control system is rudimentary by today's standards, requiring the station to be fully staffed at all times during flood pumping operations.

Figure 28: Paddy's Run Pump Station

2.8.13 Upper Mill Creek Pump Station

The Upper Mill Creek Pump Station (Figure 29), located 1 mile south of the terminus of Lee's Lane at the levee, is the fifth station downstream of the McAlpine LG to go online should a flood occur on the Ohio River. On average, the pump station operates about every other year. The pump station was designed by the Corps and put into service in 1983.The original pumps, motors, and ancillary systems are still in service and have not had a major rebuild since they were originally installed. The electrical system is original equipment and replacement parts are becoming increasingly more difficult to obtain. The control system is rudimentary by today's standards, requiring the station to be fully staffed at all times during flood pumping operations.

Figure 29: Upper Mill Creek Pump Station

2.8.14 Riverport Pump Station

The Riverport Pump Station (Figure 30), located at 8100 Cane Run Road just inside the levee, is the seventh station downstream of the McAlpine LG to go online should a flood occur on the Ohio River. On average, the pump station operates about every other year. The pump station was designed by the Corps and put into service in 1980. The original pumps, motors, and ancillary systems are still in service and have not had a major rebuild since they were originally installed. The electrical system is original equipment and replacement parts are becoming increasingly more difficult to obtain, when needed. The control system is rudimentary by today's standards, requiring the station to be fully staffed at all times during flood pumping operations.

Figure 30: Riverport Pump Station

2.8.15 Lower Mill Creek Pump Station

The Lower Mill Creek Pump Station (Figure 31), located at 12701 Lower River Road, is the third station downstream of the McAlpine LG to go online should a flood occur on the Ohio River. On average, the pump station operates about every other year. The pump station was designed by the Corps and put into service in 1980. The original pumps, motors, and ancillary systems are still in service and have not had a major rebuild since they were originally installed. The electrical system is original equipment and replacement parts are becoming increasingly more difficult to obtain, when needed. The control system is rudimentary by today's standards, requiring the station to be fully staffed at all times during flood pumping operations.

Figure 31: Lower Mill Creek Pump Station

2.8.16 Pond Creek Pump Station

The Pond Creek Pump Station (Figure 32), located on U.S. Highway 44 just east of Dixie Highway, is the sixth station downstream of the McAlpine LG to go online should a flood occur on the Ohio River. On average, the pump station operates about every other year. The pump station was designed by the Corps and put into service in 1989. Three of the four pumps are original equipment (MSD is currently completing a rebuild of one pump at the station). All pump motors and ancillary systems are still in service and have not had a major rebuild since they were originally installed. A bearing goes out almost every time the pumps are operated impacting operability of the pump station during flood events. The shaft only has an upper bearing and a lower bearing. The 2015 LSE noted the motors should be checked for insulation deterioration. The electrical system is original equipment and replacement parts are becoming increasingly more difficult to obtain, when needed. The control system is rudimentary by today's standards, requiring the station to be fully staffed at all times during flood pumping operations.

I-Walls adjacent to Pond Creek Pump Station were identified as having the potential for a pre-mature failure in the 2019 SQRA, which was completed concurrently with the Louisville Metro Flood Protection System Feasibility Study. The reinforcing bars on the tension side (riverside face) of the I-Walls are not anchored to or through the sheet piling, in accordance with modern design guidance. Lack of anchorage of the tension bars allows the I-Wall to rotate about the top of the sheet pile, which could lead to a brittle failure under a hydrostatic loading condition less than the original design load.

Figure 32: Pond Creek Pump Station

2.8.17 Sluice Gates-General

Most sluice gates were operated during the 2019 PI. The interior drainage sluice gates were given an overall rating of minimally acceptable due to some gates having corrosion leading to section loss. A total of 40 gates were identified for refurbishment or replacement.

2.8.18 Floodwalls-General

Tilting, sliding, and settlement were observed in multiple monoliths. However, no indication of active movements were observed, based on comparison of measurements from the 2019 PI and the measurements performed by Heritage Engineering in June 2015. Differential movements of one inch or greater have the potential to damage the water stop. This determination is based on recent experience by the Louisville District in the Paducah, Kentucky levee System. During the development of the 2011 Paducah Reconstruction Feasibility Report, core samples were taken of potentially damaged water stops and it was determined that differential movements of greater than 1 inch could damage water stops. The PDT assumed the same damage would or has occurred in the LMFPS and a total of 26 locations were identified in the 2019 PI where water stops may have been damaged base differential movement.

2.8.19 Butchertown I-Wall

First noted during the 2007 Phase II I-Wall evaluations and subsequently further investigated during the 2019 SQRA, two locations of I-Walls in the Butchertown Neighborhood were identified as having inadequate global stability safety factors (see Figure 33 and Figure 34), which presents a failure risk under certain loading conditions. Additional detail on the current condition of the I-Walls is located in Volume 2.

Figure 33: Butchertown I-Wall - Segment 1

Figure 34: Butchertown I-Wall - Segment 2

2.8.20 Johnsontown Road Closure Vault

The Johnsontown Road Closure Vault, as shown in Figure 35, was noted to have significant deterioration due to its age. In addition, the current grading adjacent to the closure vault was identified as an issue during the 2019 PI. Moisture intrusion because of missing weep holes or clogged weep holes in the brick has resulted in joint reinforcement corrosion. As a result of the joint reinforcement corrosion, the mortar in the bed joints is spalling. Multiple areas of the inside face of the CMU are cracking.

Figure 35: Johnsontown Road Closure Vault

2.8.21 Canal Station

The Canal Station building foundation walls are considered part of the Louisville Metro Levee System project. The building was constructed many years before the levee system. However, the designers of the levee system evaluated the foundation walls during the construction of the Louisville Reach and determined that they would be able to provide flood risk reduction to the leveed area. Therefore, when the Louisville Reach was constructed, the foundation walls became integral with the levee system alignment (Figure 36). The generating station is no longer in service and was previously condemned. The building is anticipated to be demolished in the future by the owner (LG&E) or their representative. The demolition of the generating station building is considered a separate action not connected to the project.

Figure 36: Canal Station Floodwall

2.8.22 10th Street Closure

The 10th Street Closure (Figure 22) is placed in service at relatively low river elevations and this closure is the second most frequently installed. The Non-Federal Sponsor must use large equipment and numerous personnel to install the closure, which shifts resources that could be directed to other locations accelerating the closure plan for the LMFPS.

2.8.23 27th Street Closure

The closure at 27th Street closure (Figure 24) can only be installed from the riverside and is the first closure to be placed due to its comparatively low sill elevation. The closure is located beneath deteriorating overhead railroad structure and the closure itself is in poor condition including the sill, supporting walls and area near the bridge abutments. Installation can be delayed by broken parts requiring field modification and could present a problem during a rapidly rising flood event.

3 FUTURE WITHOUT PROJECT CONDITION

The Future Without Project (FWOP) Condition is developed to describe the most likely future conditions in the project area if no Federal action is taken to address the identified problems. It forms the baseline for identifying the effects of the alternatives and is equivalent to the No Action alternative. In order to identify the FWOP that would be used for evaluation purposes, the study team began with the existing conditions information and considered where potential changes could occur in the future.

3.1 Pump Stations

A pump's life is not usually determined by age, but by run-hours. In the case of flood pumping stations, they are run infrequently over several years and many do not have a good record of run-hours. In some cases, the life-span of the pump will be determined by corrosion, rather than mechanical wear. The style of pump, the operating range, chemical composition of the pumping fluid, and other factors can affect the life of the pump.

Large contributors to failure during the periods of idleness would be corrosion and lubrication migration. MSD does help mitigate lubrication migration by frequently lubricating and testing the pumps. Combined Sewer Overflows can release hydrogen sulfide gas, which converts to sulfuric acid and will greatly increase the corrosion rate of mechanical and structural components. Pump columns corrode from the inside out, since the inside would be the first to lose any protective coating. Disassembling the pumps for a thorough inspection is the best way to determine the extent of wear, damage, and corrosion. While vibration readings and external visual inspections are valuable, pump failures are not entirely predictable. It is not until a pumping event that the pumps and equipment ever experience an actual operating load. As an example, during the 2018 flood event, 6 pumps at larger pump stations were taken out of service due to mechanical or electrical issues. During the event, Beargrass Creek had as little as 71% pumping capacity, Paddy's Run had 80% pumping capacity, Pond Creek had 50% pumping capacity, and Upper Mill Creek was temporarily repaired to operate at 60% pumping capacity, up from 30%. Performance issues with these pumps were unknown until they were placed into operation.

According to EM 1100-2-3105 *Mechanical and Electrical Design of Pump Stations*, it is not feasible to expect pump station equipment to last through the full 50-year estimated lifespan of a federally constructed project. The EM notes:

> *Most of the equipment would be rehabilitated or replaced at least once, except for very large pumping stations. The periods between the rehabilitation/replacement could be shorter if the operating time were great. Major items such as pumps, drivers, and switchgear are figured to be rehabilitated or replaced once during the 50-year life. This major equipment rehabilitation or replacement is usually estimated to occur between 20 and 40 years after placing the station into operation.*

All pump stations under consideration fall into this timeframe and as the pumps and motors continue to age, the service outages are only expected to become more frequent. Given the volume of required repairs, specifically at the LMFPS pump stations, a repair and replacement schedule of all aging and degraded components extends nearly twenty years into the future leaving residents and structures exposed to flooding in the event a pump station fails to perform during a flood event.

3.2 Climate Forecasts

With direction from the Engineering Construction Bulletin 2018-14 (ECB 2018-14), Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects, climate impacts are assessed and incorporated into the Feasibility Study analysis through a qualitative analysis of regional and local hydrologic trends and projections.

The Non-Federal Sponsor, MSD, has conducted a quantitative derivation of projected rainfall depths at specific frequencies for the years 2065 and 2035. Based on those results, MSD outlined a preferred level of service for a 10-year event (10-percent annual chance of exceedance, 24-hour storm) and identified seven pump stations that do not meet that criteria with their current pumping capacity (Table 11).

Table 11: Pump Station Current Capacity and MSD Preferred Level of Service

Pump Station	Current Pump Capacity (MGD)	MSD Preferred Level of Service (MGD)
Beargrass Creek	3,555	4,700
4th Street	137	195
17th Street	51	122
27th Street	239	320
Shawnee Park	770	1,250
Western Parkway	1,150	1,600
Paddy's Run	925	1,900

Note that this deterministic level of service does not consider the total probability of flooding to the drainage/ponding areas as current Corps design guidance requires.

With respect to the guidance outlined in ECB 2018-14 and in consultation with the Climate Preparedness and Resilience Community of Practice experts, the Corps conducted a non-stationarity analysis of rainfall in the local region in order to supplement the Non-Federal Sponsor's quantitative analysis on projected rainfall depths. In general, non-staionarity means that a change has occurred to the natural variability of rainfall.

Non-stationarity detections were found; however the lack of consensus between detections only revealed weak non-stationarities. The lack of strong non-stationarity detections revealed by the results

of the analysis does not provide enough evidence to support the use of any quantitatively projected precipitation depths to represent future conditions for the project area.

There is significant uncertainty regarding future rainfall. The combination of urbanization, observed increasing streamflows, and potential for more intense rainfall frequencies could increase the stress on LMFPS pump stations. Due to these uncertainties, in evaluating the need for increased pump station capacity, the 90% upper confidence limit (UCL) of the Atlas 14 precipitation frequency estimates was selected as the basis of design. This provides some conservatism in design as opposed to the standard usage of the median Atlas 14 values, accounting for a portion of the hydrologic uncertainty associated with this project. Selection of the UCL values constitutes risk informed decision making accounting for uncertainty and does not constitute a quantitative analysis of climate change as defined by ECB 2018-14.

3.3 Land Use

The majority of the interior drainage area in Jefferson County has been developed, limiting the possibility of future significant increase in impervious surfaces and resulting run-off. In addition, future population and land use may change in the study area; however, the future hydrologic condition will likely be held constant due to the regulations on development that MSD has in place. In short, MSD requires all new development to provide mitigation for increased runoff as well as floodplain compensation in both the existing and fully developed floodplains.

4 PLAN FORMULATION

4.1 Problems and Opportunities

The general features of the levee system include earthen levees, floodwalls, closures, gates, and pump stations. The predominant issues that impact the overall system performance of the LMFPS were identified at 14 of the 15 federally constructed pump stations and center on pump station components (i.e. pumps, motors, control centers, etc.) that exhibit long-term degradation or have exceeded their service life. Note that MSD has recently completed repairs and upgrades to the 4th Street Pump Station and no issues were identified at that location.

Also, multiple gates, two road closures, and several segments of floodwall were identified as experiencing long-term degradation or exceeding their service life. In addition to degrading and out-of-date features, four risk drivers were identified during the 2019 SQRA that were near or exceeded the Corps TRGs, which is the level where it is expected that society is willing to live with the risk to secure certain benefits of living and working in the leveed area. Collectively, features that are deteriorated, out-of-date or risk drivers are collectively referred to as performance deficiencies in this report. These performance deficiencies are described in Section 2.8 (Existing Project Description) and were identified through four primary sources:

- 2019 Periodic Assessment
- 2019 SQRA

- 2017 MSD Critical Repair and Reinvestment Plan (CRRP)
- 2015 Levee Safety Evaluation

At this stage in the plan formulation process the PDT had not yet identified if the study scope would be limited to an examination of the reconstruction of the existing project with no change in its scope or function as described in Paragraph 3.g of the August 2005 Reconstruction Guidance. The PDT determined that the decision on expanding the scope would be made following an update of the stage frequency curves for the Ohio River and further refinement of measures to address risk drivers identified in the SQRA. In addition, there was the possibility that capacity at a pump station would be increased, which could potentially impact the scope or function of the LMFPS. Consequently, problems and opportunities identified for this study consider flood risk associated with both the Ohio River and interior drainage.

Problems

- Risk to property related to flooding events in the City of Louisville over the period of analysis (50 years) due to inadequate, out of date, failing equipment of the LMFPS system and /or interior drainage components.
- Risk to public health, safety, and critical infrastructure related to flooding events in the City of Louisville over the period of analysis (50 years).

Opportunities

- Contribute to improving the overall safety of the LMFPS.
- Increase the resiliency of the LMFPS to respond to a changing climate.
- Improve MSD response time to install closures.
- Reduce operation and maintenance costs through efficiency improvements.

4.2 Planning Goal, Objectives and Constraints

The goal of this study is to continue the success of the LMFPS with the Non-Federal Sponsor assuming full responsibility for future OMRR&R of the project. Two objectives were developed to support this goal and inform measure screening and alternative development and evaluation. The first objective centers on life safety and addresses the requirements outlined in PB 2019-04, *Incorporating Life Safety into Flood and Coastal Storm Risk Management Studies* (2019) to address TRG1 (achieving risks that society is willing to live with to secure certain benefits) and TRG4 (managing the risk associated with the LMFPS and continued risk reduction actions by the Non-Federal Sponsor).

The second objective supports the intent of the 2005 Reconstruction Guidance in returning features in the system to a level of operation resulting in the system's ability to perform its authorized project functions. In addition, the two planning constraints identified highlight two critical factors in determining the eligibility of addressing out-of-date and degraded features through the same guidance memorandum.

Planning Objectives:

1. Reduce current risks to life, health, property and safety of residents in the study area for the 50 year period of analysis.

2. Address major performance deficiencies caused by degradation or exceedance of service life to restore the LMFPS to authorized level of flood damage reduction through the 50 year period of analysis.

Constraints

- Do not address a design or construction deficiency.
- Do not address non-federal O&M responsibilities.

4.3 Management Measures Considered

A management measure is a feature or activity that can be implemented at a specific geographic site to address one or both of the planning objectives identified above. Both structural and non-structural measures were considered and are outlined below.

Structural Measures

- **Pump Station – Repair / Refurbish Components**. This measure would address pump station buildings, discharge lines and gates, as well as electrical components including switch gear, motors and pumps. This measure assumes that pump station components can be removed, inspected and brought back to the level of performance equal to their original installation.
- **Pump Station – Replace Components.** This measure would also address pump station buildings, discharge lines and gates, as well as electrical components including switch gear, motors and pumps. The measure assumes that the system feature either cannot be repaired because of its deteriorated condition or lack of available replacement parts. The measure also applies to pump station components that have exceeded their expected service life.
- **Pump Station - Capacity Increase**. This measure would increase the name plate pump capacity at a station. This measure would require inclusion of electrical upgrades and potentially expansion of the pump station building and appurtenances, depending on the increase identified. Increasing the capacity of the pump stations to handle stormwater is possible through rehabilitating existing pump stations, constructing new pump stations at existing pump station locations, and/or constructing new pump stations. In addition, existing pump stations in need of significant amount of rehabilitation and with high O&M costs existing stations could be decommissioned and more efficient pump stations constructed in their place.
- **Pump Station - Structural Gate Modification**. Modification of gate operation such that gates are opened when the interior water surface elevation exceeds the exterior elevation proved beneficial from a hydraulic perspective and reduces the risk of flood damages. Additionally it does not have the heavy economic cost associated with pump capacity increases.
- **Gravity Drain Addition**. Addition of culverts, conduits, or other similar conveyance openings through the levee system alignment will permit discharge of interior floodwaters by gravity when the exterior flood stages are relatively low. Gravity outlets are equipped with gates to

prevent river flows from entering the leveed area during time of high exterior flood stages. This measure would be considered in combination with a pump station capacity increase.

- **Increase Pump Station Ponding (Sump)**. A potential approach to managing stormwater is to increase the size of retention basins, or sumps. When land is readily available, agencies can consider increasing the size of sumps to increase the amount of available volume for stormwater storage; as the size of the sump increases, the required pumping capacity decreases. This measure would be considered in combination with a pump station capacity increase.
- **Improve Conveyance Between Ponding Areas**. Improving the conveyance between sump ponds can increase the capacity of a stormwater sump and pump system to collect and move stormwater efficiently to the Ohio River. This can be done by replacing or increasing the size of existing connections in the sumps, or adding new connections. This measure would be considered in combination with a pump station capacity increase.
- **Well Deepening at Pump Stations**. This measure increases the depth of the well at the pump station to potentially provide additional storage in the drainage area. This measure will be considered in more detail if a pump station capacity increase is identified.
- **Closure structure modifications**. This measure would reduce operations measures during flood events and improve overall reliability of the LMFPS. This measure may include mechanical closures or permanent closures at specified locations.
- **Gate Repair / Replace**. This measure would replace or refurbish gates (sluice and flap), as well as associated actuators.
- **Detention Basins**. This measure would reduce interior drainage at specified locations. This measure will be considered in more detail if a pump station capacity increase is identified.
- **Floodwall modifications.** This measure would address performance deficiencies or floodwall alignments that were constructed as integral components of building structures that are no longer in service (e.g. Canal St.).
- **Overtopping modifications.** This measure would evaluate if the current overtopping location should be modified.
- **Upstream Reservoirs.** This measure would reduce stage frequencies in the project area.

Non-Structural Measures

- **Acquisition / Buy-out**. This measure would include removing or acquiring structures or property in combination with a pump station capacity increase.
- **Flood proofing / Elevation.** This measure would raise residential structures and flood proofing other structures, such as public facilities to reduce damages from flood events. This measure would be considered in combination with a pump station capacity increase.
- **Modify upstream Corps reservoir regulations**. This measure would evaluate reservoir regulation opportunities to reduce flood risk downstream. This measure would be considered in combination with a pump station capacity increase.
- **Modify Operation of Pump Station Gates**. This gate operation modification is also already part of the official operation and maintenance (O&M) manual for the system, and should therefore

be more thoroughly considered under circumstances when it would reduce the water surface on the interior of the levee. Risk of equipment failure during flood events should be considered when assessing the feasibility of gate operation modification.

- **Floodplain Management**. The technique of controlled land use is particularly helpful in planning for future development, but is of limited use in highly developed areas. This measure could have the potential to contribute to reducing economic damages in the study area, but further regulation would have limited impact as Louisville presently participates in the National Flood Insurance Program, and enforces zoning regulations for development in the floodplain.
- **Flood Warning / Notification**. This measure considers expansion of the current flood warning and notification system. The river forecasting services for the Ohio River at Louisville are provided by the National Weather Service River Forecast Center. With normal rainfall distribution over the Ohio River Basin, forecasts of stages and flood crests can be made several days in advance. A river stage forecast is issued daily under normal conditions and more frequently during periods of an emergency. River forecasts are available on MSD's and NOAA's website and in the local newspaper. Due to the relatively long warning time for Ohio River flooding, residents are generally able to evacuate and move belongings to higher ground before flooding occurs.

4.4 Measure Development and Screening

Screening is the ongoing process of eliminating, based on planning criteria, measures that will no longer be considered. Criteria are derived from the specific planning study, based on the planning objectives, constraints, and the opportunities and problems of the study/project area.

4.4.1 Ohio River Flooding

Prior to screening measures (listed in Section 4.3), the PDT completed updates of flow and stage frequency curves for the LMFPS, which accounted for unregulated flows (prior to most upstream dams being constructed) to regulated flows. The current best estimate frequency curve has the lowest point of the levee overtopping at an event with a return period of once in 8,500 years (annual chance exceedance of 0.012%). In addition to a reduced probability of overtopping, the revised frequency curve indicates that flood events that load the levee system are likely less frequent than previously thought.

Based on the updated Ohio River curves, along with coordination meetings with the Non-Federal Sponsor, the study team determined that the frequency associated with the top of the levee system provided by the system from Ohio River flooding was sufficient through the 50 year Corps planning horizon. However, the Non-Federal Sponsor, through the 2017 MSD CRRP, identified a need to increase pump station capacity at several facilities in order to convey future forecasted increase in precipitation based on their modeling. The PDT determined that the effectiveness of pump station capacity increase would be evaluated following the development of the focused array of alternatives.

4.4.2 Measure Screening Criteria

In addition to the two Corps planning objectives and two constraints identified in Section 4.2, above the following two additional local planning objectives identified in the MSD 20-Year Comprehensive Facility Plan – Critical and Reinvestment Plan (2017) were applied to evaluate measures.

Local Planning Objectives:

1. Expand the capacity of flood pump stations to reduce flooding potential in the community in response to changing precipitation and land use patterns.

2. Modernize the flood pumping stations with current mechanical and electrical equipment that can provide continued reliability and a predictable cost because parts will be more readily available.

The PDT assessed whether the measure met each objective and avoided constraints on a three tiered rating scale:

- Fully meets objectives / avoids constraints (2)
- Partially meets objectives / avoids constraints (1)
- Does not meet objectives / avoids constraints (0)

Then the PDT assigned each measure a 2, 1 or 0 rating on how well it met the criteria. Measures that are highlighted in Table 12 below were screened. As existing and FWOP conditions were more clearly defined, measures initially considered were eliminated. Finally, other factors relevant to the screening of measures are discussed which begin to incorporate the Principles & Guidelines alternative selection criteria of Completeness, Effectiveness, Efficiency and Acceptability. After initial screening, the following measures were carried forward for further analysis:

Structural Measures

- Pump Station – Repair / Refurbish Components
- Pump Station – Replace Components
- Pump Station - Capacity Increase
- Pump Station – Structural Gate Modification
- Gravity Drain Addition
- Increase Pump Station Ponding (Sump)
- Improve Conveyance Between Ponding Areas
- Well Deepening at Pump Stations
- Closure Structure Modifications
- Gate Repair / Replace
- Floodwall Modifications

Non-Structural Measures

- Acquisition / Buy-out
- Flood proofing / Elevation
- Modify Operation of Pump Station Gates

Table 12: Measure Screening

		Planning Objectives		Planning Constraints		Local Objectives			
Screening Key 2 = Fully meets objective/avoids constraint 1 = Partially meets objective/avoids constraint 0 = Does not meet objective/avoids constraint Orange = Screened (score of **7** or less)		#1 Address major performance deficiencies caused by degradation or exceedance of service life to restore the LMFPS to authorized level of flood damage reduction through the 50 yr. period of analysis.	#2 Reduce current risks to life, health, property and safety of residents in the study area for the 50 year period of analysis.	#1 Does not address a design or construction deficiency	#4 Does not address non-federal O&M responsibility	#1 MSD Critical Repair and Reinvestment Plan (climate forecast)	#2 MSD Critical Repair and Reinvestment Plan (Reliability enhancements)	**TOTAL**	Measure Carried Forward (Yes /No)
ID	**STRUCTURAL**								
S-1	Pump Station - Repair / Refurbish Components	**2** Returns pump station to authorized level of performance	**2** Improves reliability of the pump station and reduces risk of failure or outage	**2** Observed degradation and out-of-date equipment are not related to design or construction deficiency	**2** Pump station repair is beyond current required O&M responsibilities	**1** Increases reliability in future climate scenarios, but doesn't expand capabilities	**2** Increases the reliability pump stations and their components	**11**	**Y**
S-2	Pump Station - Replace Components	**2** Returns pump station to authorized level of performance	**2** Improves reliability of the Pump Station and reduces risk of failure or outage	**2** Observed degradation and out-of-date equipment are not related to design or construction deficiency	**2** Pump station replacement is beyond current required O&M responsibilities	**1** Increases reliability in future climate scenarios, but doesn't expand capabilities	**2** Increases the reliability pump stations and their components	**11**	**Y**
S-3	Pump Station - Capacity Increase	**1** Increasing capacity will address degraded and out-of-date stations. However, increasing capacity exceeds authorized level of performance	**2** Provides potential increase in risk reduction	**2** Current capacity was based on optimal reductions of interior ponding as determined during the original design	**2** Pump station capacity increase is beyond current required O&M responsibilities	**2** Allows the station to maintain the sponsor's identified level of service	**2** Future OMRRR cost will be higher than present	**11**	**Y** Sensitivity analysis will be conducted to determine effectiveness

		Planning Objectives		Planning Constraints		Local Objectives			
S-4	Pump Station - Structural River Gate Modification	**0** This measure would addresses lifting river gates when there is differential head and not degradation	**1** Provides potential increase in risk reduction to pump stations where measure can be applied	**2** River gates were constructed with prevailing techniques at the time of design	**2** Sponsor maintains and tests gates in accordance with O&M manual	**1** Provides additional capability to address increased interior ponding	**2** Provides additional capability to address interior ponding	**8**	**Y**
S-5	Gravity Drain Addition	**0.5** Not considered a major performance deficiency, but could reduce frequency of pump station operation	**2** Provides potential increase in risk reduction	**2** The current location and configuration of gravity drains appears sufficient	**2** Additional gravity drains are above current required O&M responsibilities	**1** Could be considered in combination with capacity increase.	**1** Only reduces rainfall during low river conditions and adds an additional feature to the system that requires OMRRR	**8.5**	**Y** To be considered in combination if pump station capacity is increased
S-6	Increase Ponding (sump)	**0.5** Could address performance issues by reducing frequency of pump station operation	**1** Provides potential increase in risk reduction, but the application is limited to a few pump stations with ponding areas	**2** Current interior drainage was based on infrastructure at the time of construction	**2** Sponsor maintains boundary of ponding. Increases are above current O&M responsibilities	**1** This maximizes capacity for future interior drainage needs in locations with ponding	**1** Considered in combination with capacity increase could reduce pump size required for future interior drainage needs	**7.5**	**Y** To be considered in combination if pump station capacity is increased
S-7	Improve conveyance between ponding areas	**0.5** Could address performance issues by reducing frequency of pump station operation	**1** Provides potential increase in risk reduction, but the application is limited to a few pump stations	**2** Current interior drainage was based on infrastructure at the time of construction	**2** Improving conveyance above current required O&M responsibilities	**1** Could be considered in combination with capacity increase, but doesn't increase storage.	**1** Considered in combination with capacity increase could reduce pump size required for future interior drainage needs	**7.5**	**Y** To be considered in combination if pump station capacity is increased

		Planning Objectives		Planning Constraints		Local Objectives			
S-8	Well Deepening (Pump Stations)	**0.5** Observed well condition does not display significant degradation at pump stations. Could address performance issues by reducing frequency of pump station operation	**1** Provides potential increase in risk reduction, but significant reductions would be limited	**2** Well configuration is sufficient for current capacity at pump stations	**2** Well deepening is above current O&M responsibilities	**1** Provides limited capacity increase for interior drainage	**1** Provides additional operational capability	**7.5**	**Y** To be considered in combination if pump station capacity is increased
S-9	Closure Structure Modification	**2** Addresses locations that have exceeded their service life and /or are degraded	**2** Reduces installation time allowing sponsor to direct limited resources to other priority locations	**2** Closures were constructed with prevailing techniques at the time of design	**2** Sponsor maintains and inspects closures as required in O&M manual	**1** Maintains current level of protection from Ohio River flooding	**2** Abandonment would reduce O&M costs as well as reduce the demand on the operators to get all closures installed in a timely manner	**11**	**Y**
S-10	Overtopping Modification	0 Current Levee Control Location does not exhibit degradation	1 Current overtopping event is 1 / 8,500 years. Consequences are high; however probability is low	2 Current overtopping location was optimal at time of construction	2 Sponsor maintains and inspects levee overtopping location as described in O&M manual	1 Potential increase to risk reduction from overtopping	1 Reduces consequences from a breach	**7**	**N** Screened as cost prohibitive based on overtopping frequency
S-11	Gate Repair / Replace	2 Multiple gates (river, sluice, etc.) were observed with long-term degradation	2 Functioning and reliable gates are essentially to system function	2 Gates were constructed with prevailing techniques at that time of design	2 Sponsor maintains and inspects gates as required in O&M manual	2 Maintains current level of protection from Ohio River flooding	2 Improves reliability of gate operation	**12**	**Y**

		Planning Objectives		Planning Constraints		Local Objectives			
S-12	Floodwall Modification	2 Floodwall segments have exceeded their service life and / or are experience degradation	2 Improving floodwall stability will increase risk reduction	2 Floodwalls were constructed with prevailing techniques at that time of design	2 Sponsor maintains and inspects floodwalls as required in O&M manual	2 Maintains current level of protection from Ohio River flooding	2 Increases system resiliency to loading from flood events	**12**	**Y**
S-13	Upstream Reservoir(s)	0 Upstream Reservoirs are outside the scope of the original project	1 Additional storage above the current project could reduce level and frequency of loading. No impact on interior drainage	2 Upstream Reservoirs are outside the scope of the original project	2 Upstream Reservoirs are outside the scope of the original project	1 Does not address interior drainage	1 Could reduce frequency of use of LMFPS	**7**	**N** Measure would provide no direct impact to interior drainage issues
S-14	Detention Basins (Interior)	0 Detention basins are outside of the scope of the original project	1 Level of risk reduction would be marginal for interior drainage	2 Detention basins are outside the scope of the original project	2 Detention basins are outside the scope of the original project	1 Potential localized reductions only	1 Could reduce frequency of use of LMFPS	**7**	**N** Measure would provide no direct impact to interior drainage issues with LMFPS
ID	**NON-STRUCTURAL**								
NS-1	No-Action	0	0	2	2	0	0	**4**	**Y**
NS-2	Acquisition / Buy-out	0 Does not address performance issues or system features that have exceeded their service life	1 Locations of industrial structures are dependent on proximity to Ohio River and limits application of measure	2 Outside of the scope of the original project	2 Outside of the scope of the original project	2 Opportunities to address residential structures near ponding areas	1 Could reduce frequency of use of LMFPS	**8**	**Y** To be considered in combination if PS Capacity is increased

		Planning Objectives		Planning Constraints		Local Objectives			
NS-3	Flood Proofing / Elevation	0 Does not address performance issues or system features that have exceeded their service life	1 Limited to certain structure types	2 Outside of the scope of the original project	2 Outside of the scope of the original project	2 Opportunities to address residential structures near ponding areas	1 Could reduce frequency of use of LMFPS	**8**	**Y** To be considered in combination if PS Capacity is increased
NS-4	Floodplain Management	0 Does not address performance issues or system features that have exceeded their service life	1 Limited impact given current land development patterns	2 Outside of the scope of the original project	2 Outside of the scope of the original project	1 Could reduce impact from surface drainage	0 Does not directly improve the reliability of the system	**6**	**N** Local sponsor already has robust floodplain management regulations and policies.
NS-5	Flood Warning / Notification	0 Does not address performance issues or system features that have exceeded their service life	1 Limited impact given slow rise of exterior and interior stages	2 Outside of the scope of the original project	2 Outside of the scope of the original project	1 Limited impact given slow rise of exterior and interior stages	0 Does not directly improve the reliability of the system	**6**	**N** A warning system is already established.
NS-6	Modify existing USACE reservoir regulations	0 Does not address performance issues or system features that have exceeded their service life	1 No impact on interior drainage and limited impact on Ohio River stages	2 Outside of the scope of the original project	2 Outside of the scope of the original project	1 No impact on interior drainage and limited impact on Ohio River stages	0 Does not directly improve the reliability of the system	**6**	**N** Measure would provide no direct impact to interior drainage issues
NS-7	Modify Operation of pump stations / gates	0 Does not address performance issues or system features that have exceeded their service life	1 Provides potential increase in risk reduction	2 Outside of the scope of the original project	2 Outside of the scope of the original project	1 Provides additional capability to address increased interior ponding	2 Could reduce frequency of use of LMFPS	**8**	**Y**

4.5 Initial Array of Alternative Plans

The remaining flood risk management measures were combined to form an initial array of alternative plans. Below is a description of the alternatives and Table 13 displays how measures were combined and considered for each plan.

- **No-Action**: Under this alternative MSD will continue with responsibilities as described in the project O&M manual and outlined in 33 CFR 2018.10. As funding is identified, MSD will continue to address long-term degradation and out-of-date components at pump stations and other features in the LMFPS. However, given the extensive quantity of work, complete restoration of the system will extend a repair schedule over 20 years into the future. A most likely scenario will be fix-as-fails. The full condition of pump station components cannot be determined through routine inspections, and failures of system components (especially at pump stations) often occur while they are in operation.

- **Reconstruction Only**: This alternative only addresses system features that have experienced long-term degradation or exceeded their expected service life. The components of 15 pump stations (i.e. pumps, motors, control centers, transformers, Motor Control Centers, etc.) will either be replaced or repaired depending on factors such as age, condition and availability of parts. In addressing the pump stations, opportunities to improve safety and meet current design standards (EM 110-2-3105) will be considered. Examples include updating Supervisory Control and Data Acquisition (SCADA) and greasing systems. Performance issues with 26 water stops, one closure vault and 40 gates will also be addressed. Approximately 530 linear feet of floodwall (Canal Station) will be constructed and two closure structures (10th and 27th Streets) that have exceeded their service life will be permanently sealed. Overall, this alternative increases the reliability of the system and reduces the uncertainty associated with system components that have exceeded their expected service life.

- **SQRA Only**: This alternative addresses three risk drivers identified in the 2019 SQRA that plotted near or above the societal risk line. A fourth risk driver that plotted above the societal risk line (breach from overtopping) was not addressed through this alternative. Breach from overtopping would likely occur at the 8 mile long LCL. The frequency of overtopping is approximately an 8,500 year event. The length of the LCL makes any type of measure to either raise the levee or protect against erosion impractical and outside of the scope of this reconstruction study. The specific details of this alternative include reinforcing the Pond Creek Pump Station floodwalls; adding capacity to the Beargrass Creek Pump Station roller gates hoist mechanism and a secondary access to the hoist; and buttressing or replacement of several monoliths of I-wall in the Butchertown neighborhood. All three of these measures are being recommended at system features that are also experiencing degradation or have exceeded their expected service life.

- **Reconstruction & SQRA**: This alternative combines both the Reconstruction and SQRA alternatives. Combining these two alternatives restores the LMFPS functions to meet its

authorized level of performance at the time of original construction, as well as further reduces life safety risk. Measures identified in this alternative do not increase the scope or function of the project and qualify for a simplified approach to arrive at the recommended plan that only compares the "with" and "without" project condition.

- **Reconstruction & SQRA & Capacity Increase**: This alternative includes the Reconstruction and SQRA alternatives, as well as considers pump station capacity increases at seven pump stations (Section 3.2) in the LMFPS. The team also developed five additional alternatives that would be evaluated in the event that a pump station capacity increase were authorized. These additional capacity increase alternatives considered various combinations of structural and non-structural measures to reduce water surface elevations in ponding areas. In the event that a capacity increase was identified, incremental analysis, through HEC-FDA, would only be applied to pump stations where a potential increase may be needed to convey forecasted precipitation through the 50 year period of analysis.

Table 13: Initial Array of Alternatives

Initial Array of Alternatives	Alternative	No Action	Reconstruction: Degradation & Service Life Only	SQRA: Risk Drivers Only	Reconstruction & SQRA	Reconstruction & SQRA with Pump Capacity Increase	Pump Capacity increase with Non-Pump combination measures	Pump Capacity Increase with Non-structural Measures	Pump Capacity increase with Non-Pump combination measures and Non-Structural	Non-Pump Capacity Measures Only	Non-Pump Capacity Measures with Non-Structural	
ID	**Measure**											DEPENDENT
S-1	Pump Station - Repair / Refurbish		X		X	X	X	X	X	X	X	
S-2	Pump Station - Replace Components		X		X	X	X	X	X	X	X	
S-3	Pump Station - Capacity Increase					X	X	X	X			S-1 OR S-2
S-4	Pump Station - Structural Gate Modification			X	X	X	X	X	X	X	X	
Combined Non-Pump Capacity (S-5, S-6, S-7, S-8)							X		X	X	X	S-1 OR S-2
S-9	Closure Structure Modification		X		X	X	X	X	X	X	X	
S-11	Gate Repair /Replace		X		X	X	X	X	X	X	X	
S-12	Levee / Floodwall Modification		X	X	X	X	X	X	X	X	X	
NS-2	Acquisition / Buy-out							X	X		X	S-1 OR S-2
NS-3	Flood Proofing / Elevation							X	X		X	S-1 OR S-2
NS-7	Modify Operation of existing pump stations gates			X	X			X	X		X	

4.5.1 Screening Initial Array of Alternatives

Upon formulation of the initial array of alternatives, the PDT performed a screening based on how each plan met the four Principles & Guidelines Criteria. Table 14 describes the screening criteria and Table 14 Illustrates how they were applied to screening the initial array. Alternatives highlighted orange in the screening table in Table 15 were screened and the summary in Table 15 provides additional discussion on the rationale for screening or carrying the alternative forward to the focused array.

Table 14: Screening Criteria for Initial Array of Alternatives

Completeness - Accounts for all measures and implementation actions to achieve planning objectives.	
4	All actions / measures
3	Most actions / measures
2	Some actions / measures
1	Unknown
0	None
Effectiveness - How an alternative addresses objectives.	
4	Meets both objectives completely
3	Partially meets one / fully other
2	meets one fully or both partially
1	Partially meets one
0	Meet neither
Efficiency - Alternatives were compared against each other to evaluate whether an alternative returned the system to the same level of performance at a lower cost, and with greater certainty, than another Alternative.	
4	High
3	Medium
2	Low
1	Varied
0	Unknown
Acceptability - Applicable laws, regulations and public policies.	
4	No Violation
3	Significant
2	Can be resolved
1	Unknown
0	Not Acceptable

Table 15: Initial Array of Alternatives - Screening

							Retained for further evaluation if a pump station capacity increase is identified					
Initial Array of Alternatives and Screening Orange = Alternative was screened (score = less than 14) Alternatives A, B & C **(Bold)** were identified as the Focused Array		Alternative	No Action	Reconstruction: Degradation & Service Life Only	SQRA: Risk Drivers Only	Reconstruction & SQRA	Reconstruction & SQRA & Capacity Increase	Pump Capacity increase with Non-Pump combination measures	Pump Capacity Increase with Non-structural Measures	Pump Capacity increase with Non-Pump combination measures and Non-Structural	Non-Pump Capacity Measures Only	Non-Pump Capacity Measures with Non-Structural	
ID	**Measure**		**ALT A**			**ALT B**	**ALT C**	ALT C.2	ALT C.3	ALT C.4			DEPENDENT
S-1	Pump Station - Repair / Refurbish			X		X	X	X	X	X	X	X	
S-2	Pump Station - Replace Components			X		X	X	X	X	X	X	X	
S-3	Pump Station - Capacity Increase						X	X	X	X			S-1 OR S-2
S-4	Pump Station - Structural Gate Modification				X	X	X	X	X	X	X	X	
Combined Non-Pump Capacity (S-5, S-6, S-7, S-8)								X		X	X	X	S-1 OR S-2
S-9	Closure Structure Modification			X		X	X	X	X	X	X	X	
S-11	Gate Repair /Replace			X		X	X	X	X	X	X	X	
S-12	Levee / Floodwall Modification			X	X	X	X	X	X	X	X	X	
NS-2	Acquisition / Buy-out								X	X		X	S-1 OR S-2
NS-3	Flood Proofing / Elevation								X	X		X	S-1 OR S-2
NS-7	Modify Operation of existing pump stations gates				X	X			X	X		X	
Completeness				2	2	4	4	4	4	4	4	4	
Effectiveness				3	2	4	4	4	4	4	4	4	
Efficiency				3	1	4	2	2	2	2	1	1	
Acceptability				4	4	4	4	4	4	4	4	4	
TOTAL				**12**	**9**	**16**	**14**	**14**	**14**	**14**	**13**	**13**	

Initial Array Screening Summary

- **Reconstruction Only:** This alternative was screened based on completeness, effectiveness and efficiency. Specific to completeness, the alternative does not account for all measures to fully address both study objectives (Section 4.2). The PDT determined that given the minimal level of investment required to address risk drivers and shift societal risk, this alternative should include the measures identified in the SQRA alternative to be carried forward to the focused array. This alternative also was screened based on efficiency. While the measures identified to address risk drivers didn't directly address degraded or out-of-date systems the measures do increase the certainty that the project would be returned to the same level of performance at the time of original construction.

- **SQRA Only:** Similar to Reconstruction Only, this alternative was also screened based on completeness, effectiveness and efficiency. This alternative fails to address all system features that are degraded or have exceeded their service life and is not considered complete. It was identified as part of the initial array because it had not been determined which of the 57 potential failure modes would be evaluated in further detail and there was the possibility that many of the features identified for reconstruction could be addressed by this alternative. At the time of the screening the list of risk drivers was narrowed to three that plotted near or above the societal risk line. Additionally, the certainty at which this alternative would restore the performance of the system was marginal compared to other alternatives in the initial array.

- **Reconstruction & SQRA (Alternative B)**: This alternative fully accounts for all measures and completely meets study objectives. Additionally, the alternative meets planning objectives more efficiently as compared to the other nine alternatives identified in the initial array. Specific to the six alternatives that consider a capacity increase, it was determined that even if a capacity increase was identified, repair or replacement of pump station components would be more efficient at returning the system to its original level of performance. Consequently, this alternative was carried forward for further evaluation.

- **Reconstruction & SQRA & Capacity Increase (Alternative C):** As mentioned previously, this alternative was developed to address the potential need to increase capacity at seven pump stations (Section 3.2). It received the same scores as the Reconstruction & SQRA alternative (Table 15) in all evaluation criteria except for efficiency. The efficiency of pump station capacity increase would be highly dependent on the station and its service area. Three sub-variations of this alternative labeled C.2, C.3, and C.4 in Table 14 were also developed and retained for further evaluation if a pump station capacity increase was identified. The alternative was carried forward to the focused array for further evaluation. Note that two capacity alternatives were screened. These two only considered capacity increases through structural and non-structural measures that did not increase the actual size of the pump. The PDT determined that these two approaches were not as efficient compared to other capacity increase alternatives.

4.6 Focused Array of Alternative Plans

Based on the results of the screening of the initial array of alternatives, the following three alternatives were considered for further analysis and labeled A, B and C for assessment of environmental Impacts.

- Alternative A. No Action (FWOP)
- Alternative B. Reconstruction & SQRA
- Alternative C. Reconstruction & SQRA & Capacity Increase

4.6.1 Environmental Impacts of Focused Array of Alternative Plans

As set forth in Chapter 2, above, NEPA requires that an Environmental Assessment identify the likely environmental effects of a proposed project and that the agency determine whether those impacts may be significant. This section considers the existing environmental conditions in the project area and presents the adverse and beneficial environmental effects (direct and indirect) of the considered alternatives, including the No Action alternative. The section is organized by resource topic, with the effects of alternatives discussed under each resource topic. Impacts are quantified whenever possible. Qualitative descriptions of impacts are explained by accompanying text where used.

4.6.1.1 Climate

None of the alternatives considered in this Feasibility Study would be expected to significantly contribute to greenhouse gas emissions and/or climate change within the study area. Pumps are designed to operate on an as-needed basis after rainfall events. The differences in expected pump running times and energy consumption for all alternatives would be negligible.

4.6.1.2 Air Quality

Alternative A (No Action) – No impacts to air quality would be expected from the No Action alternative.

Alternative B (Pump Station Reconstruction & SQRA) and Alternative C (Pump Station Reconstruction & SQRA & Capacity Increase) – These alternatives would require similar methods and equipment, and would cause some localized and temporary emissions associated with construction of new outlet works and associated features. Emissions from construction actions would typically include byproducts of diesel and gasoline combustion, and fugitive dust. The emissions associated with equipment operation and pump repair and/or replacement would be localized, of relatively short duration, and would only occur during the time period when the pumps are being repaired or replaced.

4.6.1.3 Topography, Geology, and Soils

Alternative A (No Action) - No impacts to the topography, geology, or soils of the project area would be expected from the No Action alternative.

Alternative B (Pump Station Reconstruction & SQRA) and Alternative C (P Pump Station Reconstruction & SQRA & Capacity Increase) – Impacts to topography, geology and soils would be similar between the action alternatives. Each alternative would require minor excavation for floodwall modification and discharge pipe replacement. Construction of the new floodwall section at Canal Station would occur on

previously disturbed land, and would not significantly impact topography, geology, or soils of the project area.

Prior to implementation of either alternative, best management practices would be deployed (e.g., use of silt fences) to minimize erosion and soil loss, when appropriate. As a result of the reasonable use of best management practices, no significant effects would be predicted to topography, geology, and soils from implementing either alternative.

4.6.1.4 Surface Water Hydrology and Groundwater

Alternative A (No Action) – By implementing No Action, the risk of pump failure would increase in the future. Impacts to surface water hydrology would not occur until one or more pumps experience failure during a high water event within the interior of the leveed area. Complete failure or reduced efficiency of pumps would result in prolonged back-water effects and flooding of the interior basins.

Because groundwater hydrology in Louisville is greatly influenced by the Ohio River, this alternative would not be expected to have significant impacts on groundwater resources.

Alternative B (Pump Station Reconstruction & SQRA) - Implementation of this alternative would act to maintain the current surface water hydrology within the leveed area. Neither water surface elevations, nor groundwater resources would be effected by this alternative.

Alternative C (Pump Station Reconstruction & SQRA & Capacity Increase) – Implementation of this alternative would result in water surface elevations in the leveed area being reduced faster than the current rate. This increase in efficiency would allow the flood protection system to operate as designed, and would not act to induce flooding of unprotected areas downstream or adjacent to the levee system during high water events. No impacts to surface hydrology would be expected when pumps are not diverting flow through the levee during high-water events. No significant impacts to groundwater would be expected from this alternative.

4.6.1.5 Water Quality

Alternative A (No Action) - By implementing no action, the risk of pump failure during future high-water events in the Louisville area would be expected to increase. Pump failure would likely result in higher surface water elevations of the associated streams within the leveed area, resulting in flooding of urban environments. Flooding of urban areas is known to result in increased pollutant input into streams and reduced water quality. For this reason, this alternative would have the potential to adversely affect water quality in the event of deficient or failed pumps during high-water events.

Alternative B (Pump Station Reconstruction & SQRA) and Alternative C (Pump Station Reconstruction & SQRA & Capacity Increase) – Implementation of either of these alternatives would be expected to result in similar impacts to water quality. By ensuring full functionality of the Louisville Metro levee system, these alternatives would reduce the chances of flooding during future high-water events and possibly lessening the pollutant load of streams by keeping water within the banks of streams and out of the developed floodplain. For this reason, Alternatives B and C would be expected to promote minor to moderate improvements to water quality of streams within the leveed area during high water events.

4.6.1.6 Biological Environment

Alternative A (No Action) – Implementing no action would not be expected to have significant effects to the biological environment of the project area, including terrestrial and aquatic habitat. The levee system would be expected to continue operating with reduce efficiency, resulting in slightly higher water surface elevations of the tributaries within in the leveed area during high water events.

Alternative B (Pump Station Reconstruction & SQRA) – This alternative would increase the reliability of the levee system and ensure the system is operating as designed to reduce flood damages. This alternative would not alter the biological environment, including terrestrial and aquatic habitat in the project area. Construction best management practices for erosion control and spill prevention and response would be implemented to reduce any potential impacts during replacement of pumps and modification of floodwalls. Construction laydown areas would consist of existing road easements and previously disturbed and/or developed areas near the immediate construction site.

Alternative C (Pump Station Reconstruction & SQRA & Capacity Increase) –The scope and locations of construction measures and pump replacements would be the same and would result in similar, insignificant impacts to the biological environment as those expected for Alternative B. Pumps with greater capacity would act to lower water surface elevations of tributaries within the leveed area at a faster rate than possible with the current pump capacities. This would keep streams within their banks and reduce the streams interaction with the floodplain. This is generally not desired for health of the aquatic ecosystem. However, in the case of these highly modified urban streams, reducing interaction with floodplains can improve the biological environment by reducing stream contact with pollutants in the urban environment.

4.6.1.7 Threatened and Endangered Species

Alternative A (No Action) – Under this alternative, the levee system would continue to be operated and maintained as it is currently, with minimal repairs and a fix-as-fails maintenance approach. This would be expected to have no effect to the listed species in Table 3.

Alternative B (Pump Station Reconstruction & SQRA) – This alternative would ensure operation of the levee system as originally designed and repairs would take place within pumping stations and/or on developed lands and would result in no effect to listed species in Table 3.

Alternative C (Pump Station Reconstruction & SQRA & Capacity Increase) – This alternative would result in negligible impacts to water surface elevations on both sides of the levee system, and repairs would take place within pumping stations and/or on developed lands. Therefore, implementation of Alternative C would result in no effect to listed species in Table 3.

4.6.1.8 Demographics and Environmental Justice

Alternative A (No Action) – A large portion of the leveed area in Louisville is comprised of low-income households. It is these households that would be most greatly impacted by a failure of the levee system. Implementing no action would act to increase the risk of failure of the system in the future, and would result in disproportionately high and significantly adverse impacts to these minority and low-income populations.

Alternative B (Pump Station Reconstruction & SQRA) - This alternative would ensure operation of the levee system as originally designed and would not result in adverse impacts to any demographic in the project area.

Alternative C (Pump Station Reconstruction & SQRA & Capacity Increase) – This alternative would increase the levee system's effectiveness over and above the original design and would not result in adverse impacts to any demographic in the project area.

4.6.1.9 Recreation

Alternative A (No Action) – Implementing No Action could result in adverse impacts to the recreational resources of the Louisville Metro area if the levee system is unable to prevent interior flooding. Recreational amenities especially vulnerable to impacts would be those adjacent to tributaries, such as trails, parks, and golf courses. Impacts would likely be temporary, but could potentially be long-term if extensive damage is incurred during flooding.

Alternative B (Pump Station Reconstruction & SQRA) – Implementation of this alternative would not be expected to result in significant impacts to recreation. Localized and temporary impacts to the Louisville Loop trail may occur during pump replacement.

Alternative C (Pump Station Reconstruction & SQRA & Capacity Increase) – Impacts to recreation for this alternative would be the same as those for Alternative B.

4.6.1.10 Cultural Resources

Alternative A (No Action) - Alternative A may result in impacts to historic properties located both within and near the Area of Potential Effect (APE) due to adhoc repairs and fixes carried out on the existing and aging infrastructure. Anticipated impacts to NRHP listed properties include the Olmstead Park System Historic District, the Portland Historic District, Butchertown Historic District, New Enterprise Tobacco Warehouse, the Tobacco Realty Company Building, and the Louisville Railway Company High Street Power Station. These impacts may include future ground disturbance to replace aging infrastructure, replacement of structures that are greater than 50 years of age, or addition to expansion of existing facilities and buildings. These impacts could cause both visual and physical impacts to nearby historic properties and archaeological sites.

Alternative B (Pump Station Reconstruction & SQRA) - Alternative B may result in impacts to historic properties located both within and near the APE due to closure of two gate structures, floodwall modifications in Butchertown, modification of gate operations at Beargrass Creek and Pond Creek pump stations, gate repairs and replacement (40 planned), replacement of waterstops in floodwall joints (26 planned), the addition of an access road at McAlpine Lock and Dam associated with permanently sealing the 27th Street closure, and pump station repairs (in-kind replacement only). Anticipated impacts to NRHP listed properties include the Olmstead Park System Historic District, the Portland Historic District, Butchertown Historic District, New Enterprise Tobacco Warehouse, the Tobacco Realty Company Building, and the Louisville Railway Company High Street Power Station. The Louisville District is currently in the process of evaluating the Louisville Reach to determine its eligibility for listing in the NRHP. These impacts may include future ground disturbance as a result of replacement of aging

infrastructure or the expansion of existing facilities and buildings. These impacts could cause both visual and physical impacts to both nearby historic properties and archaeological sites.

Alternative C (Pump Station Reconstruction & SQRA & Capacity Increase) – Alternative C may result in impacts to historic properties located near the proposed project area due to proposed footprint expansions of pump stations, expansion of conveyance lines, and alterations of the exteriors of the pumping stations. Anticipated impacts to NRHP listed properties include the Olmstead Park System Historic District, the Portland Historic District, Butchertown Historic District, New Enterprise Tobacco Warehouse, and the Tobacco Realty Company Building. The Louisville District is currently in the process of evaluating the Louisville Reach to determine its eligibility for listing in the NRHP. The expansions of the pump stations and conveyance lines may impact archaeological resources. The alterations to the exteriors of the pumping stations could alter the viewshed of the surrounding area which would impact historic properties, districts, and neighborhoods. Additional impacts from Alternative C would include replacement of structures that are greater than 50 years of age, and the addition or expansion of existing facilities and buildings.

4.6.1.11 Hazardous, Toxic and Radioactive Waste Materials (HTRW)

Alternative A (No Action) – This alternative would not create HTRW materials nor impact existing HTRW materials.

Alternative B (Pump Station Reconstruction & SQRA) - Implementing Alternative B would be expected to have no effect on HTRW materials, as there are no known pre-existing sources within the immediate project sites. While the potential to create HTRW materials as a result of equipment malfunction or failure during the construction process exists (e.g., fluid leaks from heavy equipment), best management practices and regular equipment maintenance reduce these risks for any future development that may occur. Storage, fueling, and lubrication of equipment and motor vehicles associated with the construction process (e.g., pavers, trenchers, cement trucks) would be conducted in a manner that affords the maximum protection against accidents and spills.

Alternative C (Pump Station Reconstruction & SQRA & Capacity Increase) – Impacts to HTRW materials for this alternative would be the same as those for Alternative B.

4.6.1.12 Noise

Alternative A (No Action) - Under the No Action alternative, repair and replacement measures would occur at a slower rate over time and would result in localized and temporary increases in noise levels at the site of the work being conducted.

Alternative B (Pump Station Reconstruction & SQRA) – Implementation of Alternative B would not result in long-term effects on the level of background or ambient noise character in the project area. Localized and temporary increases in noise would occur during construction, but implementing best management practices would minimize the temporary noise effects during construction.

Alternative C (Pump Station Reconstruction & SQRA & Capacity Increase) – Impacts to noise for this alternative would be similar to those anticipated for Alternative B, as construction methods would be similar.

4.6.2 Cumulative Effects of the Focused Array of Alternatives

The NEPA requires a Federal agency to consider not only the direct and indirect impacts of a proposed action, but also the cumulative impact of the action. A cumulative impact is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions (40 CFR § 1508.7)." Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time. These actions include on- or off-site projects conducted by government agencies, businesses, or individuals that are within the spatial and temporal boundaries of the actions considered.

Alternative A (No Action) – the No Action Alternative could potentially result in an increased risk of flooding within the leveed area due to inefficient or nonworking pumps. An increased risk of flooding could result in adverse socioeconomic impacts for the affected areas. This could contribute cumulatively to other socioeconomic factors affecting these communities such as generational poverty, concentrated environmental hazards, and job availability.

Alternative B (Pump Station Reconstruction & SQRA) and Alternative C (Pump Station Reconstruction & SQRA & Capacity Increase) –

The action alternatives presented in this EA would only have negligible or temporary impacts on climate, air quality, topography, geology, soils, groundwater, biological environment, terrestrial and aquatic habitat, listed species, demographics, socioeconomics, recreation, HTRW materials, and noise; and therefore, such impacts will not contribute to any cumulative environmental impacts in the region. Ongoing coordination with consulting parties will determine whether the action alternatives would result in an adverse effect to the historic properties and, if so, would develop alternatives to avoid, minimize, or mitigate those effects.

4.6.3 Summary of Environmental Effects of the Focused Array of Alternatives

Table 16 summarizes the potential environmental and socioeconomic consequences of implementation of each alternative, including the no action alternative.

Table 16: Summary of Potential Environmental and Socioeconomic Consequences

Resource	Alternative A No Action	Alternative B Pump Station Reconstruction & SQRA	Alternative C Pump Station Reconstruction & SQRA & Capacity Increase
Climate	No significant impact	No significant impact	No significant impact
Air Quality	No changes from baseline conditions	No significant impact	No significant impact
Topography, Geology and Soils	No changes from baseline conditions	Minor, localized impacts within project footprint	Minor, localized impacts within project footprint
Surface Water Hydrology	Increased risk of short term flooding in leveed area.	Long term benefits	Long term benefits
Groundwater	No significant adverse impact	No significant impact	No significant impact
Water Quality	No changes from baseline conditions	Long term minor benefits	Long term minor benefits
Vegetation	No changes from baseline conditions	No significant impact	No significant impact
Wetlands	No significant impact	No significant impact	No significant impact
Terrestrial Wildlife	No changes from baseline conditions	No significant impact	No significant impact
Aquatic Resources	No changes from baseline conditions	No significant impact	No significant impact
Threatened and Endangered	No impact	No impact	No impact
Socioeconomic Resources	Potential for moderate adverse impacts	Long term benefit	Long term benefit
Historic and Archaeological Resources	The Corps is currently evaluating the historic significance of historic properties and archaeological sites located within the APE to determine eligibility for listing in the NRHP. Once complete, the Corps will make a determination if there will be an adverse effect to any NRHP listed or eligible properties or archaeological sites.	The Corps is currently evaluating the historic significance of historic properties and archaeological sites located within the APE to determine eligibility for listing in the NRHP. Once complete, the Corps will make a determination if there will be an adverse effect to any NRHP listed or eligible properties or archaeological sites.	The Corps is currently evaluating the historic significance of historic properties and archaeological sites located within the APE to determine eligibility for listing in the NRHP. Once complete, the Corps will make a determination if there will be an adverse effect to any NRHP listed or eligible properties or archaeological sites.
HTRW	No impact	No impact	No impact
Cumulative Effects	Potential of minor to moderate adverse impacts from lack of flood control	Long-term beneficial impacts	Long-term beneficial impacts

4.6.4 Screening of the Focused Array of Alternative Plans

Following the Alternatives Milestone Meeting in February 2019 with the Vertical Team (Appendix D for more information on the meeting) and the development of the focused array of alternatives, a sensitivity analysis was conducted to investigate if further (incremental) analysis may be required. This would be to determine if the Corps can participate in a pump station capacity increase. The full analysis is contained in Volume 2, Appendix B.

Coincident frequency curves were computed at the seven pump stations identified by MSD (Section 3.2), which do not meet their preferred level of service for 3 scenarios: existing conditions, increased pump capacity (as identified by MSD), and increased pump capacity with increased conveyance lines leading to the pumps. In order to account for the variability of the pump station operation under differing exterior river stages, each scenario was run with a variable exterior river stage elevation.

The reduction in water surface elevation and corresponding inundation areas were used to screen pumping stations for the effectiveness of increased pump capacities. In general, stations with ponding areas showed larger reductions in water surface elevations in response to increased pump capacities. Other stations, including most in-line stations, showed very little change in water surface elevation in response to relatively large increases in pump capacity. A few examples of these coincident frequency curves are included below for Beargrass Creek, Paddy's Run, and 4th Street (Figures 37, 38 and 39).

In these figures, the blue line represents existing conditions, red line represents increased pump capacity at LOP5, green line represents increased conveyance and pump capacity, and the orange line represents a modification in gate operating procedure. Beargrass Creek did not include a conveyance increase scenario. Note that the horizontal purple dashed line represents the approximate elevation corresponding to the start of economic consequences; in other words, this dashed-line delineates where the flooding of structures begins. Also, the horizontal x-axis of these figures is displayed as a probability scale beginning at 0.5 ACE (2 year recurrence) and extending to 0.001 ACE (1,000 year recurrence).

Figure 37: Coincident Frequency Curves for Beargrass Creek Pump Station

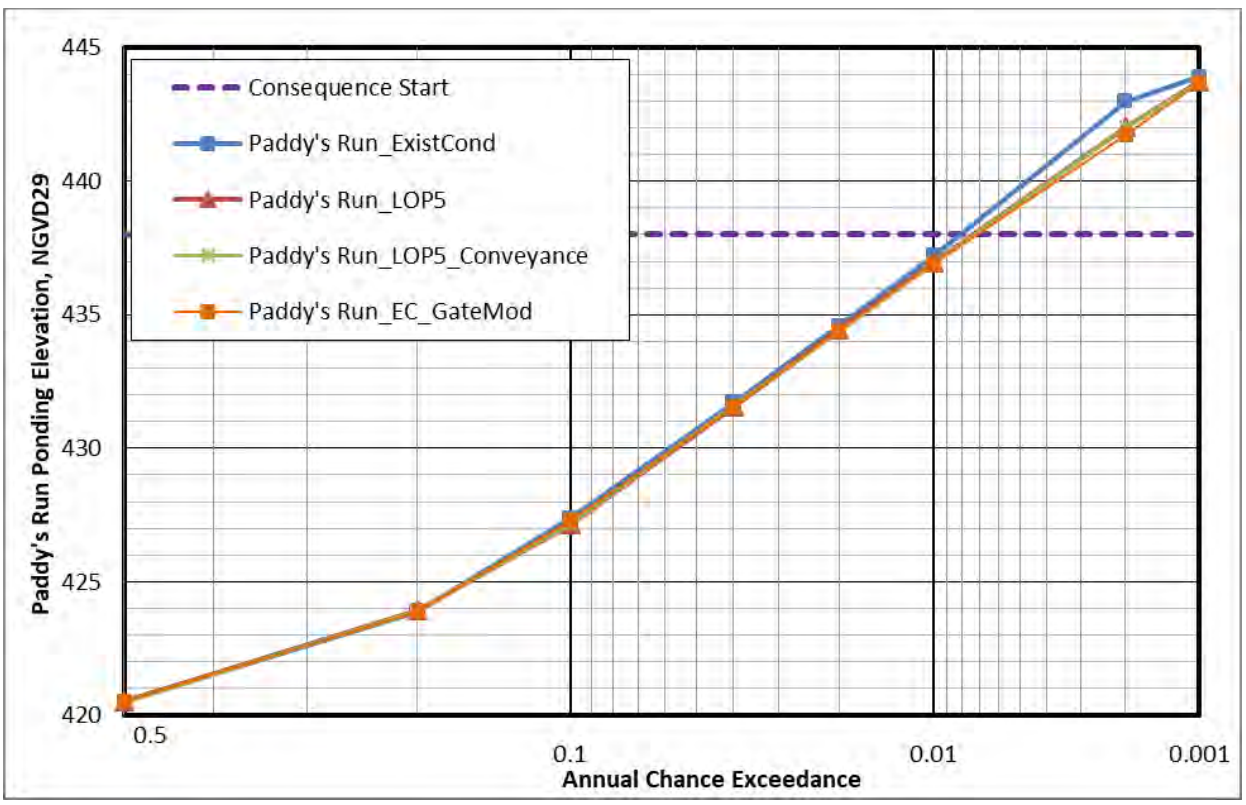


Figure 38: Coincident Frequency Curves for Paddy's Run Pump Station

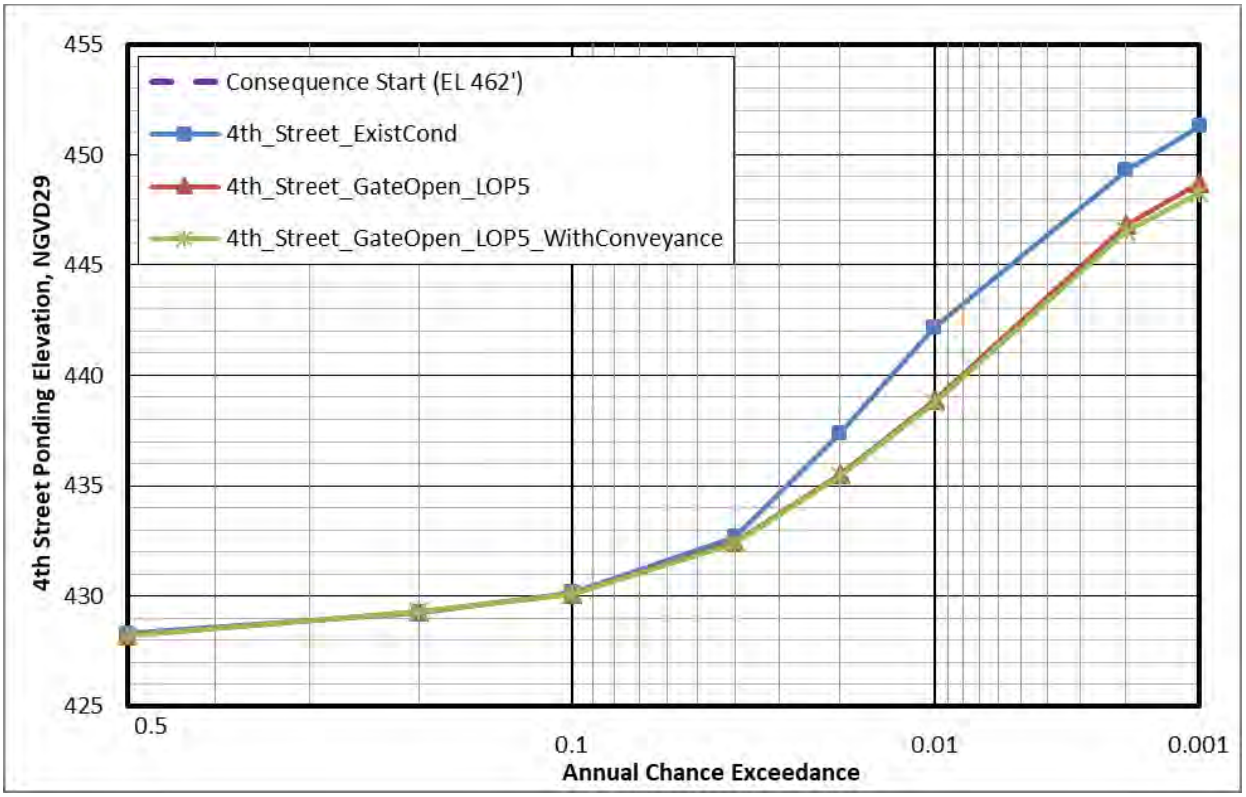


Figure 39: Coincident Frequency Curves for 4th Street Pump Station

It should be noted from these results that all three scenarios are nearly identical up until the annual chance exceedance event that corresponds to a closed-gate condition. This is generally 1 to 4% of the time for stations in the system. At that point the curves begin to diverge as pump capacity comes into play. The coincidence represented by these curves is that the river is up, and a rainfall event occurs at the same time.

Figure 40 displays the statistical reduction in water surface elevation frequencies due to increasing pump capacity to LOP5 levels for each pumping station versus existing conditions (E.C.). As displayed in the figure, Beargrass Creek and 4th Street display the largest magnitude water surface frequency reductions. However it is important to note that for nearly all scenarios where a substantial reduction in the frequency of water surface elevations were observed, the water surface elevation frequency remained within the channel and flooding of structures was very limited. This is true even for fairly extreme frequencies with annual chances of exceedance less than 1%. Using Beargrass Creek as an example, near the pumping station, the top of bank elevation is approximately 445 feet, whereas the 0.1% ACE water surface elevation is only approximately 438 feet and therefore the elevation frequency remains within the channel. For this reason and the lack of structures which would benefit from pump capacity increases, increasing capacity at the pumping stations was shown to statistically not significantly reduce the likelihood of flood damages, and subsequently not economically justified.

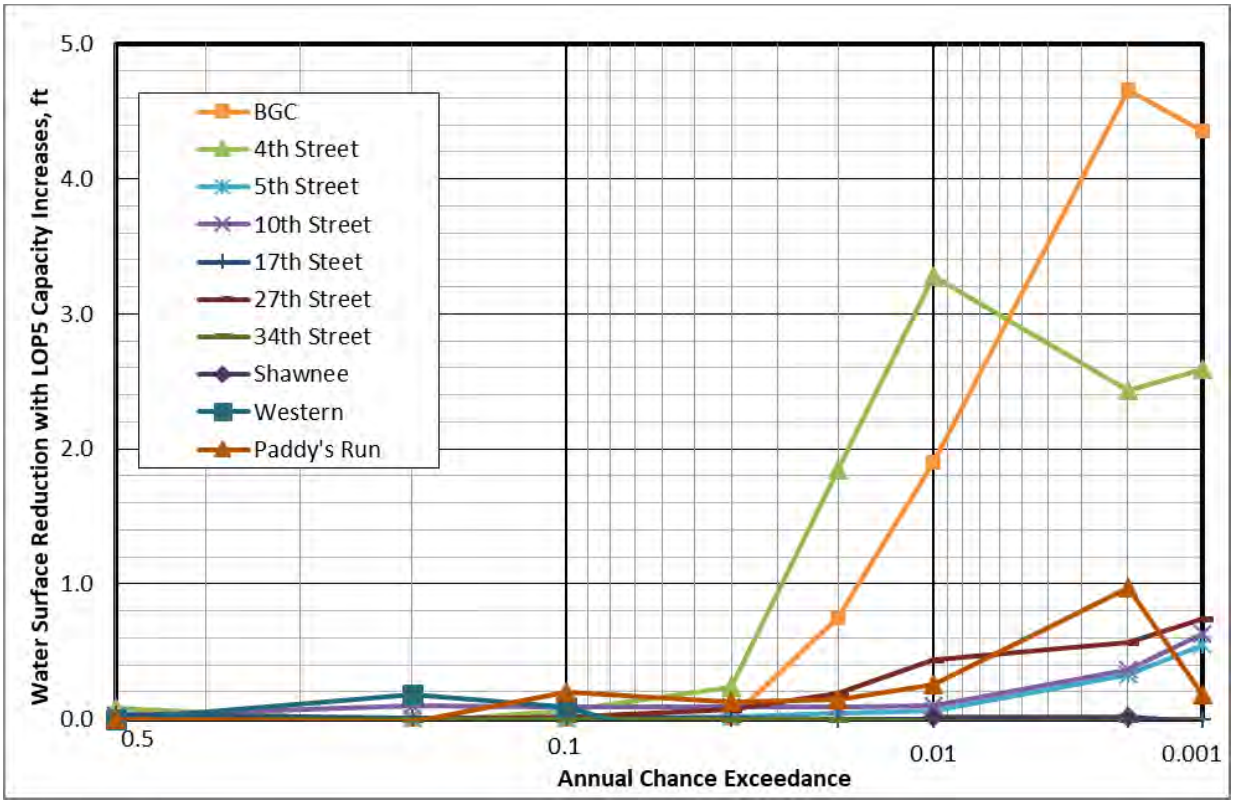


Figure 40: Water Surface Reduction with Capacity Increase (versus existing condition)

Based on this analysis the pump station capacity increase alternative (Alternative C) was screened from further consideration because it was not as efficient at meeting objectives as the Reconstruction & SQRA alternative (Alternative B), which resulted in the two remaining alternatives:

- No-Action (Alternative A); and
- Reconstruction & SQRA (Alternative B).

At this point in the study it was determined that the project would not expand the project scope or level of ponding reduction for interior drainage or Ohio River flooding and the Reconstruction & SQRA alternative (Alternative B) is the Tentatively Selected Plan (TSP).

5 TENTATIVELY SELECTED PLAN (TSP)

Following screening of pump station capacity increase and identification of the TSP, two evaluation procedures were then applied to confirm what specific system features would be considered for inclusion in the TSP.

5.1 TSP Evaluation 1: 2005 Reconstruction Guidance

The first evaluation procedure validated qualification for reconstruction under the 2005 Reconstruction Guidance and evaluated long-term degradation of features, as well as features that had exceeded their expected service life. No system features were identified to increase the extent of the leveed area, which allowed the team to run the feature through the following sequence of decisions:

- Does **not** address design or construction deficiency.
- Does **not** address maintenance deficiency.
- Does **not** increase authorized project scope (scope is defined by the PDT as project footprint).
- Does **not** increase authorized project function (function is defined as the extent of the leveed area).
- **Addresses** long-term degradation and/or exceeded service life with current design and safety standards.

Once a feature was determined to qualify for reconstruction, based on long-term degradation or exceedance of its expected service life, measures were then developed to restore the feature to its original (authorized) level of performance. Generally, selection of the recommended measure was based on the least-cost technically feasible measure. Additionally, system features that qualified for reconstruction were also evaluated for updates of feature components to current design and safety standards.

<u>Pump Stations</u>

Table 17 outlines the rationale for pump stations to be eligible for reconstruction. The predominant qualifying factor for pumps and motors is age (service life). All of the stations are older than twenty years and nine are operating with original equipment from the 1950s. Frequency of use and outages are also contributing factors that were considered when identifying what features would be included as part of the TSP.

Table 17: Pump Station Eligibility Under the 2005 Reconstruction Guidance

Pump Station	Date Constructed	Total Pumps	Frequency of Station Operation	Pump Recommendation	Motor Recommendation	Pump/Motor Recommendation Justification
Beargrass Creek	1952	8	Once every 3-4 year	Rebuild All	Inspect / Refurbish	Age / Outages
Robert J. Starkey	2005	4	Annually	Rebuild All	Inspect / Refurbish	Frequency of use
5th Street	1952	4	Once every 5 years	Replace All	Integrated with Submersible Pump	Age
10th Street	1952	4	Once every 5 years	Replace All	Integrated with Submersible Pump	Age
17th Street	1952	4	Once every 5 years	Replace All	Integrated with Submersible Pump	Age
27th Street	1952	5	Once every 5 years	Replace All	Integrated with Submersible Pump	Age
34th Street	1951	6	Annually	Replace All	Integrated with Submersible Pump	Age / Frequency of use
Shawnee Park	1951	7	Once every 5 years	Rebuild (5) / Replace (2)	Rebuild (5) / Integrated with Submersible Pump (2)	Age
Western Parkway*	1952	3	Twice per year	No Action	Sponsor has completed repairs	N/A
Paddy's Run	1953	6	Annually	Replace All	Replace or Refurbish All	Age / Outages / Frequency of use
Upper Mill Creek	1983	3	Once every 2 years	Rebuild All	Refurbish / Replace (1)	Age
Riverport	1980	3	Once every 2 years	No Action	Inspect / Refurbish	Age
Lower Mill Creek	1980	3	Once every 2 years	Rebuild All	Inspect / Refurbish	Age
Pond Creek	1989	4	Once every 2 years	Rebuild (3)	Refurbish / Replace (4)	Age / Outages / Frequency of use

*Western Pump Station qualifies based on transformers and controls exceeding their service life.

Specific to pump stations, installation of new submersible column pumps were selected based on their low first cost to install and less labor in the field (machining, alignments, etc.) as compared to other pump and motor configurations considered. The PDT expects that this will allow for a shorter contract duration for submersible column pumps vs rebuilding or replacing the existing pump with an exact match. Based on recent Corps experience on the Paducah, Kentucky Levee System Reconstruction project and similar levee systems in the region, it has been found that if smaller pumps (typically less than 100,000 gallons per minute) require extensive repair work, the cost to rebuild may be greater than providing new pumps. The material cost for smaller pumps is often less than performing extensive repairs. As mentioned previously (Section 2.8.1), actual pump conditions cannot be fully determined until they are disassembled. Selecting new pumps during feasibility limits the risk of being forced into providing new pumps during construction and the design work necessary to make the change.

With the larger pumps (typically greater than 100,000 gallons per minute), submersible column pumps are not a technically feasible option. The decision to recommend rebuilding the current larger pumps over replacing with similar pumps is based on cost. Even if a pump requires extensive repair work, there

is not much, if any money to be saved by recommending new pumps. Replacing in-kind will require more work in the field for installation. If the pumps are replaced, the likelihood of reusing any of the existing motors is very low, further increasing cost. With new motors, there is a risk that there may be significant electrical or structural upgrades as well. There would also need to be additional vibration analysis, since vibration with the larger pumps can have a significant impact on the structure. The only obvious benefit is that there is a possible reduction in contract time and no need for pump phasing to limit the duration that a pump station has reduced capacity. However, the benefits are outweighed by the risks previously mentioned.

The Beargrass Creek Pump Station has significant additional design requirements, because of the custom discharge connection and siphoning discharge. Selecting new pumps for Beargrass would require a significant design effort, or reverse engineering of what is currently operating at that location.

The exceptions are Starkey and Paddy's Run Pump Station. The Starkey Pump Station currently has smaller submersible pumps, but were identified only for refurbishment, because of the age of the pumps. They are relatively new and believed to be in fair condition; however, their run time indicates a rehabilitation of the pumps is needed. Paddy's Run has large pumps that are recommended to be replaced. The pumps are overall in the worst condition compared to all other stations. The likelihood of the necessary repairs costing more than replacement is high. Making the decision for recommending new pumps during feasibility allows decisions to be made in design vs during construction when disassembly provides a full assessment of their condition.

Street Closures & Closure Vault & Gates

The two closures identified to be permanently abandoned both have exceeded their service. The closures at 27th and 10th Streets are the first and second to be installed and no longer are needed to provide necessary access to the river side of the levee/floodwall.

The existing Johnsontown closure vault has reached its design service life and needs replacement. Maintaining a watertight structure will reduce O&M cost associated with the closure. Repair of the existing closure vault is not feasible due to the high cost of repairs compared to the relatively low cost of replacement. Therefore, demolition of the existing structure, re-grading of the site, and construction of a new closure vault is recommended.

Inspection, repair and replacement of gates will reduce the risk of failure of the levee system. Further analysis will be completed following and inspection that will be completed during construction. Gates larger than 96” X 96” will be designed by the structural engineer should replacement be necessary. Most gates are 65 years old; as such, replacement or repair of multiple gates is likely.

Floodwalls

The Canal Station building is scheduled for demolition by its owner (LG&E). Currently the levee system uses the eastern wall of this structure as part of the project alignment and since the structure is being demolished, it would leave a gap in the levee system. The I-wall just upstream of Canal Station is

considered to be one of the more failure prone floodwall sections and has numerous structural issues in its foundation.

Degraded water stops at 26 locations have the potential to cause erosion and scour on the leveed area side of floodwalls. Water stop repairs on the waterside will improve system performance and lower the risk of erosion on the leveed area side of the floodwalls.

5.2 TSP Evaluation 2: 2019 SQRA

The second evaluation procedure to validate system features for reconstruction focused on reducing the life safety risk through addressing potential failure modes identified during the 2019 SQRA. The full report is located in Volume 4. During the SQRA, 57 potential failure modes were identified for consideration and six were considered in detail because of their contribution of risk to the performance of the LMFPS. Of the potential failure modes, three exceeded the Corps guidelines for tolerable risk and one plotted adjacent to the line when uncertainty is considered. (Figure 41)

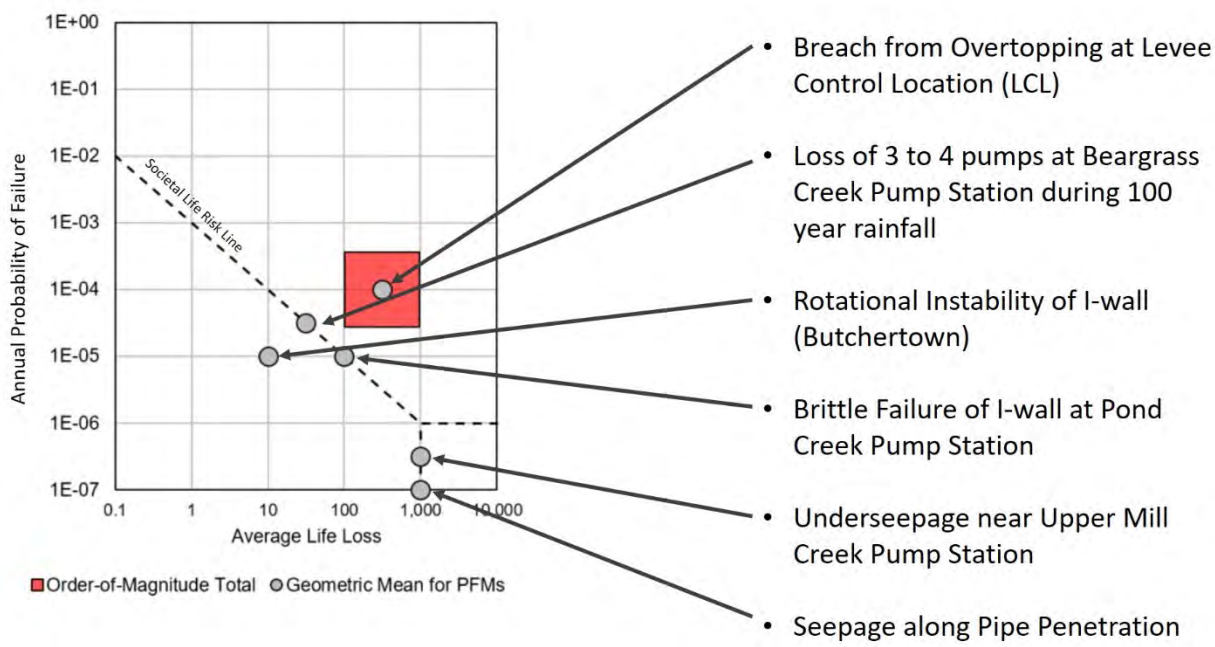


Figure 41: Societal Incremental Life Safety Risk Matrix

Note that one of the potential failure modes where a measure was not recommended is breach from overtopping at the Levee Control Location (LCL). Overtopping for the project is expected to occur along an approximate 8-mile long stretch of earthen embankment in the Southwestern Jefferson County reach of the levee where the frequency of overtopping is essentially the same with an AEP of approximately 1/8,500. The length of the low area makes any type of intervention to either raise the levee or protect against erosion impractical.

As a result, measures were only identified for three potential failure modes (green text in Figure 42) during the 2019 SQRA to reduce the risk to an acceptable level and selected based on the criteria of least cost and technically feasible. The Red Block in Figure 42 represents the overall total incremental risk and it was shifted a ½ order of magnitude based on recommend structural measures; however, it is still controlled by the overtopping. All other failure modes have dropped below the diagonal societal risk line which informs TRG1. Once validated for their risk reduction these three measures were carried forward for inclusion in the TSP.

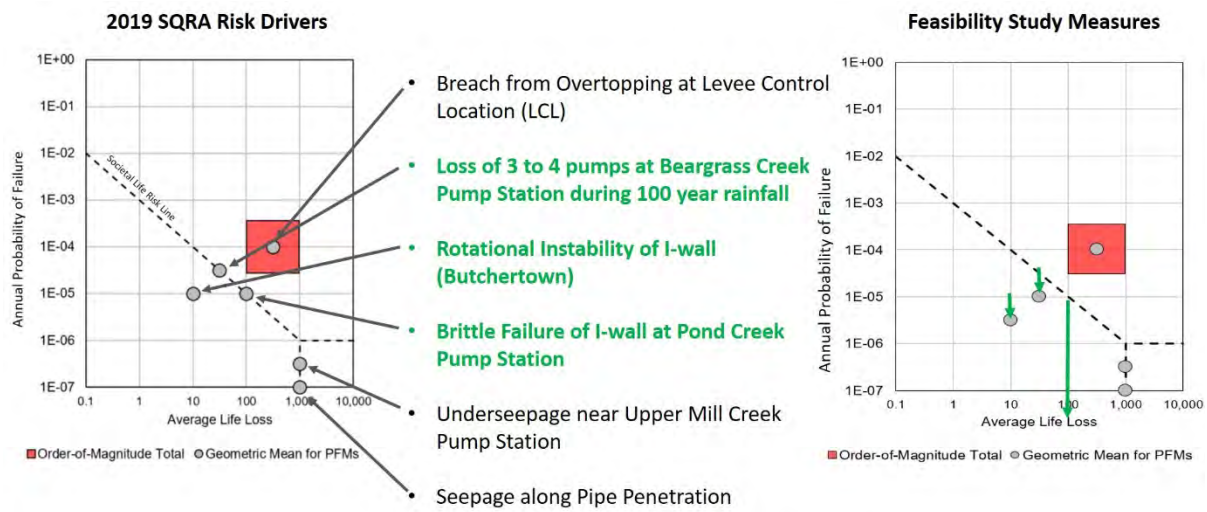


Figure 42: Societal Incremental Life Safety Risk Matrix Reductions with Feasibility Study Measures

In addition to reduction in life safety risk, these measures also qualify under the 2005 Reconstruction Guidance for project inclusion, as they are recommended for implementation at system features that qualify for reconstruction and are considered to be updates to current design and safety standards. The discussion below outlines the specific recommended measures to address the risk drivers identified in the SQRA.

<u>Pond Creek Pump Station I-Walls</u>

The Pond Creek Pump Station I-Walls present a unique challenge. Typical methods of reinforcing the walls are not feasible (i.e. backfilling on the landside). Consequently, the recommendation includes post-installed adhesive anchors while using a strut and tie method of analysis to determine the exact layout and number of studs in design will allow these walls to be repaired efficiently. Cost savings can be achieved by using large washers (plates) at each anchor instead of placing one large plate over the entire wall. Hot dip galvanization of steel parts will increase the life of steel parts while decreasing O&M costs.

<u>Beargrass Creek Gate Modification</u>

Modifications to the Beargrass Creek Pump Station are dependent on the configuration and selection of mechanical equipment. Basic assumptions about size and configuration have led to the determination

that having the ability to open the river gates under 7 to 8 feet of differential head is possible with minor structural modifications to the station and gates. The equipment was assumed to remain in a similar configuration to existing, would be larger, an extra sheave would be added to the gate, and that lifting loads would increase. Based on the stated assumptions, two reinforcing plates will need to be added to each side of the gate lifting lugs, the lifting pins will need to be lengthened, two new continuity plates will need to be added, openings will need to be widened, a spreader beam will need to be added to reinforce the widened openings, and new anchorage will need to be provided. Access to the gate mechanical room is restricted by a 10 ton crane support beam. The exterior crane support beam will be removed to facilitate the installation of new equipment. During the design phase, a full inspection of both river gates at Beargrass Creek will need to be completed and any damage to the gate, that is not O&M related, will be repaired.

Butchertown I-Walls

Three locations consisting of a total of approximately 280 linear feet of I-wall in the Butchertown neighborhood are recommended for replacement or buttressing to address global stability issues. At one segment, an adjacent structure prevents buttressing on the landside of the wall. Due to this structure, a modified T-Wall replacement is recommended. During the planning engineering and design (PED) phase, king piles will be considered in-place of the modified T-Wall to reduce costs and construction time.

5.3 TSP Description

The TSP includes replacement and refurbishment of equipment at 14 pump stations in the LMFPS. The other three grouping of system features identified for inclusion in the TSP include closures, gates and floodwalls. The TSP does not address any routine O&M items identified during the most recent 2019 PI. A full list of features included in the TSP is located in Table 18. Figure 43 provides a visual overview of the TSP by location in the LMFPS.

Table 18: Description of the TSP

Beargrass Creek Pump Station	Rebuild Pump 1 - 52,750 GPM
	Rebuild Pump 2 - 300,000 GPM
	Rebuild Pump 3 - 350,000 GPM
	Rebuild Pump 4 - 350,000 GPM
	Rebuild Pump 5 - 350,000 GPM
	Rebuild Pump 6 - 350,000 GPM
	Rebuild Pump 7 - 350,000 GPM
	Rebuild Pump 8 - 350,000 GPM
	Upgrade river gate hoist machinery, repair gate, add interior walkway to gate hoist
	New Transducers for Upstream/Downstream Control
	Replace Service Transformers
	Inspect all motors and refurbish motor components as needed
Starkey Pump Station	Rebuild Pump 1 - 24,500 GPM
	Rebuild Pump 2 - 24,500 GPM
	Rebuild Pump 3 - 24,500 GPM
	Rebuild Pump 4 - 24,500 GPM
	Replace Service Transformers
	Replace Variable Frequency Drives (VFD), New Motor Control Center (MCC)
	Inspect all motors and refurbish motor components as needed
5th Street Pump Station	Replace Pump 1 - 11,070 GPM with Submersible Column Pump
	Replace Pump 2 - 11,070 GPM with Submersible Column Pump
	Replace Pump 3 - 11,070 GPM with Submersible Column Pump
	Replace Pump 4 - 3,000 GPM with Submersible Pump
	New MCC and Replace of Controls
	Replace Service Transformers
10th Street Pump Station	Replace Pump 1 - 1,530 GPM with Submersible Pump
	Replace Pump 2 - 19,950 GPM with Submersible Column Pump
	Replace Pump 3 - 19,950 GPM with Submersible Column Pump
	Replace Pump 4 - 19,950 GPM with Submersible Column Pump
	New MCC and Replace Controls
	Replace Service Transformers
17th Street Pump Station	Replace Pump 1 - 1,300 GPM with Submersible Pump
	Replace Pump 2 - 11,400 GPM with Submersible Column Pump
	Replace Pump 3 - 11,400 GPM with Submersible Column Pump
	Replace Pump 4 - 11,400 GPM with Submersible Column Pump
	New MCC and Replace Controls
	Replace Service Transformers

Table 18: Continued

27th Street Pump Station	Replace Pump 1 - 5,710 GPM with Submersible Pump
	Replace Pump 2 - 40,000 GPM with Submersible Column Pump
	Replace Pump 3 - 40,000 GPM with Submersible Column Pump
	Replace Pump 4 - 40,000 GPM with Submersible Column Pump
	Replace Pump 5 - 40,000 GPM with Submersible Column Pump
	New MCC and Replace Controls
	Replace Service Transformers
34th Street Pump Station	Replace Pump 3 - 15,600 GPM with Submersible Column Pump
	Replace Pump 4 - 15,600 GPM with Submersible Column Pump
	Replace Pump 5 - 15,600 GPM with Submersible Column Pump
	Replace Pump 6 - 15,600 GPM with Submersible Column Pump
	New MCC and Replace Controls
	Replace Service Transformers
	Replace/Refurbish Two 75 HP Motors
Shawnee Park Pump Station	Replace Pump 1 - 9,000 GPM with Submersible Column Pump
	Rebuild Pump 2 - 103,500 GPM
	Rebuild Pump 3 - 103,500 GPM
	Rebuild Pump 4 - 103,500 GPM
	Rebuild Pump 5 - 103,500 GPM
	Rebuild Pump 6 - 103,500 GPM
	Replace Pump 7 with Submersible Pump
	New MCC and Replace Controls
	Replace Service Transformers
	Replace/Refurbish Five 800 HP Motors
Western Parkway Pump Station	No Mechanical Work
	Replace Controls
	Upgrade Service Transformers

Table 18: Continued

Paddy's Run Pump Station	Replace Pump 1 - 60,750 GPM
	Replace Pump 2 - 60,750 GPM
	Replace Pump 3 - 121,500 GPM
	Replace Pump 4 - 121,500 GPM
	Replace Pump 5 - 121,500 GPM
	Replace Pump 6 - 121,500 GPM
	Replace trash rake
	Install Centralized Automatic Grease System
	New MCC
	Replace Service Transformers
	Replace Controls
	Replace/Refurbish Two 700 HP Motors
	Replace/Refurbish Four 1250 HP Motors
	Structurally refurbish station
	Paddy's discharge lines replacement/rehab
	Upgrade overhead crane
Riverport Pump Station	New MCC
	Replace Service Transformers
	Replace Controls
	Replace horizontal portion of discharge pipes
Lower Mill Creek Pump Station	Rebuild Pump 1 - 73,500 GPM
	Rebuild Pump 2 - 73,500 GPM
	Rebuild Pump 3 - 73,500 GPM
	Install Centralized Automatic Grease System
	New MCC
	Replace Service Transformers
	Inspect all motors and refurbish motor components as needed
	Replace Controls
	Rehab of horizontal portion of discharge pipes

Table 18: Continued

Upper Mill Creek Pump Station	Rebuild Pump 1 - 173,000 GPM
	Rebuild Pump 2 - 173,000 GPM
	Rebuild Pump 3 - 173,000 GPM
	Rehab of horizontal portion of discharge pipes
	Install Centralized Automatic Grease System
	New MCC
	Replace Service Transformers
	Replace Controls
	Replace/Refurbish One 3000 HP Motor
Pond Creek Pump Station	Rebuild Pump 1 - 460,082 GPM
	No Work on Pump 2 - 460,082 GPM
	Rebuild Pump 3 - 460,082 GPM
	Rebuild Pump 4 - 460,082 GPM
	Install vibration sensors and trend data
	Install Formed Suction Intake (FSI) or Vortex Suppression Grid for all pumps
	New MCC
	Replace Service Transformers
	Replace Controls
	Replace/Refurbish Four 4700 HP Motors
	Repair water service
	Repair I-walls on either side of station - structural modification
Canal Station	Construct T-wall between wall and levee in order to demolish abandoned building between Northwestern Parkway and Louisville River walk and to abandon I-wall.
Butcher town I-Wall	Stabilize I-wall sections (2 locations)
10th St Closure	Permanently abandon closure (betterment: install swing gate closure)
27th St Closure	Permanently abandon closure, construct new asphalt access road from 31st Street South of McAlpine Lock.

Table 18: Continued

Johnsontown Road Closure	Replace closure vault with a new closure vault.
Water Stop Repair	Installation of new external water stops at approximately 26 locations along the floodwall. New water stops will consist of a steel plate, adhesive anchors and new PVC water stops.
Gate Repair	Replace actuators at multiple gates, replace multiple gates, and refurbish multiple gates. Approximately 15 new actuators, 13 new gates and 10 gates to be refurbished.

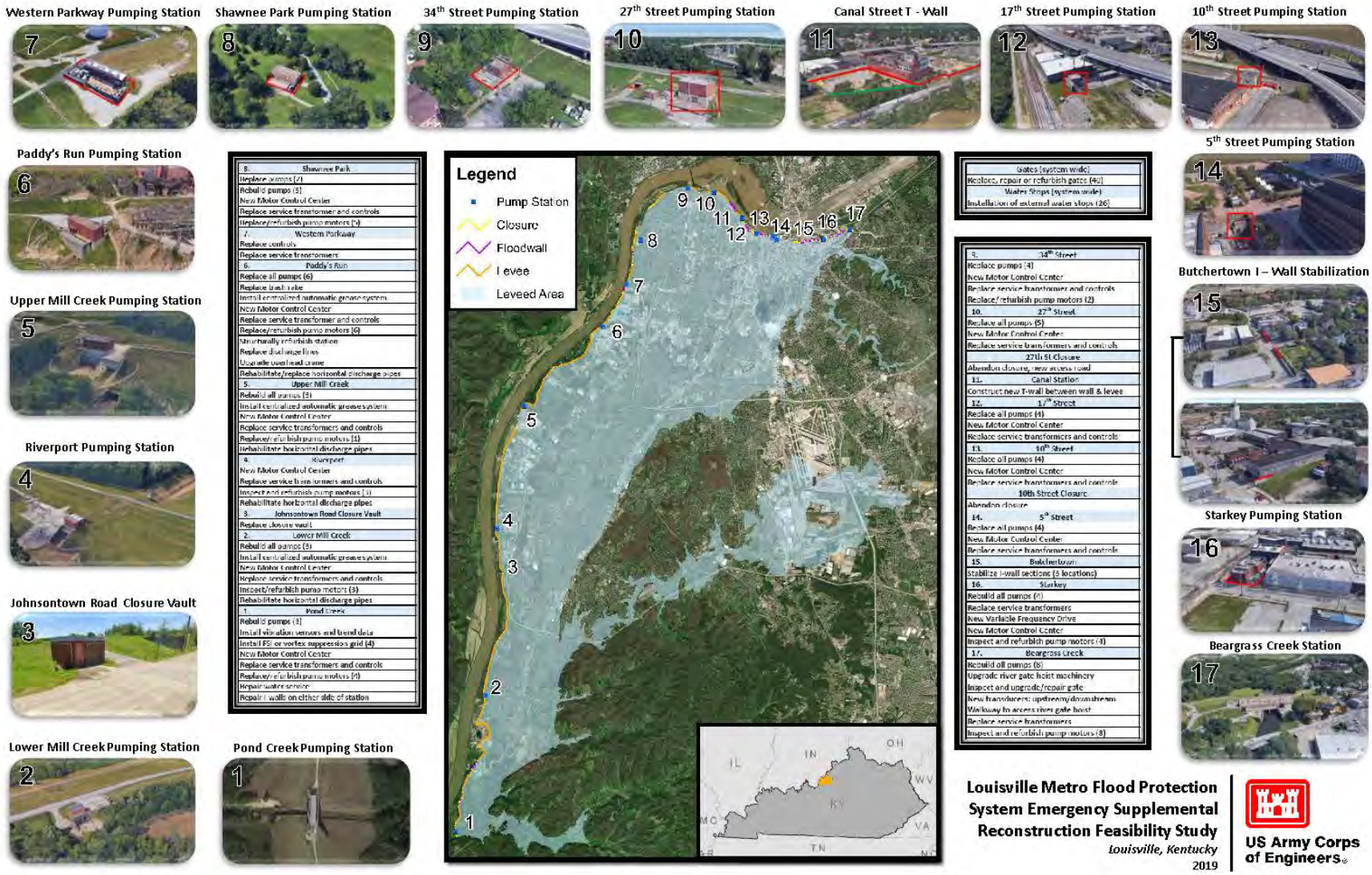


Figure 43: Overview of TSP by Location in the LMFPS

5.4 TSP Cost Overview

The estimated first cost of the TSP is $167,742,252 (2019 price level). Table 19 is a summary of the TSP First Costs by account.

Table 19: Summary of First Costs by Account

Cost Summary (October 2019 Price Levels)		
Construction Items		Cost
01 - Lands & Damages	**$**	**130,000**
Elements		
13 - Pumping Plants	**$**	**121,651,131**
Starkey FPS	$	5,385,999
Western FPS	$	1,820,437
Upper Mill FPS	$	11,765,274
Lower Mill FPS	$	5,355,305
Riverport FPS	$	2,089,528
Pond Creek FPS	$	23,744,950
Beargrass Creek FPS	$	24,629,212
Fourth Street FPS	$	-
Fifth Street FPS	$	2,159,682
Tenth Street FPS	$	3,278,710
Seventeenth Street FPS	$	2,105,238
Twenty Seventh Street FPS	$	5,694,337
Thirty Fourth Street FPS	$	2,811,856
Shawnee Park FPS	$	12,050,092
Paddy's Run FPS Remodel	$	18,760,508
11 - Levees & Floodwalls	**$**	**25,147,028**
Canal Station Floodwall	$	1,446,086
27th Street Closure	$	536,602
10th St. Swing Gate Concrete Closure	$	219,346
Pond Creek Wall	$	423,219
Butchertown T Wall	$	1,123,460
Johnontown Road Closure Vault	$	73,993
Repair Waterstops	$	703,881
Sluice Gates	$	20,620,441
Elements Subtotal	**$**	**146,798,159**
18 - Cultural Resource Mitigation	**$**	**121,000**
30 - Preconstruction Engineering & Design (PED)	**$**	**13,347,183**
31 - Construction Management (E&D, S&A)	**$**	**7,345,910**
Total First Cost	**$**	**167,742,252**

5.5 Benefits (1962 Stage Damage Curve)

A summary of annual costs and benefits based on project accomplishments is presented in Table 20. No additional system features were identified during this reconstruction Feasibility Study which would expand current O&M expenditures by MSD. Overall, it is expected that there will be a reduction in average annual O&M due to the removal of two road closures as well as remote monitoring and operation of pump stations through the installation of SCADA systems. The reduction was not calculated by the PDT and was reported as $0 cost in the calculations present below for annual benefits and costs.

Table 20: Summary of Annual Benefits and Costs Based on Project Accomplishments

(August 2019 Price Level, 50-Year Period of Analysis, 2.875 Percent Discount Rate)

Investment Costs	
Total Project Construction Costs	$ 167,742,000
Interest During Construction	12,468,000
Total Investment Cost	$ 180,210,000
Average Annual Costs	
Interest and Amortization of Initial Investment	$ 6,839,000
OMRR&R	0
Total Average Annual Costs	$ 6,839,000
Average Annual Benefits	$ 6,999,000
Net Annual Benefits	$ 161,000
Benefit-Cost Ratio	1.02 to 1
Benefit-Cost Ratio (computed at 7%)[1]	0.48 to 1

[1] Per Executive Order 12893 and OMB Circular A-94

5.6 Benefits (HEC-FIA)

Prior to submission of the Draft Final Feasibility Study, HEC-FIA version 2.2 will be used to estimate damages produced by 1-, 2-, 5-, 10-, 25-, 50-, 100-, and 500- year flood events in a simulation wherein the city is vulnerable without the levee system. The River Analysis System (RAS) output provided by H&H for the similar modeling that was done in HEC-LifeSim will be used to produce maximum depth grids for each event. Those depths will be applied to the NSI 2.0 to calculate damages. The damages for each frequency event will be used to calculate the expected annual damages that would occur to the up-to-

date inventory in the absence of the protection levee system. Additionally, the PDT will complete estimates for assurance (long-term non-exceedance) using HEC-FDA.

5.7 Risk and Uncertainty

Levee Risk

The 2019 SQRA was moderately confident in the levee risk (incremental risk) described in Section 2.4 of this report. The levee, floodwalls and pump stations are generally in satisfactory condition and are well-maintained by the Non-Federal Sponsor. The levee system appears to have been well designed and constructed; however, the leveed area is large with widespread development. Uncertainties related to the probability of failure consists of limited performance data (as the levee has never been loaded above 50%), the probability of loading, the reliability of the pump stations, the erosion characteristics of the embankment soils and the community's preparedness. The key uncertainty for the probability of failure is related to the inflow frequency analysis including the regulated-unregulated relationship and transference of inflow data from upstream gauges to the project location. The preparedness of emergency management officials and population at risk during a flood emergency was a key uncertainty related to consequences. A full description of the uncertainty analysis completed for the 2019 SQRA is located in Volume 4.

Cost Risk

As this project cost is above $40M, a full Cost Schedule Risk Analysis (CSRA) was performed with the PDT. A CSRA is a method of determining contingencies, developed by the Cost Engineering Civil Works Center of Expertise and used to identify key areas for potential risk mitigation efforts. The process focuses on the development of a Risk Register (RR) where the PDT meets to brainstorm and discuss potential risk elements. The PDT, collectively, agrees upon, and assigns a "likelihood" and "impact" level if the occurrence where to happen.

At Beargrass Pump Station, Starkey Pump Station, Riverport Pump Station, Lower Mill Creek Pump Station, and at Upper Mill Creek Pump Station, the PDT identified concern that the existing motors, which are over 60 years old, could need refurbishment within the planning horizon of this project. This was determined to be possible or very likely, given the age, and also as having moderate to significant impacts to the cost. In an effort to mitigate this uncertainty, the cost estimate has included money to inspect each motor as well as a contingency for the cost of refurbishing the existing motors.

At the Western Parkway Pump Station, the sponsor (MSD) requested that operation of existing pumps be reviewed and possibly add Variable Frequency Drives (VFDs) to mitigate over cycling of the pumps. Additionally, it was recommended that the wet well hydraulics be reviewed for possible improvement. This was determined to be a likely course of action with a moderate impact to the cost estimate. Therefore, contingency has been included for this additional scope.

Overall there was additional concern that the existing cranes at new submersible stations may need replacing. This would be due to the newer, replacement pumps weighing more than the existing pumps. Additional weight would require a structural analysis of the supports. It was determined that this could

be possible and have a moderate impact to the cost estimate. Some risk can be possibly mitigated by load testing of the cranes during PED.

5.8 Residual Risk

Residual flood risk is the risk that remains after a flood risk management project is implemented. Residual risk includes the consequence of capacity exceedance as well as consideration of project performance.

The trends in observed and projected streamflow and precipitation are driving vulnerability within the watershed and for the LMFPS. This system includes miles of levee embankment and floodwall to reduce the risk of flooding in the leveed area induced by the Ohio River. While some residual risk exists regarding the floodwalls and levees, these features are largely resilient to the impacts of climate change. This is due to the conservative, and therefore resilient, design of these features which were sized based upon the 1937 flood plus 3 feet of freeboard, as well as substantial upstream construction of flood risk management reservoirs which has occurred since the levee system's inception. Due to the upstream reservoir construction alone, flow frequency estimates are assumed to have dropped since the levee system was constructed and an overtopping event is estimated to occur at a 1 in 8,500 year event. During this rare event, the weighted average life loss was estimated to be between 1000 and 10,000 lives per flood.

This combination of circumstances has produced a rather robust levee system from a hydraulic adequacy perspective. At the same time, these factors increase the consequence that could occur in the event that a levee breach would happen. As described in Section 2.4, the overall levee risk is mostly driven by a breach due to an overtopping of the levee embankment by a depth of 1.5 feet of water. This means that during a 1 in 15,400 year event (6.5E-05 AEP), flood water from the Ohio River would be 1.5 feet higher than the top of the levee and possibly cause the levee to breach and result in inundated area of over 46 square miles.

Other features of the system, such as flood pump stations are more vulnerable to the potential impacts of climate change. Increased frequency and intensity of rainfall on interior areas translates to increased frequency of use on the pump stations. The combination of urbanization, observed increasing streamflows, and potential for more frequent future rainfall increases the stress on these pump stations.

5.9 Lands, Easements, Rights-of-Way, Relocations and Disposals (LERRD) Considerations

The majority of the activities included in the proposed project (TSP) will take place within the existing levee right-of-way owned in fee and easement by MSD. Sufficient access to the pump stations will be obtained through existing ingress/egress easements and public rights-of-way owned by Louisville/Jefferson County or MSD. No significant earthwork is anticipated and no borrow or spoil site is

required to implement the TSP. The following project features are anticipated to require additional real estate interests outside of those already owned by the non-federal sponsor to support construction:

Canal Street T-Wall (New Alignment): acquisition of a 0.32 acre Perpetual Flood Protection Floodwall Easement will be required to accommodate a new T-Wall section. In addition, acquisition of a 0.96 acre Temporary Work Area Easement will be required for staging and construction. The owner of the site is Louisville's primary electric and gas utility provider (LG&E). Although the value of these easements is included in the Real Estate cost estimate in accordance with current planning guidance, it is anticipated that the necessary easements will be provided at no cost to the non-federal sponsor.

Butchertown I-Wall Stabilization: an existing section of I-Wall will be replaced in its current location on the east side of N Shelby Street, south of the Franklin Street intersection. The existing floodwall is located within MSD right-of-way. The northbound lane of Shelby Street will be used during construction, however, additional area on the east side of the wall will be necessary to facilitate replacement. Acquisition of a 0.06 acre Temporary Work Area Easement will be required for staging and construction. (See Real Estate Appendix, Exhibit RE-2).

New Access Road at N 31st Street: there are currently two existing access routes to McAlpine Locks and Dam and Shippingport Island. The N 26th Street access includes crossing an active railway line in which railcars are often staged due to a nearby track interchange causing the route to be blocked for indeterminate periods of time. The N 27th Street access has vehicle height restrictions due to an overhead railway bridge. The construction of a new road will provide an alternate route for emergency vehicles to reach Marine Street in the event the N 26th Street access is blocked. The 27th Street levee opening will be permanently closed as part of the project. The new road will be located partially on existing public right-of-way and partially on property currently owned in fee by the United States of America.

Lands Owned by the Non-Federal Sponsor

MSD currently owns fee simple and easement interests in all lands required to implement the TSP with the exceptions noted above. Credit for the value of lands, easements, rights-of-way, relocations, and suitable borrow and dredged or excavated material disposal areas (LERRD's) will not be afforded to the non-federal sponsor for any portion of the existing levee right-of-way. The existing right-of-way was provided previously as an item of cooperation to support the original Federal construction of the flood protection system.

Standard Estates

The standard estates of Flood Protection Levee/Floodwall Easement and Temporary Work Area Easement will be required to implement the project.

Existing Federal Lands or Projects

The 31st Street access road to be constructed will be partially located on portions of McAlpine Locks & Dam Parcel Nos. 3 and 12. MSD will not be required to obtain a real property interest in those lands and as such, its value will not be included in total project costs and LERRD credit will not be afforded.

5.10 Operation, Maintenance, Replacement, Repairs and Rehabilitation (OMRR&R)

MSD will continue to have responsibility for operating, maintaining, replacing, repairing, and rehabilitating the project or completed functional portions of the project, including mitigation features without cost to the Government. The manner in which these activities are completed will be compatible with the project's authorized purpose and in accordance with applicable federal and state laws and specific directions prescribed by the Government in the Operation and Maintenance manual and any subsequent amendments thereto.

The O&M requirements for features reconstructed will reduce the average annual expenditures of the Non-Federal Sponsor. The level of reduction in expenditures will vary depending on fluctuations caused by high river levels and the resultant need for additional labor and electricity. Maintenance will continue to include, but not be limited to annual routine inspections of and repairs to the permanent project levees, floodwalls and interior drainage facilities. Operation will continue to include, but not be limited to the operation of pumping plants, gates, and servicing of all project structures.

Following completion of the project and issuance of a notice of completion, MSD will also be fully responsible for RR&R. Specifically, repair is considered to entail those activities of a routine nature that maintain the project in a well-kept condition. Replacement covers those activities taken when a worn-out element or portion thereof is replaced. Rehabilitation refers to a set of activities as necessary to bring a deteriorated project back to its original condition. RR&R actions will conform to the project as-built plans and specifications unless other arrangements are made with the Louisville District commander.

5.11 Plan Accomplishments

In reviewing the planning objectives developed for this Feasibility Study outlined earlier in this report, all objectives were met in formulation of the recommended plan (TSP). Problems were identified and potential structural and non-structural alternatives that would continue to alleviate out-of-bank flooding problems within the study area were developed and evaluated. Coordination efforts with MSD took place throughout the study, taking into account the Non-Federal Sponsor's goals, to identify the recommended plan. Based on MSD's input and Louisville District evaluations, the social and economic effects of the recommended plan will continue to be positive. The most important effect of implementation of the recommended plan would be a lower flood risk for 76 square miles of densely populated urban development, which includes a total of 86,000 structures and a population of 215,000. It is important to note that the economic analysis completed as part of this study claims only National Economic Development (NED) benefits from flood risk management.

5.11.1 National Economic Development (NED)

Future Without Project Conditions provide annual benefits of $7,225,000 (resulting from the Reconstruction action). Giving consideration to the total annual charges of $6,645,000 provides a Benefit-to-Cost ratio of 1.09 to 1. This Reconstruction Plan generates a Benefit-to-Cost ratio above unity and produces a positive net benefit of $580,000 to the Nation. It's therefore considered to be economically feasible and is viewed as the NED plan.

5.11.2 Regional Economic Development (RED)

The Regional Economic Development (RED) impacts are essentially the same as the National Economic Development (NED) benefits for this project. The Recommended Plan for flood risk management continues to provide benefits to impacted areas Louisville, Kentucky.

5.11.3 Other Social Effects (OSE)

Other social effects (OSE) would include negative impacts to community businesses. Relocations of businesses or residences could impact employment in the area, property values, public facilities and services, tax revenues, community cohesion, and transportation. These threats would potentially increase under the "No Action Alternative," as chances of failure of the levee become greater with increasingly deteriorating equipment. The Recommended Plan for Reconstruction will continue to reduce the threat to loss of health and economic standing.

5.11.4 Environmental Quality (EQ)

The proposed project has been reviewed for compliance with other federal legislation including the National Environmental Policy Act, Endangered Species Act, Clean Air Act, Clean Water Act, and Section 106 of the National Historic Preservation Act of 1966 (as amended). At this time no significant impacts have been identified, and no mitigation is required to support project implementation.

5.12 Compliance with Environmental Laws

Implementation of the recommended alternative (Alternative B) would not commence until the proposed actions achieve environmental compliance with the applicable laws and regulations, as described below. Environmental compliance for any proposed actions would be achieved upon coordination of this Environmental Assessment with appropriate agencies, organizations, and individuals for their review and comments.

<u>Bald Eagle Protection Act, 16 U.S.C. Sec. 668, 668 note, 668a-668d.</u>

In compliance.

The Bald Eagle Protection Act contains requirements on Corps of Engineers projects concerning bald eagles. Implementation of the preferred alternative would not adversely affect bald eagles or their habitat.

Clean Air Act, as amended, 42 U.S.C. 1857h-7, et seq.

In compliance.

The purpose of this Act is to protect public health and welfare by the control of air pollution at its source, and to set forth primary and secondary National Ambient Air Quality Standards to establish criteria for States to attain, or maintain. The federal action would not contribute to long-term impacts to air quality.

Clean Water Act, as amended, (Federal Water Pollution Control Act) 33 U.S.C. 1251, et seq.

In compliance.

The objective of this Act is to restore and maintain the chemical, physical and biological integrity of the Nation's waters (33 U.S.C. 1251). The Corps of Engineers regulates discharges of dredge or fill material into waters of the United States pursuant to Section 404 of the Clean Water Act. This permitting authority applies to all waters of the United States including navigable waters and wetlands. The Section 404 requires authorization to place dredged or fill material into water bodies or wetlands. If a Section 404 authorization is required, a Section 401 water quality certification from the state in which the discharge originates is also needed. The recommended plan would not involve the placement of dredge or fill material or any other discharge into waters of the U.S. Therefore, the recommended plan is in compliance with the Clean Water Act, as amended.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

Not applicable. The federal action does not occur on a CERCLA site and is not subject to the requirements of this Act.

Endangered Species Act (ESA), as amended. 16 U.S.C. 1531, et seq.

In compliance.

Section 7 (16 U.S.C. 1536) states that all Federal departments and agencies shall, in consultation with and with the assistance of the Secretary of the Interior (Secretary), insure that any actions authorized, funded, or carried out by them do not jeopardize the continued existence of any threatened or endangered (T&E) species, or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary to be critical.

This EA represents the assessment and findings regarding the proposed actions and serves as the Biological Assessment with a determinations of effect to the species listed in Section 2.1.7 of this Feasibility Study. The District determined no effect to threatened or endangered species from implementation of the recommended plan. Because a determination of no effect was made, concurrence from the USFWS is not required according to the ESA. However, the USFWS will have the opportunity to review this EA and to provide comments regarding the plan's compliance with the ESA.

Environmental Justice (E.O. 12898).

In compliance. The recommended plan would not disproportionately affect minority or low-income populations.

Federal agencies shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low- income populations in the United States.

Fish and Wildlife Coordination Act (FWCA), as amended, 16 U.S.C. 661, et seq.

In progress.

The FWCA requires governmental agencies, including the Corps, to coordinate activities so that adverse effects on fish and wildlife would be minimized when water bodies are proposed for modification. This EA will be provided to the USFWS, Kentucky Ecological Field Office and the KDFWR for their review and comment. Any comments received from the agencies will be provided in Appendix B.

Migratory Bird Treaty Act (MBTA)

In compliance.

The Migratory Bird Treaty Act of 1918 (MBTA) is the domestic law that affirms, or implements, the United States' commitment to four international conventions with Canada, Japan, Mexico, and Russia for the protection of shared migratory bird resources. The MBTA governs the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts and nests. The take of all migratory birds is governed by the MBTA's regulation of taking migratory birds for educational, scientific, and recreational purposes and requiring harvest to be limited to levels that prevent over utilization. Executive Order 13186 (2001) directs agencies to take certain actions to implement the act. The Corps will consult with the USFWS (through their review of the draft EA) with regard to their consideration of the effects of the actions identified in this EA for potential effects on migratory birds. No effects are anticipated.

National Historic Preservation Act (NHPA), as amended, 16 U.S.C. 470a, et seq.

In progress.

Section 106 of the NHPA, as amended, requires federal agencies to consider the effects of their undertakings on historic properties. The implementing regulations at 36 CFR 800 detail the process that requires consultation with the SHPO, tribes, local governments, the public, and others. Suitable efforts to identify historic properties must be taken and consulting parties afforded an opportunity to comment on the affects to these historic properties by the proposed undertaking. Only sites, building structures, objects, or landscapes listed on or determined eligible for listing in the NRHP are afforded the safeguards of the NHPA. Archival research for this project involved consulting the SHPO, and a review of

KHC, OSA, and the NRHP databases. The Corps initiated the Section 106 consultation under the NHPA with both the SHPO and the Osage Nation, Eastern Shawnee Tribe, Absentee Shawnee, Shawnee Tribe of Oklahoma, Cherokee Nation, United Keetoowah Band of Indians, Eastern Band of Cherokee, and the Delaware Nation in a letter dated February 11, 2019. The SHPO responded in a letter dated March 8, 2019 indicating they concur the project has the potential to affect historic properties and look forward to continuing the identification and consultation process. The Osage Nation responded in a letter dated March 27, 2019 indicating there are no known Osage resources within the APE and they look forward to reviewing the final report for the project. The Eastern Shawnee Tribe responded in a letter dated March 20, 2019 indicating the project proposed no adverse effect or endangerment to known sites of interest to the Eastern Shawnee Tribe. The Delaware Nation in a letter dated March 21, 2019 stated that no endangered, cultural, or religious sites of interest to the Delaware Nation are located within the APE. The Cherokee Nation responded in a letter dated February 18, 2019 stating there are no culturally sensitive resources located within the APE. They also stated they look forward to reviewing the final report for the project. Coordination with the SHPO and Tribes is ongoing.

The Corps is currently in the process of evaluating the historic significance of historic properties and archaeological sites located within the APE to determine whether they are eligible for listing in the NRHP in accordance with 36 CFR 800. 4(c). A MOA will be developed with USACE, SHPO, Tribal Nations, and Consulting parties to resolve the projects adverse effects to any historic properties or archaeological sites that have either been recommended eligible or have been previously listed in the NRHP that are located within the APE. All correspondence related to this consultation is included in the Appendix B.

<u>Native American Graves Protection and Repatriation Act (NAGPRA), 25 U.S.C. 3000-3013, 18 U.S.C. 1170</u>

In compliance.

If human remains are discovered during the course of the project and are determined to be of Native American descent, regulations implementing NAGPRA and state cemetery laws will be followed to identify the patrimony of those remains. Proper course of action for their disposition will be coordinated with the SHPO and all federally recognized tribes.

<u>National Environmental Policy Act (NEPA), as amended, 42 U.S.C. 4321, et seq.</u>

In progress.

This Environmental Assessment and Finding of No Significant Impact (FONSI) has been prepared in accordance with the Council on Environmental Quality's NEPA Implementing Regulations (40 CFR 1500-1508). If it is found there is no significant impact, an Environmental Impact Statement (EIS) is not required. The signing of the FONSI by the District Commander will complete compliance of NEPA.

<u>Noise Control Act of 1972, 42 U.S.C. Sec. 4901 to 4918.</u>

In compliance.

This Act establishes a national policy to promote an environment for all Americans free from noise that jeopardizes their health and welfare. Federal agencies are required to limit noise emissions to within compliance levels. Noise emission levels at the Project sites would increase above current ambient levels temporarily due to construction of improvements or features identified in the proposed master plan revision. Appropriate measures would be taken to keep the noise level within the compliance levels.

Floodplain Management (E.O. 11988).

In compliance.

Section 1 of E.O. 11988 requires each agency to provide leadership and take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for (1) acquiring, managing, and disposing of Federal lands and facilities; (2) providing Federally undertaken, financed, or assisted construction and improvements; and (3) conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities. The actions identified are required to fulfill the authorized purpose of the flood protection system. The activity would not adversely affect the flood holding capacity or flood surface profiles of the protected area.

Protection of Wetlands (E.O. 11990).

In compliance.

Federal agencies shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agencies responsibilities. Each agency, to the extent permitted by law, shall avoid undertaking or providing assistance for new construction located in wetlands unless the head of the agency finds (1) that there is no practicable alternative to such construction, and (2) that the proposed action includes all practicable measures to minimize harm to wetlands, which may result from such use. The actions identified in the recommended plan would not involve construction in, or affects to, wetlands.

6 PROJECT IMPLEMENATION

This section summarizes action items and the schedule to complete the project; institutional requirements; Federal and non-Federal cost-sharing requirements; Real Estate requirements; Environmental requirements; and procedures necessary to implement the flood risk management measures of the selected/recommended plan.

The project schedule assumes that work, specifically to the pump stations, will be staggered to accommodate requirements of operation during in, and off, flood season time periods. This, and the duration of the work to the pump stations, will cause the pump station work to be the critical path of the construction schedule. Coordination with MSD, including station sequencing, number of pumps allowed to be out-of-service, etc., will be necessary to develop a detailed construction schedule.

Through discussions with the PDT it was determined that an assumed overall construction schedule of five (5) years should be assumed.

A detailed project schedule will be developed using software such as Microsoft Project. A detailed construction schedule was developed (Volume 2, Appendix J) with the following project-specific assumptions:

- Two (2) pumps will be rebuilt at two (2) different pump station at a time.
- Electrical and Controls work will be performed in sequence by pump station, staggered by approximately two (2) weeks.
- Discharge pipe repair / replacement work will be performed in sequence by pump station, staggered by approximately two (2) weeks.
- Discharge pipe repair / replacement work will be performed following the start of pump rebuilds (Start-to-Start) at each station.
- Work to repair/replace/add lubrication will follow the completion of the pump rebuild work for each station.

The detailed cost estimate assumed a construction completion date of July 2026, which is within the range of uncertainty associated with the administration's budget process and Congressional appropriation process. The latest timeframes are subject to change based on availability of funding.

The schedule for project implementation shown above assumes additional authorization for the project. After additional authorization the project would be eligible for construction funding. The project would be considered for inclusion in the President's budget based on: national priorities, magnitude of Federal commitment, economic and environmental feasibility, level of local support, willingness of the non-federal sponsor to fund its share of the project cost and the budget constraints that may exist at the time of funding.

Once Congress appropriates Federal construction funds, USACE and the Non-Federal Sponsor would enter into a project partnership agreement (PPA). This agreement would define the Federal and non-federal sponsor responsibilities for implementing, operating and maintaining the project. USACE would officially request the non-federal sponsor to acquire the necessary real estate immediately after the signing of this agreement. The advertisement of the first construction contract would follow certification of real estate. USACE would provide a revised O&M Manual and as-built drawings to the non-federal sponsor at the end of construction at turnover of the project back to the levee sponsor.

6.1 Institutional Requirements

The following are procedures necessary for authorization of the recommended plan:

(1) USACE, Great Lakes and Ohio Rivers Division Commander will review the final report, and then issue a public notice announcing completion of the final Feasibility Report. This is referred to as the Division Engineer's Notice, or DE's Notice.

(2) This report will be submitted for review by the Headquarters of USACE, Washington D.C.

(3) The Chief of Engineers will seek formal review and comment by the City and interested federal agencies.

(4) Following City and other agency review, the report will be sent to the Assistant Secretary of the Army for Civil Works.

(5) Upon approval of the Assistant Secretary, the report will be forwarded to the Office of Management and Budget to obtain the relationship of the project to programs of the President.

(6) The Assistant Secretary of the Army for Civil Works will then forward the final report of the Chief of Engineers to Congress.

(7) Congressional review of the feasibility report and possible authorization of the recommended plan for the project would follow.

(8) Pending construction authorization, the Chief of Engineers could include funds where appropriate, in his budget requests for preconstruction engineering and design of the project.

(9) Following receipt of funds, a design agreement would be executed between the non-federal interests and the Government, preconstruction engineering and design (PED) would be initiated, and surveys and detailed engineering designs would be accomplished.

6.1.1 Alternative Path to Implementation

Once the Feasibility Study is approved by the Corps Headquarters (HQUSACE), a Chief's Report will be processed for approval by the Assistant Secretary of the Army for Civil Works (ASA(CW)). Should the feasibility study be approved by the ASA (CW), the project will not require additional authorization for construction. Public Law 115-123 provides that a project that is studied using Supplemental Investigations funds is eligible for implementation using Construction funds provided in that Act if the ASA (CW) determines that the project is technically feasible, economically justified, and environmentally acceptable. A total of $15,055,000,000 in Supplemental Construction funds was provided in Public Law 115-123. The LMFPS Feasibility Study is one of 38 studies, along with 58 projects, eligible for potential implementation by the Corps of Engineers using these Supplemental Construction funds as available. At this time this path to project implementation does not appear to be viable given the limited funding and volume of projects seeking funding under Public Law 115-123. Appendix D contains the full text of the Corps Policy Guidance on Implementation of Supplemental Appropriations in the Bipartisan Act of 2018.

6.2 Division of Plan Responsibilities and Cost Allocation

6.2.1 Federal Responsibilities

Cost sharing for construction of this project would be in keeping with current USACE policy for flood control projects. The Federal Government will be responsible for preparation of the Feasibility Study, Project Partnership Agreement (PPA), Design Documentation Report (DDR), and Plans and Specifications for this project.

6.2.2 Anticipated Non-Federal Responsibilities

(1) Provide a minimum of 35 percent, but not to exceed 50 percent of total project costs as further specified below:

(a) Provide 25 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
(b) Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs;
(c) Provide, during construction, a contribution of funds equal to 5 percent of total project costs;
(d) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project;
(e) Provide, during construction, any additional funds necessary to make its total contribution equal to at least 35 percent of total project costs;

(2) Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;

(3) Not less than once each year, inform affected interests of the extent of protection afforded by the project;

(4) Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;

(5) Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a Project Partnership Agreement, and to implement such plan not

later than one year after completion of construction of the project;

(6) Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

(7) Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;

(8) Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

(9) For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

(10) Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

(11) Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

(12) Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

(13) Comply with all applicable Federal and State laws and regulations, including, but not limited to:

Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*);

(14) Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-federal sponsor with prior specific written direction, in which case the non-federal sponsor shall perform such investigations in accordance with such written direction;

(15) Assume, as between the Federal Government and the non-federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

(16) Agree, as between the Federal Government and the non-federal sponsor, that the non-federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and

(17) Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

6.2.3 Non-Federal Sponsor's Financial Self-Certification

Financial information on the Non-Federal Sponsor's ability to fund its share of the plan is required to proceed with the project as required by USACE Principles and Guidelines. The information includes a

statement of financial capability by the Non-Federal Sponsor. The City has expressed their financial capability in their Letter of Intent. A Statement of Financial Capability will be submitted with the final Feasibility Report. The City intends to provide its financial requirements through issuing the sale of appropriate bonds applicable to municipalities for qualified projects such as this of which the debt service of these bonds will be met through its normal annual budget appropriations process. Table 21 shows the estimated distribution of the project costs.

Table 21: Distribution of Federal and Non-Federal Project Costs

Louisville Metro - Cost Sharing (October 2019 Price Level)			
Item	Federal Cost	Non-Federal Cost	Total Cost
Flood Damage Reduction (FDR)			
Lands & Damages	$ -	$ 130,000	$ 130,000
Pumping Plants	$ 79,073,235	$ 42,577,896	$ 121,651,131
Levess & Floodwalls	$ 16,345,568	$ 8,801,460	$ 25,147,028
Cultural Resource Mitigation	$ 78,650	$ 42,350	$ 121,000
PED	$ 8,675,669	$ 4,671,514	$ 13,347,183
E&D, S&A	$ 4,774,842	$ 2,571,069	$ 7,345,910
Subtotal	$ 108,947,964	$ 58,794,289	$ 167,742,252
FDR Subtotal	**$ 108,947,964**	**$ 58,794,289**	**$ 167,742,252**
Total Project	$ 108,947,964	$ 58,794,289	$ 167,742,252
Associated Cost	$ -	$ -	$ -
Total with Associated Cost	**$ 108,947,964**	**$ 58,794,289**	**$ 167,742,252**

6.2.4 Betterments

The Non-Federal Sponsor, MSD, has conducted a quantitative derivation of projected rainfall depths at specific frequencies for the years 2065 and 2035. Based on those results, MSD outlined a preferred level of service (10-percent annual chance of exceedance, 24-hour storm) and identified seven pump stations that do not meet that criteria with their current pumping capacity. Through this study it was determined that further evaluation of pump station capacity increase at any station was not justifiable as part of this reconstruction study or under a Locally Preferred Plan. It is expected that MSD may request a capacity increase as a betterment for at least one pump station (Paddy's Run). If betterments are identified as part of this project, compliance with NEPA and all other required federal laws will be completed prior to implementation.

6.2.5 Real Estate Requirements

In accordance with the Project Partnership Agreement (PPA), the Non-Federal Sponsor will be required to furnish all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas, and perform all utility/facility relocations (LERRDs) determined by the Government to be necessary for construction, operation, and maintenance of the project. All lands, easements and rights-of-way determined by the Government to be necessary for work to be performed under a construction contract must be furnished prior to the solicitation of that construction contract. The Non-Federal Sponsor will be required to conduct real estate acquisitions in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646), as amended. The Non-Federal Sponsor will be required to document its ownership of the project's real estate requirements and provide an Authorization-for-Entry-for-Construction.

A Risk Notification letter was provided to the Non-Federal Sponsor in July, 2018.

6.2.6 Environmental Requirements

Consultation under Section 106 of the National Historic Preservation Act (NHPA) on effects to historic properties and cultural resources by the proposed undertaking is underway. This consultation involved the SHPO, federally-recognized Native American tribes and other concerned parties and focused on avoiding impacts to significant historic properties and cultural resources. See Appendix B (Public and Agency Coordination) for their response.

If cultural resources are discovered during construction and cannot be avoided, work will be suspended in that area until the properties are evaluated for eligibility for listing in the NRHP in consultation with the SHPO and Tribes, and the Advisory Council on Historic Preservation will be provided the opportunity to comment.

7 SUMMARY OF COORDINATION, PUBLIC VIEW AND COMMENTS

To be completed following Concurrent review.

8 REFERENCES

McGrain, P., and Currens, J.C., 1978, Topography of Kentucky: Kentucky Geological Survey, ser. 11, Special Publication 25, 76 p.

U.S. Environmental Protection Agency. *Current Nonattainment Counties for All Criteria Pollutants*. http://www3.epa.gov/airquality/greenbook/ancl.html. 31 July 201p. Accessed 19 August 2019.

U.S. Environmental Protection Agency. *EJScreen: Environmental Justice Screening and Mapping Tool*. https://www.epa.gov/ejscreen. Accessed 26 AUG 2019.

9 CONCLUSIONS AND RECOMMENDATIONS

This report concludes that there is a feasible reconstruction project for the existing LMFPS. I have considered all significant public interest aspects of the recommended plan for flood risk management at Louisville, Kentucky. This single-purpose project is feasible from an economic, engineering, environmental, and social perspective. The recommended plan will ensure the system continues to provide average annual net National Economic Development benefits of over TO BE UPDATED AFTER HEC-FIA IS COMEPLETED. The total cost to implement the recommended reconstruction of the existing project is $ of which an estimated $ would be the Non-Federal Sponsor's responsibility.
The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to Congress as proposals for authorization and implementation funding. However, prior to transmittal to Congress, the Non-Federal Sponsor, the Commonwealth of Kentucky, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

The Non-Federal Sponsor understands its responsibilities as discussed in Section 6.2.2 above and has indicated its willingness to execute a Project Partnership Agreement with the Federal Government for implementation of the recommended plan. I recommend approval of the recommended plan as presented in this report, with such modifications thereof as in the discretion of the Commander, HQUSACE, may be advisable.

_____ _____

(Date)

ANTOINETTE R. GANT
COL, EN
District Commander

US Army Corps of Engineers
Louisville District®

Great Lakes and Ohio River Division
Louisville District

Louisville Metro Flood Protection System
Emergency Supplemental
Reconstruction Feasibility Study

VOLUME 1

APPENDIX A

FONSI AND ENVIRONMENTAL DOCUMENTATION

FINDING OF NO SIGNIFICANT IMPACT

LOUISVILLE METRO FLOOD PROTECTION SYSTEM
EMERGENCY SUPPLEMENTAL RECONSTRUCTION FEASIBILITY STUDY
AND INTEGRATED ENVIRONMENTAL ASSESSMENT
JEFFERSON COUNTY, KENTUCKY

The U.S. Army Corps of Engineers, Louisville District (Corps) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The final Integrated Feasibility Report and Environmental Assessment (IFR/EA) dated [*TBD*], for the Louisville Metro Flood Protection System (LMFPS) Emergency Supplemental Reconstruction Feasibility Study evaluated alternatives to reconstruct aging facilities of the LMFPS.

The Final IFR/EA, incorporated herein by reference, evaluated various alternatives that would improve the reliability of pump stations, closures, and floodwalls of the LMPFS. The recommended plan is the National Economic Development (NED) Plan and the significant measures of the plan include:

- Pump station repair by in-kind replacement
- Closure structures
- Floodwall modifications at Canal Street and Butchertown
- Modification of gate operations at the Beargrass Creek pump station
- Gate repair and replacement
- Water stop replacement

In addition to a “no action” plan, two alternatives were evaluated. The alternatives included the preferred alternative (recommended plan), and a plan that included each measure from the recommended plan, except the pumps would be replacement with larger capacity pumps. Section 3 of the IFR/EA provides an in-depth analysis each considered alternative. The No Action Alternative was evaluated as the least cost, most likely alternative to be implemented by the local sponsor in the event that a Federal project was not implemented. This was determined to be the continued basic maintenance of the flood protection system by the local sponsor.

For all alternatives, the potential effects were evaluated, as appropriate. A summary assessment of the potential effects of the recommended plan are listed in Table 1:

Table 1: Summary of Potential Effects of the Recommended Plan

	In-depth evaluation conducted	Brief evaluation due to minor effects	Resource unaffected by action
Air quality	☐	☐	☒

Aquatic resources/wetlands	☐	☒	☐
Invasive species	☐	☐	☒
Fish and wildlife habitat	☐	☐	☒
Threatened/Endangered species	☐	☐	☒
Historic properties	☒	☐	☐
Other cultural resources	☐	☒	☐
Floodplains	☐	☒	☐
Hazardous, toxic & radioactive waste	☐	☐	☒
Hydrology	☒	☐	☐
Land use	☐	☐	☒
Noise levels	☐	☒	☐
Public infrastructure	☐	☒	☐
Socio-economics	☐	☒	☐
Environmental justice	☐	☒	☐
Topography, geology, & soils	☐	☒	☐
Water quality	☐	☒	☐
Climate change	☒	☐	☒
Tribal Resources	☐	☐	☒

All practical means to avoid or minimize adverse environmental effects were analyzed and incorporated into the recommended plan. All appropriate best management practices will be incorporated in the construction of the recommended plan to minimize impacts to the human environment to the maximum extent practicable.

No compensatory mitigation is required.

Public review of the IFR/EA was completed on [*TBD*]. All comments submitted during the public comment period were responded to in the Final IFR/EA. A 30-day state and agency review of the Report and EA was also completed on [*TBD*].

Pursuant to section 7 of the Endangered Species Act of 1973, as amended, the U.S. Army Corps of Engineers determined that the recommended plan will have no effect on federally listed species or their designated critical habitat.

Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, ongoing coordination with consulting parties will determine whether the action alternatives would result in an adverse effect to the historic properties and, if so, would develop alternatives to avoid, minimize, or mitigate those effects.

Technical, environmental, and economic criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable

laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on this report, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the recommended plan would not significantly affect the human environment; therefore, preparation of an Environmental Impact Statement is not required.

Antoinette R. Gant
Colonel, Corps of Engineers
Commanding

Date

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-mile radius
Description:

Summary of ACS Estimates	2012 - 2016
Population	241,887
Population Density (per sq. mile)	2,846
Minority Population	114,344
% Minority	47%
Households	96,588
Housing Units	111,938
Housing Units Built Before 1950	41,552
Per Capita Income	18,836
Land Area (sq. miles) (Source: SF1)	84.98
% Land Area	95%
Water Area (sq. miles) (Source: SF1)	4.15
% Water Area	5%

	2012 - 2016 ACS Estimates	Percent	MOE (±)
Population by Race			
Total	241,887	100%	1,294
Population Reporting One Race	233,945	97%	2,312
White	133,950	55%	907
Black	96,103	40%	610
American Indian	267	0%	66
Asian	2,144	1%	283
Pacific Islander	289	0%	151
Some Other Race	1,192	0%	295
Population Reporting Two or More Races	7,942	3%	465
Total Hispanic Population	9,325	4%	595
Total Non-Hispanic Population	232,561		
White Alone	127,543	53%	853
Black Alone	95,443	39%	610
American Indian Alone	180	0%	66
Non-Hispanic Asian Alone	2,123	1%	283
Pacific Islander Alone	255	0%	151
Other Race Alone	296	0%	101
Two or More Races Alone	6,722	3%	363
Population by Sex			
Male	115,595	48%	622
Female	126,292	52%	998
Population by Age			
Age 0-4	15,799	7%	309
Age 0-17	57,781	24%	394
Age 18+	184,106	76%	972
Age 65+	29,123	12%	166

Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race.
N/A means not available. Source: U.S. Census Bureau, American Community Survey (ACS) 2012 - 2016 .

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-mile radius
Description:

	2012 - 2016 ACS Estimates	Percent	MOE (±)
Population 25+ by Educational Attainment			
Total	156,137	100%	496
Less than 9th Grade	8,149	5%	216
9th - 12th Grade, No Diploma	20,230	13%	185
High School Graduate	56,562	36%	307
Some College, No Degree	50,925	33%	308
Associate Degree	12,136	8%	275
Bachelor's Degree or more	20,270	13%	169
Population Age 5+ Years by Ability to Speak English			
Total	226,088	100%	1,270
Speak only English	211,733	94%	1,284
Non-English at Home[1+2+3+4]	14,354	6%	541
[1]Speak English "very well"	7,757	3%	288
[2]Speak English "well"	3,292	1%	163
[3]Speak English "not well"	2,257	1%	175
[4]Speak English "not at all"	1,048	0%	202
[3+4]Speak English "less than well"	3,305	1%	241
[2+3+4]Speak English "less than very well"	6,597	3%	280
Linguistically Isolated Households*			
Total	1,404	100%	89
Speak Spanish	834	59%	88
Speak Other Indo-European Languages	170	12%	54
Speak Asian-Pacific Island Languages	115	8%	38
Speak Other Languages	286	20%	63
Households by Household Income			
Household Income Base	96,588	100%	194
< $15,000	22,905	24%	214
$15,000 - $25,000	15,379	16%	146
$25,000 - $50,000	26,739	28%	169
$50,000 - $75,000	15,010	16%	165
$75,000 +	16,555	17%	146
Occupied Housing Units by Tenure			
Total	96,588	100%	194
Owner Occupied	47,230	49%	174
Renter Occupied	49,359	51%	188
Employed Population Age 16+ Years			
Total	190,192	100%	1,264
In Labor Force	117,351	62%	718
Civilian Unemployed in Labor Force	13,898	7%	236
Not In Labor Force	72,842	38%	622

Data Note: Datail may not sum to totals due to rounding. Hispanic population can be of any race.
N/A means not available. Source: U.S. Census Bureau, American Community Survey (ACS)
*Households in which no one 14 and over speaks English "very well" or speaks English only.

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-mile radius
Description:

	2012 - 2016 ACS Estimates	Percent	MOE (±)
Population by Language Spoken at Home*			
Total (persons age 5 and above)	218,993	100%	1,219
English	203,791	93%	1,257
Spanish	7,737	4%	598
French	550	0%	309
French Creole	N/A	N/A	N/A
Italian	N/A	N/A	N/A
Portuguese	N/A	N/A	N/A
German	435	0%	63
Yiddish	N/A	N/A	N/A
Other West Germanic	N/A	N/A	N/A
Scandinavian	N/A	N/A	N/A
Greek	N/A	N/A	N/A
Russian	N/A	N/A	N/A
Polish	N/A	N/A	N/A
Serbo-Croatian	N/A	N/A	N/A
Other Slavic	N/A	N/A	N/A
Armenian	N/A	N/A	N/A
Persian	N/A	N/A	N/A
Gujarathi	N/A	N/A	N/A
Hindi	N/A	N/A	N/A
Urdu	N/A	N/A	N/A
Other Indic	N/A	N/A	N/A
Other Indo-European	1,155	1%	433
Chinese	255	0%	217
Japanese	N/A	N/A	N/A
Korean	103	0%	71
Mon-Khmer, Cambodian	N/A	N/A	N/A
Hmong	N/A	N/A	N/A
Thai	N/A	N/A	N/A
Laotian	N/A	N/A	N/A
Vietnamese	646	0%	253
Other Asian	673	0%	200
Tagalog	74	0%	46
Other Pacific Island	N/A	N/A	N/A
Navajo	N/A	N/A	N/A
Other Native American	N/A	N/A	N/A
Hungarian	N/A	N/A	N/A
Arabic	526	0%	228
Hebrew	N/A	N/A	N/A
African	N/A	N/A	N/A
Other and non-specified	2,392	1%	380
Total Non-English	15,202	7%	1,751

Data Note: Detail may not sum to totals due to rounding. Hispanic popultion can be of any race.
N/A means not available. Source: U.S. Census Bureau, American Community Survey (ACS) 2012 - 2016.
*Population by Language Spoken at Home is available at the census tract summary level and up.

EJSCREEN Report (Version 2018)

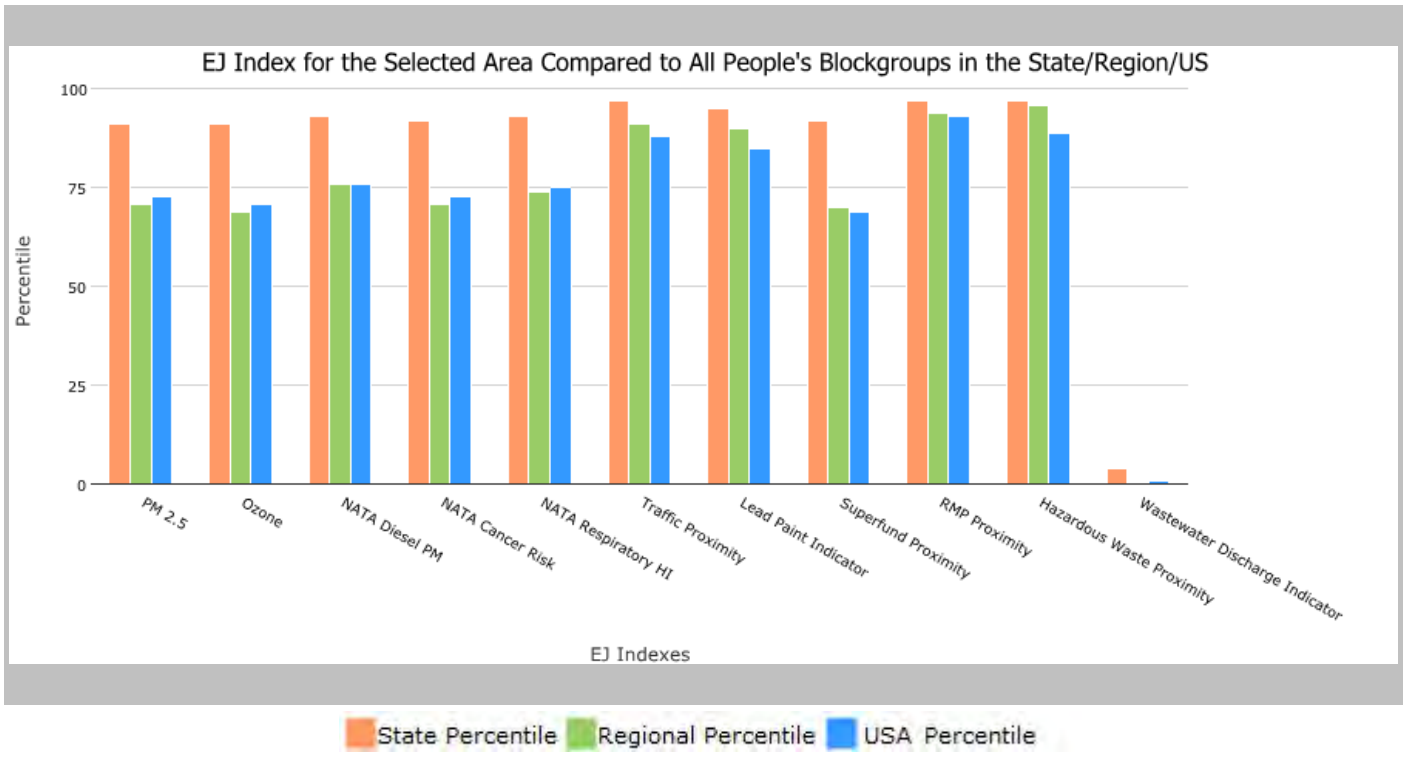
the User Specified Area, KENTUCKY, EPA Region 4

Approximate Population: 241,887

Input Area (sq. miles): 89.43

(The study area contains 1 blockgroup(s) with zero population.)

Selected Variables	State Percentile	EPA Region Percentile	USA Percentile
EJ Indexes			
EJ Index for PM2.5	91	71	73
EJ Index for Ozone	91	69	71
EJ Index for NATA* Diesel PM	93	76	76
EJ Index for NATA* Air Toxics Cancer Risk	92	71	73
EJ Index for NATA* Respiratory Hazard Index	93	74	75
EJ Index for Traffic Proximity and Volume	97	91	88
EJ Index for Lead Paint Indicator	95	90	85
EJ Index for Superfund Proximity	92	70	69
EJ Index for RMP Proximity	97	94	93
EJ Index for Hazardous Waste Proximity	97	96	89
EJ Index for Wastewater Discharge Indicator	4	0	1



This report shows the values for environmental and demographic indicators and EJSCREEN indexes. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher block group value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports.

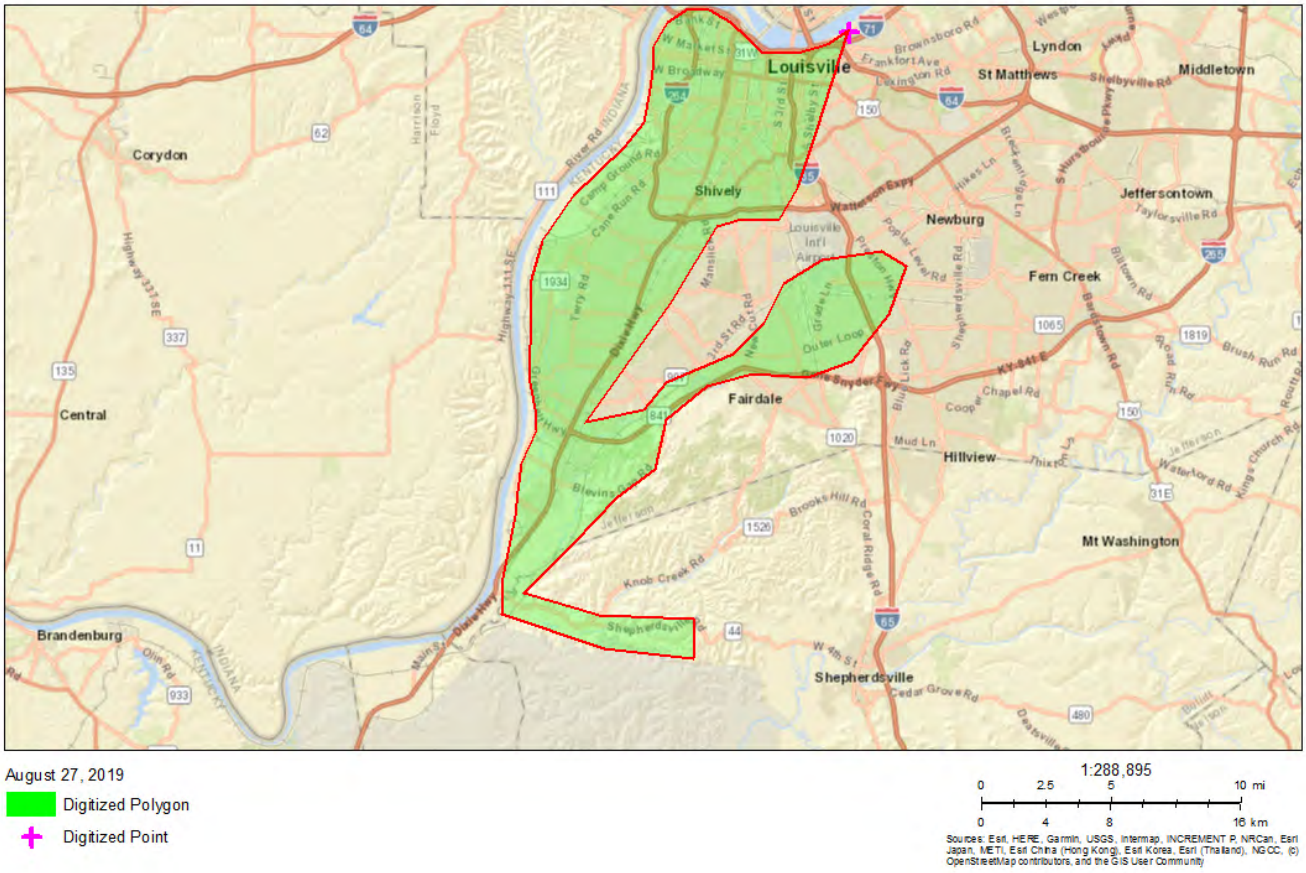
EJSCREEN Report (Version 2018)

the User Specified Area, KENTUCKY, EPA Region 4

Approximate Population: 241,887

Input Area (sq. miles): 89.43

(The study area contains 1 blockgroup(s) with zero population.)



Sites reporting to EPA	
Superfund NPL	0
Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	34

EJSCREEN Report (Version 2018)

the User Specified Area, KENTUCKY, EPA Region 4

Approximate Population: 241,887

Input Area (sq. miles): 89.43

(The study area contains 1 blockgroup(s) with zero population.)

Selected Variables	Value	State Avg.	%ile in State	EPA Region Avg.	%ile in EPA Region	USA Avg.	%ile in USA
Environmental Indicators							
Particulate Matter (PM 2.5 in µg/m^3)	12.3	10.9	95	9.48	99	9.53	93
Ozone (ppb)	46	44.2	80	39.4	96	42.5	80
NATA* Diesel PM (µg/m^3)	1.08	0.669	82	0.755	70-80th	0.938	60-70th
NATA* Cancer Risk (lifetime risk per million)	50	39	92	42	80-90th	40	80-90th
NATA* Respiratory Hazard Index	2.3	1.6	87	1.7	80-90th	1.8	70-80th
Traffic Proximity and Volume (daily traffic count/distance to road)	1100	230	95	290	94	600	88
Lead Paint Indicator (% Pre-1960 Housing)	0.55	0.24	89	0.15	94	0.29	79
Superfund Proximity (site count/km distance)	0.053	0.034	86	0.079	65	0.12	52
RMP Proximity (facility count/km distance)	2.9	0.66	95	0.58	97	0.72	95
Hazardous Waste Proximity (facility count/km distance)	4.2	0.8	95	0.5	98	4.3	88
Wastewater Discharge Indicator (toxicity-weighted concentration/m distance)	2.4	0.55	95	0.27	98	30	96
Demographic Indicators							
Demographic Index	50%	27%	91	38%	72	36%	73
Minority Population	47%	15%	93	38%	66	38%	65
Low Income Population	53%	39%	72	38%	75	34%	80
Linguistically Isolated Population	1%	1%	79	3%	59	4%	52
Population With Less Than High School Education	18%	15%	64	14%	69	13%	74
Population Under 5 years of age	7%	6%	58	6%	60	6%	57
Population over 64 years of age	12%	15%	36	16%	40	14%	44

* The National-Scale Air Toxics Assessment (NATA) is EPA's ongoing, comprehensive evaluation of air toxics in the United States. EPA developed the NATA to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that NATA provides broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. More information on the NATA analysis can be found at: https://www.epa.gov/national-air-toxics-assessment.

For additional information, see: www.epa.gov/environmentaljustice

EJSCREEN is a screening tool for pre-decisional use only. It can help identify areas that may warrant additional consideration, analysis, or outreach. It does not provide a basis for decision-making, but it may help identify potential areas of EJ concern. Users should keep in mind that screening tools are subject to substantial uncertainty in their demographic and environmental data, particularly when looking at small geographic areas. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports. This screening tool does not provide data on every environmental impact and demographic factor that may be relevant to a particular location. EJSCREEN outputs should be supplemented with additional information and local knowledge before taking any action to address potential EJ concerns.

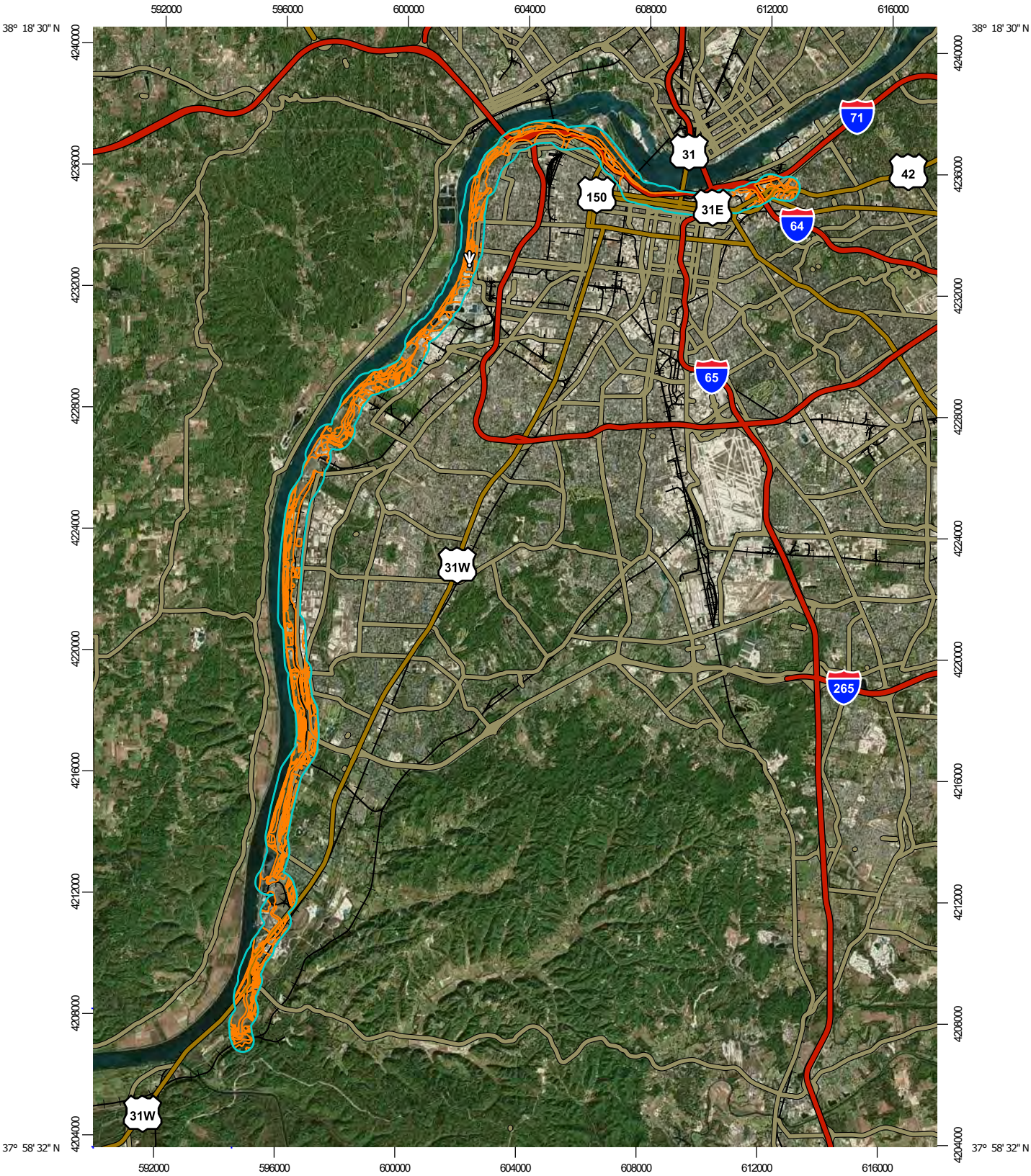
EPA-Regulated Facilities near the McAlpine Access Road

FACILITY INFORMATION	ICIS-Air	ACRES	BR	SEMS	GHG	ICIS-NPDES	RAD Info	RCRA Info	TRI	TSCA
CVS PHARMACY #6199 3130 PORTLAND AVE. LOUISVILLE, KY 40212 Latitude: 38.27435 Longitude: -85.79913 Summary Report Facility Report Compliance Report			View Report					View Report		
KENTUCKY & INDIANA TERM 2910 NORTH WESTERN PARKWAY LOUISVILLE, KY 40212-1124 Latitude: 38.275284 Longitude: -85.793626 Summary Report Facility Report Compliance Report								View Report		

FACILITY INFORMATION	ICIS-Air	ACRES	BR	SEMS	GHG	ICIS-NPDES	RAD Info	RCRA Info	TRI	TSCA
FAMILY DOLLAR #10270 2124 BANK STREET LOUISVILLE, KY 40212 Latitude: 38.26669 Longitude: -85.78376 Summary Report Facility Report Compliance Report								View Report		
FAMILY HEALTH CENTER 2215 PORTLAND AVENUE LOUISVILLE, KY 40212-1094 Latitude: 38.269039 Longitude: -85.784344 Summary Report Facility Report Compliance Report	View Report							View Report		
FAMILY HEALTH CENTERS INC 2214 NORTHWESTERN PARKWAY LOUISVILLE, KY 40212 Latitude: 38.27061 Longitude: -85.78333 Summary Report Facility Report Compliance Report								View Report		
HOLSCLAW TRANSFER COMPANY INC 2111 LYTLE LOUISVILLE, KY 40212 Latitude: 38.26782 Longitude: -85.78389 Summary Report Facility Report Compliance Report								View Report		
LOUISVILLE FACILITY MAINTENANCE 1731 NORTHWESTERN PARKWAY LOUISVILLE, KY 40203-1455 Latitude: 38.26525 Longitude: -85.7757 Summary Report Facility Report Compliance Report								View Report		
LOUISVILLE GAS & ELECT-CANAL STATION 2005 NORTHWESTERN PARKWAY LOUISVILLE, KY 40203 Latitude: 38.26896 Longitude: -85.78049 Summary Report Facility Report Compliance Report								View Report		
OCCIDENTAL CHEMICAL CORP 575A NO 34TH ST LOUISVILLE, KY 40212 Latitude: 38.267 Longitude: -85.784 Summary Report Facility Report Compliance Report								View Report		
PORTLAND PROMISE CENTER 1800 PORTLAND AVE. LOUISVILLE, KY 40203 Latitude: 38.26458 Longitude: -85.77741 Summary Report Facility Report Compliance Report								View Report		
VULCAN HART CO. 2006 NORTHWESTERN PARKWAY LOUISVILLE, KY 40203-1054 Latitude: 38.26787 Longitude: -85.77898 Summary Report Facility Report Compliance Report								View Report		

FACILITY INFORMATION	ICIS-Air	ACRES	BR	SEMS	GHG	ICIS-NPDES	RAD Info	RCRA Info	TRI	TSCA
BITTNERS, LLC 731 E. MAIN STREET LOUISVILLE, KY 40202-1005 Latitude: 38.25473 Longitude: -85.739205 Summary Report Facility Report Compliance Report								View Report		
IRING TRANSFER INC. 509 FRANKLIN STREET LOUISVILLE, KY 40202 Latitude: 38.256671 Longitude: -85.740377 Summary Report Facility Report Compliance Report								View Report		
LOUIS TRAUTH DAIRY LLC 617 EAST WASHINGTON STREET LOUISVILLE, KY 40202-1048 Latitude: 38.25565 Longitude: -85.74047 Summary Report Facility Report Compliance Report									View Report	
MAIN & CLAY MIXED USE BUILDING 637 E MAIN ST LOUISVILLE, KY 40202 Latitude: 38.25482 Longitude: -85.74006 Summary Report Facility Report Compliance Report						View Report				
NST METALS INC 721 E MAIN ST LOUISVILLE, KY 40202-1088 Latitude: 38.25469 Longitude: -85.73887 Summary Report Facility Report Compliance Report						View Report				
THE LOCAL 700 E MAIN ST LOUISVILLE, KY 40202 Latitude: 38.254722 Longitude: -85.739722 Summary Report Facility Report Compliance Report						View Report				
VENDOME COPPER & BRASS WORKS INC. 729 E FRANKLIN ST LOUISVILLE, KY 40202 Latitude: 38.25644 Longitude: -85.73822 Summary Report Facility Report Compliance Report									View Report	

Soil Map—Bullitt and Spencer Counties, Kentucky, and Jefferson County, Kentucky
(Louisville Metro Flood Protection System)



Map Scale: 1:180,000 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 2500 5000 10000 15000

Feet: 0 5000 10000 20000 30000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:12,000 to 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Bullitt and Spencer Counties, Kentucky
Survey Area Data: Version 14, Sep 11, 2018

Soil Survey Area: Jefferson County, Kentucky
Survey Area Data: Version 17, Sep 11, 2018

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 1, 1999—Dec 31, 2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CnE	Caneyville-Rock outcrop complex, 20 to 40 percent slopes	0.9	0.0%
CrC	Crider silt loam, 6 to 12 percent slopes, eroded	2.3	0.0%
CrD	Crider silt loam, 12 to 20 percent slopes, eroded	28.6	0.3%
ElC	Elk silt loam, occasionally flooded, 6 to 12 percent slopes	9.6	0.1%
GmF	Garmon silt loam, 25 to 60 percent slopes	18.0	0.2%
La	Lawrence silt loam, 0 to 2 percent slopes, rarely flooded	9.8	0.1%
Ne	Newark silt loam, 0 to 2 percent slopes, frequently flooded	4.6	0.1%
No	Nolin silt loam, 0 to 2 percent slopes, frequently flooded	18.5	0.2%
OtC	Otwood silt loam, 6 to 12 percent slopes	21.8	0.3%
Subtotals for Soil Survey Area		**114.0**	**1.4%**
Totals for Area of Interest		**8,291.6**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Cm	Cemeteries	0.1	0.0%
CnF	Chagrin-Nelse-Wheeling complex, 2 to 75 percent slopes, frequently flooded	269.9	3.3%
Co	Combs fine sandy loam, occasionally flooded	110.6	1.3%
DAM	Dam, large	1.0	0.0%
Dp	Dumps, ash	453.6	5.5%
EoA	Elk silt loam, 0 to 2 percent slopes, occasionally flooded	2.4	0.0%
Ha	Huntington silt loam, 0 to 2 percent slopes, occasionally flooded	20.1	0.2%
Hf	Huntington silt loam, 0 to 2 percent slopes, frequently flooded	34.0	0.4%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Ld	Lindside silt loam, 0 to 2 percent slopes, occasionally flooded	32.5	0.4%
Ln	Lindside silt loam, 0 to 2 percent slopes, frequently flooded	4.2	0.1%
Me	Melvin silt loam, 0 to 2 percent slopes, occasionally flooded	25.1	0.3%
Mf	Melvin silt loam, frequently flooded	19.9	0.2%
Ne	Newark silt loam, 0 to 2 percent slopes, occasionally flooded	40.2	0.5%
Nf	Newark silt loam, 0 to 2 percent slopes, frequently flooded	6.9	0.1%
No	Nolin silt loam, 0 to 2 percent slopes, occasionally flooded	0.9	0.0%
OtA	Otwood silt loam, 0 to 2 percent slopes	40.8	0.5%
OtB	Otwood silt loam, 2 to 6 percent slopes	71.4	0.9%
OtC	Otwood silt loam, 6 to 12 percent slopes	15.8	0.2%
OwB	Otwood silt loam, 2 to 6 percent slopes, occasionally flooded	7.6	0.1%
Pt	Pits, quarries	41.0	0.5%
RoA	Robertsville silt loam, 0 to 2 percent slopes	28.5	0.3%
RpA	Robertsville silt loam, 0 to 2 percent slopes, ponded	2.2	0.0%
ScA	Sciotoville silt loam, 0 to 2 percent slopes	135.3	1.6%
ScB	Sciotoville silt loam, 2 to 6 percent slopes	34.4	0.4%
ScC	Sciotoville silt loam, 6 to 12 percent slopes	2.9	0.0%
SdA	Sciotoville silt loam, 0 to 2 percent slopes, occasionally flooded	6.5	0.1%
SdB	Sciotoville silt loam, 2 to 6 percent slopes, occasionally flooded	0.5	0.0%
Ua	Urban land	953.6	11.5%
UaeB	Urban land-Haplic Udarents-Newark complex, 0 to 6 percent slopes, rarely flooded	47.2	0.6%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
UagB	Urban land-Udarents complex, wet substratum, 0 to 6 percent slopes, rarely flooded	34.3	0.4%
UahC	Urban land-Udorthents complex, 0 to 12 percent slopes	1,343.5	16.2%
UaiC	Urban land-Udorthents complex, 0 to 12 percent slopes, rarely flooded	680.3	8.2%
UajF	Urban land-Udorthents complex, refuse substratum, 0 to 50 percent slopes	29.9	0.4%
UakF	Urban land-Udorthents complex, smoothed, 0 to 50 percent slopes	991.8	12.0%
UbC	Urban land-Alfic Udarents complex, loamy substratum, 0 to 12 percent slopes	570.8	6.9%
UdC	Urban land-Alfic Udarents complex, loamy substratum, 0 to 12 percent slopes, rarely flooded	211.7	2.6%
UeC	Urban land-Alfic Udarents complex, fragipan substratum-over loamy sediment, 0 to 12 percent slopes	83.6	1.0%
UfC	Urban land-Alfic Udarents complex, fragipan substratum-over loamy sediment, 0 to 12 percent slopes, rarely flooded	12.7	0.2%
UmC	Urban land-Alfic Udarents-Crider complex, 0 to 12 percent slopes	28.7	0.3%
UmD	Urban land-Alfic Udarents-Crider complex, 12 to 25 percent slopes	20.6	0.2%
UrC	Urban land-Alfic Udarents-Otwood complex, 0 to 12 percent slopes	75.8	0.9%
UsC	Urban land-Alfic Udarents-Otwood complex, 0 to 12 percent slopes, rarely flooded	2.1	0.0%
UtC	Urban land-Alfic Udarents-Robertsville complex, 0 to 12 percent slopes	2.8	0.0%
UvC	Urban land-Alfic Udarents-Sciotoville complex, 0 to 12 percent slopes	22.0	0.3%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
UxC	Urban land-Alfic Udarents-Weinbach complex, 0 to 12 percent slopes	2.6	0.0%
UyC	Urban land-Alfic Udarents-Wheeling complex, 0 to 12 percent slopes	54.7	0.7%
UzC	Urban land-Alfic Udarents-Wheeling complex, 0 to 12 percent slopes, rarely flooded	113.8	1.4%
W	Water	1,163.2	14.0%
WeA	Weinbach silt loam, 0 to 2 percent slopes	37.0	0.4%
WeB	Weinbach silt loam, 2 to 6 percent slopes	5.9	0.1%
WfA	Weinbach silt loam, 0 to 2 percent slopes, occasionally flooded	11.6	0.1%
WhA	Wheeling loam, 0 to 2 percent slopes	26.1	0.3%
WhB	Wheeling loam, 2 to 6 percent slopes	80.7	1.0%
WhC	Wheeling loam, 6 to 12 percent slopes	43.7	0.5%
WhD	Wheeling loam, 12 to 25 percent slopes	12.3	0.1%
WhF	Wheeling loam, 25 to 55 percent slopes	6.5	0.1%
WkA	Wheeling loam, 0 to 2 percent slopes, occasionally flooded	8.3	0.1%
WkB	Wheeling loam, 2 to 6 percent slopes, occasionally flooded	36.1	0.4%
WkC	Wheeling loam, 6 to 12 percent slopes, occasionally flooded	5.2	0.1%
WkD	Wheeling loam, 12 to 25 percent slopes, occasionally flooded	40.6	0.5%
WkF	Wheeling loam, 25 to 55 percent slopes, occasionally flooded	9.4	0.1%
Subtotals for Soil Survey Area		**8,177.6**	**98.6%**
Totals for Area of Interest		**8,291.6**	**100.0%**

US Army Corps of Engineers
Louisville District®

Great Lakes and Ohio River Division
Louisville District

Louisville Metro Flood Protection System
Emergency Supplemental
Reconstruction Feasibility Study

VOLUME 1

APPENDIX B

PUBLIC AND AGENCY COORDIANTION

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR PL
LOUISVILLE, KY 40202

February 19, 2019

Civil Works - Planning, Programs
and Project Management Branch
Planning Section

To All Interested Parties:

The U.S. Army Corps of Engineers, Louisville District (Corps) is initiating scoping and preparing an Environmental Assessment (EA), under the National Environmental Policy Act (NEPA) of 1969, as amended, to evaluate alternatives for the reconstruction and rehabilitation of the Metro Louisville levee system located along the Ohio River in Jefferson County, Kentucky (Figure 1 enclosed).

The Metro Louisville levee system was constructed throughout much of the 1940s and 1950s (Louisville Reach) and again throughout the 1970s and 1980s (Southwestern Reach). The Louisville Reach includes approximately eight miles of levee embankment, 3.6 miles of floodwall and 12 pump stations (60 individual pumps). The Southwestern Reach includes approximately 13 miles of levee embankment, 0.57 miles of floodwall, and four pump stations (13 individual pumps). Since the levee system was originally installed, there have been significant changes in conditions along the Ohio River and within the interior of the levee system, which may require updated capacity to maintain the authorized level of protection.

The project will evaluate alternatives to maintain the originally authorized project through the 50-year period of analysis without changing the scope or function of the system. Alternatives will be developed to repair and modernize all 16 pump stations, permanently close the 10th and 27th street closures and realign a small segment of flood wall at Canal Street. A portion of the current Canal Street floodwall is appended to the base of a structure owned by Louisville Gas and Electric (LG&E), which is scheduled for demolition. The demolition of the LG&E facility is not considered part of this project.

In accordance with NEPA, and associated implementing regulations, the EA will be prepared to evaluate viable alternatives, including the “No Action” alternative, for the project. The enclosed document provides brief descriptions of four alternatives which the Corps is currently assessing. We request any information you may have about resources (such as biological and cultural) in or around the levee system that should be considered in the assessment. This information will aid in development and evaluation of alternatives. This EA will provide the basis for a decision whether to proceed with an Environmental Impact Statement or a Finding of No Significant Impact. Your agency will be notified when the EA is available for public review.

We request your comments by March 21, 2019. If you do not reply by that date, we will assume that you have no comments at this stage of project development. If you have any questions regarding the enclosed aerial view showing location of Louisville Metro, KY levee system, please contact Drew Russell at drew.c.russell@usace.army.mil or (502) 315-6130. You may submit comments to the same email address or send by mail to:

U. S. Army Corps of Engineers, Louisville
Attn: Drew Russell, Room 708
PO Box 59
Louisville, KY 40201-0059

Sincerely,

Amy S. Babey
Chief, Planning, Programs and
Project Management Branch

Enclosure

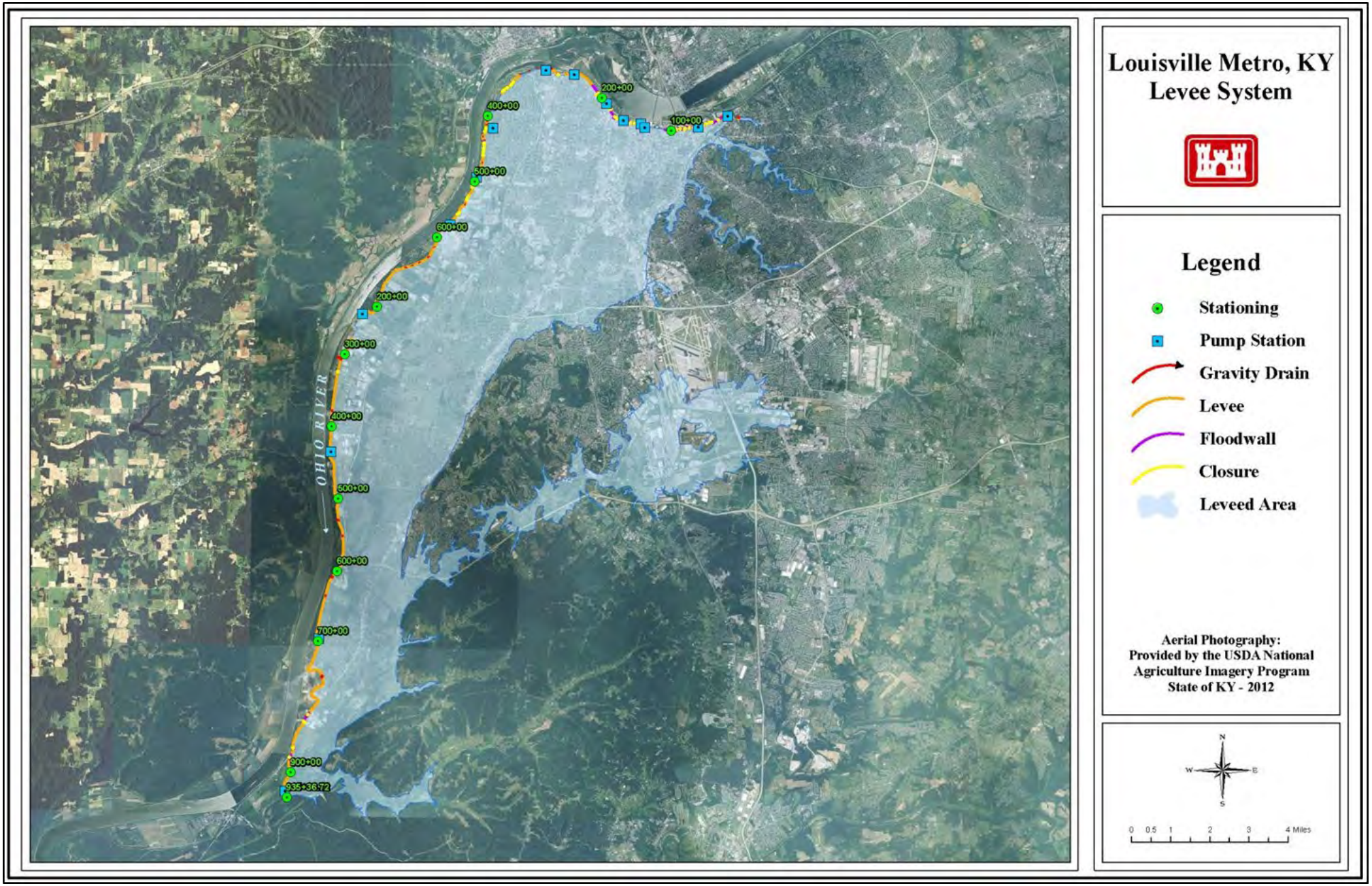


Figure 1: Aerial view showing location of Louisville Metro, KY levee system.

From: Allison, Carrie
To: Russell, Drew C CIV USARMY CELRL (US)
Subject: [Non-DoD Source] Metro Louisville Levee System
Date: Wednesday, March 27, 2019 1:38:55 PM
Attachments: Ipac.pdf

Hi, Drew-

Thank you for the correspondence and request for comments regarding the Metro Louisville Levee System project in Jefferson County, KY. Because the project is in the early stages of scoping, we recommend using IPaC to get the most up-to-date species list for the proposed project. I've attached a letter that provides the general instructions for using IPaC. If you have any questions or need more detailed information at this time, please let me know.

Sincerely,
Carrie L. Allison
U.S. Fish and Wildlife Service
330 W. Broadway, Rm. 265
Frankfort, KY 40601
502-695-0468 ext. 103 (office)
502.695.1024 (fax)

"You cannot get through a single day without having an impact on the world around you. What you do makes a difference, and you have to decide what kind of difference you want to make." ~Jane Goodall

NOTE: This email correspondence and any attachments to and from this sender is subject to the Freedom of Information Act (FOIA) and may be disclosed to third parties.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Kentucky Ecological Services Field Office
J C Watts Federal Building, Room 265
330 West Broadway
Frankfort, KY 40601-8670
Phone: (502) 695-0468 Fax: (502) 695-1024
http://www.fws.gov/frankfort/

In Reply Refer To: January 29, 2019
Consultation Code: 04EK1000-2019-SLI-0361
Event Code: 04EK1000-2019-E-01018
Project Name: Louisville Metro Levee System - Supplemental

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

Your concern for the protection of endangered and threatened species is greatly appreciated. The purpose of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.) (ESA) is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. The species list attached to this letter fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the ESA to provide information as to whether any proposed or listed species may be present in the area of a proposed action. This is not a concurrence letter; additional consultation with the Service may be required.

The Information in Your Species List:

The enclosed species list identifies federal trust species and critical habitat that may occur within the boundary that you entered into IPaC. For your species list to most accurately represent the species that may potentially be affected by the proposed project, the boundary that you input into IPaC should represent the entire "action area" of the proposed project by considering all the potential "effects of the action," including potential direct, indirect, and cumulative effects, to federally-listed species or their critical habitat as defined in 50 CFR 402.02. This includes effects of any "interrelated actions" that are part of a larger action and depend on the larger action for their justification and "interdependent actions" that have no independent utility apart from the action under consideration (e.g.; utilities, access roads, etc.) and future actions that are reasonably certain to occur as a result of the proposed project (e.g.; development in response to a new road). If your project is likely to have significant indirect effects that extend well beyond the project footprint (e.g., long-term impacts to water quality), we highly recommend that you

coordinate with the Service early to appropriately define your action area and ensure that you are evaluating all the species that could potentially be affected.

We must advise you that our database is a compilation of collection records made available by various individuals and resource agencies available to the Service and may not be all-inclusive. This information is seldom based on comprehensive surveys of all potential habitats and, thus, does not necessarily provide conclusive evidence that species are present or absent at a specific locality. New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list.

Please note that “critical habitat” refers to specific areas identified as essential for the conservation of a species that have been designated by regulation. Critical habitat usually does not include all the habitat that the species is known to occupy or all the habitat that may be important to the species. Thus, even if your project area does not include critical habitat, the species on the list may still be present.

Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the ESA, the accuracy of this species list should be verified after 90 days. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and associated information. To re-access your project in IPaC, go to the IPaC web site (https://ecos.fws.gov/ipac/), select “Need an updated species list?”, and enter the consultation code on this letter.

ESA Obligations for Federal Projects:

Under sections 7(a)(1) and 7(a)(2) of the ESA and its implementing regulations (50 CFR 402 et seq.), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

If a Federal project (a project authorized, funded, or carried out by a federal agency) may affect federally-listed species or critical habitat, the Federal agency is required to consult with the Service under section 7 of the ESA, pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at: http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). Recommended contents of a Biological Assessment are described at 50 CFR 402.12. For projects other than major construction activities, the Service suggests that a biological evaluation

similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat.

ESA Obligations for Non-federal Projects:

Proposed projects that do not have a federal nexus (non-federal projects) are not subject to the obligation to consult under section 7 of the ESA. However, section 9 of the ESA prohibits certain activities that directly or indirectly affect federally-listed species. These prohibitions apply to all individuals subject to the jurisdiction of the United States. Non-federal project proponents can request technical assistance from the Service regarding recommendations on how to avoid and/or minimize impacts to listed species. The project proponent can choose to implement avoidance, minimization, and mitigation measures in a proposed project design to avoid ESA violations.

Additional Species-specific Information:

In addition to the species list, IPaC also provides general species-specific technical assistance that may be helpful when designing a project and evaluating potential impacts to species. To access this information from the IPaC site (https://ecos.fws.gov/ipac/), click on the text "My Projects" on the left of the black bar at the top of the screen (you will need to be logged into your account to do this). Click on the project name in the list of projects; then, click on the "Project Home" button that appears. Next, click on the "See Resources" button under the "Resources" heading. A list of species will appear on the screen. Directly above this list, on the right side, is a link that will take you to pdfs of the "Species Guidelines" available for species in your list. Alternatively, these documents and a link to the "ECOS species profile" can be accessed by clicking on an individual species in the online resource list.

Next Steps:

Requests for additional technical assistance or consultation from the Kentucky Field Office should be submitted following guidance on the following page http://www.fws.gov/frankfort/PreDevelopment.html and the document retrieved by clicking the "outline" link at that page. When submitting correspondence about your project to our office, please include the Consultation Tracking Number in the header of this letter. (There is no need to provide us with a copy of the IPaC-generated letter and species list.)

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Kentucky Ecological Services Field Office
J C Watts Federal Building, Room 265
330 West Broadway
Frankfort, KY 40601-8670
(502) 695-0468

Project Summary

Consultation Code: 04EK1000-2019-SLI-0361

Event Code: 04EK1000-2019-E-01018

Project Name: Louisville Metro Levee System - Supplemental

Project Type: ** OTHER **

Project Description: Rehab of levee system

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/38.1417559600762N85.90093038499285W

Counties: Bullitt, KY | Jefferson, KY

Endangered Species Act Species

There is a total of 16 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Note that 3 of these species should be considered only under certain conditions.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

---

1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Gray Bat *Myotis grisescens*	Endangered

No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/6329

Indiana Bat *Myotis sodalis*	Endangered

There is **final** critical habitat for this species. Your location is outside the critical habitat.
This species only needs to be considered under the following conditions:

- All activities in this location should consider possible effects to this species. The project area includes known "summer 1" habitat.
- All activities in this location should consider possible effects to this species. The project area includes "potential" habitat.
- All activities in this location should consider possible effects to this species. The project area includes known "swarming 1" habitat.

Species profile: https://ecos.fws.gov/ecp/species/5949
Species survey guidelines:
https://ecos.fws.gov/ipac/guideline/survey/population/1/office/42431.pdf

Northern Long-eared Bat *Myotis septentrionalis*	Threatened

No critical habitat has been designated for this species.
This species only needs to be considered under the following conditions:

- The specified area includes areas in which incidental take would not be prohibited under the 4(d) rule. For reporting purposes, please use the "streamlined consultation form," linked to in the "general project design guidelines" for the species.

Species profile: https://ecos.fws.gov/ecp/species/9045

Birds

NAME	STATUS
Least Tern *Sterna antillarum*	Endangered

Population: interior pop.
No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/8505

Clams

NAME	STATUS
Clubshell *Pleurobema clava*	Endangered

Population: Wherever found; Except where listed as Experimental Populations
No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/3789
General project design guidelines:
https://ecos.fws.gov/ipac/guideline/design/population/352/office/42431.pdf

Fanshell *Cyprogenia stegaria* — Endangered

No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/4822
General project design guidelines:
https://ecos.fws.gov/ipac/guideline/design/population/368/office/42431.pdf

Northern Riffleshell *Epioblasma torulosa rangiana* — Endangered

No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/527
General project design guidelines:
https://ecos.fws.gov/ipac/guideline/design/population/374/office/42431.pdf

Orangefoot Pimpleback (pearlymussel) *Plethobasus cooperianus* — Endangered

No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/1132
General project design guidelines:
https://ecos.fws.gov/ipac/guideline/design/population/340/office/42431.pdf

Pink Mucket (pearlymussel) *Lampsilis abrupta* — Endangered

No critical habitat has been designated for this species.
This species only needs to be considered under the following conditions:
- The species may be affected by projects that significantly impact, directly or indirectly, the following rivers: Barren, Green, Licking, Rolling Fork, or Salt.

Species profile: https://ecos.fws.gov/ecp/species/7829
General project design guidelines:
https://ecos.fws.gov/ipac/guideline/design/population/331/office/42431.pdf

Purple Cat's Paw (=purple Cat's Paw Pearlymussel) *Epioblasma obliquata obliquata* — Endangered

Population: Wherever found; Except where listed as Experimental Populations
No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/5602
General project design guidelines:
https://ecos.fws.gov/ipac/guideline/design/population/323/office/42431.pdf

Rabbitsfoot *Quadrula cylindrica cylindrica* — Threatened

There is **final** critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/5165
General project design guidelines:
https://ecos.fws.gov/ipac/guideline/design/population/3645/office/42431.pdf

NAME	STATUS
Ring Pink (mussel) *Obovaria retusa*	Endangered

No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/4128
General project design guidelines:
https://ecos.fws.gov/ipac/guideline/design/population/341/office/42431.pdf

Rough Pigtoe *Pleurobema plenum*	Endangered

No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/6894
General project design guidelines:
https://ecos.fws.gov/ipac/guideline/design/population/338/office/42431.pdf

Sheepnose Mussel *Plethobasus cyphyus*	Endangered

No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/6903
General project design guidelines:
https://ecos.fws.gov/ipac/guideline/design/population/7816/office/42431.pdf

Spectaclecase (mussel) *Cumberlandia monodonta*	Endangered

No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/7867
General project design guidelines:
https://ecos.fws.gov/ipac/guideline/design/population/4490/office/42431.pdf

Flowering Plants

NAME	STATUS
Running Buffalo Clover *Trifolium stoloniferum*	Endangered

No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/2529
Species survey guidelines:
https://ecos.fws.gov/ipac/guideline/survey/population/1041/office/42431.pdf
Habitat assessment guidelines:
https://ecos.fws.gov/ipac/guideline/assessment/population/1041/office/42431.pdf

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

MATTHEW G. BEVIN
GOVERNOR

DON PARKINSON
SECRETARY

TOURISM, ARTS AND HERITAGE CABINET
KENTUCKY HERITAGE COUNCIL
THE STATE HISTORIC PRESERVATION OFFICE
410 HIGH STREET
FRANKFORT, KENTUCKY 40601
PHONE (502) 564-7005
FAX (502) 564-5820
www.heritage.ky.gov

REGINA STIVERS
DEPUTY SECRETARY

CRAIG A. POTTS
EXECUTIVE DIRECTOR
& STATE HISTORIC
PRESERVATION OFFICER

March 8, 2019

United States Army Corps of Engineers
ATTN: Mr. Jared Barret, PMC-PL, Rm 708
600 Dr. Martin Luther King, Jr. Place
Louisville, KY 40202

RE: Louisville Metro Flood Protection System Flood Risk Management Project

Dear Mr. Barrett:

Thank you for your letter concerning the above-mentioned project, received February 11, 2019. We understand that the United States Army Corps of Engineers is initiating consultation under Section 106 of the National Historic Preservation Act to assess the proposed project's effects to historic properties. We also understand from your letter that the Corps will undertake efforts to identify historic properties as part of the planning stages of the project.

We agree that the project has the potential to affect historic properties. We look forward to continuing consultation on the identification of historic properties and assessment of project effects.

Should you have any questions concerning archaeological resources, feel free to contact Chris Gunn of my staff at (502) 892-3615 or chris.gunn@ky.gov. Questions concerning above-ground resources can be directed to Jennifer Ryall at (502) 892-3619 or jennifer.ryall@ky.gov.

Sincerely,

Craig A. Potts,
Executive Director and
State Historic Preservation Officer

CP: cmg, jr KHC #53508

Barrett, Jared L CIV USARMY CELRL (USA)

From: Ryall, Jennifer (Heritage Council) <Jennifer.Ryall@ky.gov>
Sent: Thursday, April 4, 2019 4:49 PM
To: Barrett, Jared L CIV USARMY CELRL (USA)
Cc: Schueler, Barry J CIV USARMY CELRL (US); Moulder, Nathan A CIV USARMY CELRL (US)
Subject: [Non-DoD Source] RE: Southwest Jefferson Reach (Louisville Metro Floodwall project) (UNCLASSIFIED)

Jared, for the aboveground portion of the project, our office is agreeable to the approach summarized below based on our conversation this morning.

Thanks!
~Jenn

Jennifer Ryall
Environmental Review Coordinator
Kentucky Heritage Council
410 High Street
Frankfort, Kentucky 40601
Phone: (502) 892-3619

-----Original Message-----
From: Barrett, Jared L CIV USARMY CELRL (USA) <Jared.L.Barrett@usace.army.mil>
Sent: Thursday, April 4, 2019 3:56 PM
To: Ryall, Jennifer (Heritage Council) <Jennifer.Ryall@ky.gov>
Cc: Schueler, Barry J CIV USARMY CELRL (US) <Barry.J.Schueler@usace.army.mil>; Moulder, Nathan A CIV USARMY CELRL (US) <Nathan.A.Moulder@usace.army.mil>
Subject: RE: Southwest Jefferson Reach (Louisville Metro Floodwall project) (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Good afternoon Jennifer,
Thank you for joining us on the phone call today regarding the discussion of the treatment of Southwest Jefferson Reach and the overall Louisville Metro Floodwall project.

As we discussed, the Louisville Reach and Southwest Jefferson Reach are considered two separate systems. The Louisville Reach was constructed from 1947 to 1956 and the Southwest Jefferson Reach was constructed between 1973 and 1989. We agreed that given its age (over 50 years) we would evaluate the Louisville Reach for its significance and if it can be considered eligible for listing in the National Register of Historic Places (NRHP).

We then discussed the recent age of the Southwest Jefferson Reach (less than 50 years of age) and the proposed improvements. The proposed improvements for the Southwest Jefferson Reach will include mechanical and electrical improvements for the four existing pump stations (Upper Mill Creek, Riverport Pumping Station, Lower Mill Creek Pump, and Pond Creek Pumping Station). These four pump stations were built in the 1980s. We also discussed that the I-Wall at the Pond Creek Pumping Station would also be improved.

We discussed that given its recent age (less than 50 years old) and that it is a separate system from the Louisville Reach that the Southwest Jefferson Reach does not need to be evaluated for the NRHP. You stated you agreed that we would

not need to evaluate the Southwest Jefferson Reach for the NRHP given its recent age. We would still need to consider other impacts (if any) that the proposed improvements along the Southwest Jefferson Reach would have on other historic resources (archaeological, existing NRHP listed properties, other historic properties, etc) that are located adjacent to or near the reach.

If you could reply to this email stating you agree with the summary outlined above I would appreciate it.

Thanks again for your time this morning Jennifer and I look forward to continued consultation with this project in the future,

Jared Barrett, MA, RPA
Archaeologist
Planning Section,
Civil Works, Planning, Programs and Project Mgmt Branch Louisville District U.S. Army Corps of Engineers Office Phone 502.315.6480 Office Fax 502.315.6864
Email: Jared.L.Barrett@usace.army.mil
Blockedhttp://www.lrl.usace.army.mil/

CLASSIFICATION: UNCLASSIFIED

GWY.Ə DƆP
CHEROKEE NATION®
P.O. Box 948 • Tahlequah, OK 74465-0948 • 918-453-5000 • cherokee.org

Office of the Chief

Bill John Baker
Principal Chief
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S. Joe Crittenden
Deputy Principal Chief
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February 18, 2019

Jared Barrett
United States Army of Corps Engineers
Louisville District
600 Dr. Martin Luther King Jr. Pl
Louisville, KY 40202

Re: Planning, Programs, and Project Management Division
Louisville Metro Flood Protection System Reconstruction and Rehabilitation

Mr. Jared Barrett:

The Cherokee Nation (Nation) is in receipt of your correspondence about **Louisville Metro Flood Protection System Reconstruction and Rehabilitation**, and appreciates the opportunity to provide comment upon this project. Please allow this letter to serve as the Nation's interest in acting as a consulting party to this proposed project.

The Nation maintains databases and records of cultural, historic, and pre-historic resources in this area. Our Historic Preservation Office reviewed this project, cross referenced the project's legal description against our information, and found instances where this project is within close proximity to culturally sensitive resources located near the 27th Street Pump Plant. These resources, however, are outside the Area of Potential Effects.

The Nation looks forward to additional consultation when a project alternative is selected. The Nation also requests copies of any related reports for the primary project alternative that are anticipated at a later date. The Nation requires that cultural resources survey personnel and reports meet the Secretary of Interior's standards and guidelines.

Additionally, the Nation requests that the United States Army of Corps Engineers conduct appropriate inquiries with other pertinent Tribal and Historic Preservation Offices regarding historic and prehistoric resources not included in the Nation's databases or records.

If you require additional information or have any questions, please contact me at your convenience. Thank you for your time and attention to this matter.

Wado,

Elizabeth Toombs, Tribal Historic Preservation Officer
Cherokee Nation Tribal Historic Preservation Office
elizabeth-toombs@cherokee.org
918.453.5389

Osage Nation Historic Preservation Office

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Date: March 27, 2019 **File: 1819-2980KY-2**

RE: USACE, Louisville District, Rehabilitation and Reconstruction of the Louisville Metro Flood Protection System, Jefferson County, Kentucky

USACE - Louisville
Jared Barrett
600 Dr. Martin Luther King Jr. Place
Louisville, KY 40201-0059

Dear Mr. Barrett,

The Osage Nation Historic Preservation Office has received notification and accompanying information for the proposed USACE, Louisville District, Rehabilitation and Reconstruction of the Louisville Metro Flood Protection System, Jefferson County, Kentucky. There are no known Osage resources within the project area. This office looks forward to reviewing the final report.

Should you have any questions or need any additional information, please feel free to contact me at the number listed below. Thank you for consulting with the Osage Nation on this matter.

Sincerely,

Jackie Rodgers
Archaeologist

627 Grandview * Pawhuska, OK 74056 Telephone 918-287-5328 * Fax 918-287-5376

The Delaware Nation
Cultural Resources /106 Department
31064 State Highway 281
Anadarko, OK 73005
Phone (405)247-2448 Fax (405) 247-8905

21 March 2019

To Whom It May Concern:

The Delaware Nation Historic Preservation Department received correspondence regarding the following referenced project(s).

> **Project: Louisville District is initiating for the reconstruction and rehabilitation of an existing Flood Risk Management Project for the Louisville Metro Flood Protection System located along the Ohio River in Jefferson County, Kentucky.**

Our office is committed to protecting tribal heritage, culture and religion with particular concern for archaeological sites potentially containing burials and associated funerary objects.

The Lenape people occupied the area indicated in your letter during prior to European contact until their eventual removal to our present locations. According to our files, the location of the proposed project does not endanger cultural, or religious sites of interest to the Delaware Nation. **Please continue with the project as planned** keeping in mind during construction should an archaeological site or artifacts inadvertently be uncovered, all construction and ground disturbing activities should immediately be halted until the appropriate state agencies, as well as this office, are notified (within 24 hours), and a proper archaeological assessment can be made.

Please note the Delaware Nation, the Delaware Tribe of Indians, and the Stockbridge Munsee Band of Mohican Indians are the only Federally Recognized Delaware/Lenape entities in the United States and consultation must be made only with designated staff of these three tribes. We appreciate your cooperation in contacting the Delaware Nation Historic Preservation Office to conduct proper Section 106 consultation. Should you have any questions, feel free to contact our offices at 405/247-2448.

Dana Kelly
Historic Preservation/106 Asst.
Delaware Nation
31064 State Highway 281
Po Box 825
Anadarko, OK 73005
Ph. 405-247-2448
dkelly@delawarenation.com

The Delaware Nation
Cultural Resources /106 Department
31064 State Highway 281
Anadarko, OK 73005
Phone (405)247-2448 Fax (405) 247-8905

US Army Corps of Engineers
Louisville District®

Great Lakes and Ohio River Division
Louisville District

Louisville Metro Flood Protection System
Emergency Supplemental
Reconstruction Feasibility Study

VOLUME 1

APPENDIX C

REAL ESTATE PLAN

Real Estate Plan

Louisville/Jefferson County

Flood Protection System Rehabilitation Project

(P2# 145626)

November 2019

U.S. Army Corps of Engineers

Louisville District

Real Estate Division

Purpose of the Real Estate Plan

This Real Estate Plan (REP) will identify the real estate interests required to implement the Louisville/Jefferson County Flood Protection System Rehabilitation Project in accordance with ER 405-1-12, Chapter 12 and subsequent guidance. This REP is tentative in nature and preliminary for planning purposes only. Property ownerships and boundary lines used to prepare this report were referenced from parcel data provided by the Louisville/Jefferson County Information Consortium (LOJIC) and were not verified through actual deed description reviews or field surveys. Final real property acquisition lines and estimates of value are subject to change even after approval of the report. This REP will accompany the Feasibility Study of the same name.

Project Authority

This project is authorized by Section 216 of the Flood Control Act of 1970, Public Law 91-611.

The non-Federal Sponsor is the Louisville/Jefferson County Metropolitan Sewer District (MSD). The non-Federal Sponsor has expressed in writing its willingness to participate in the project and its understanding of the general scope of the project. A Letter of Intent dated February 2018 was provided by the non-Federal Sponsor.

Project Location, Purpose and Description

The project consists of comprehensive rehabilitation of all fifteen existing pump stations located along the levee/floodwall alignment spanning approximately 18 miles. In addition, a new section of T-Wall will be constructed between Northwestern Pkwy and the Louisville & Portland Canal, closure structures in the levee at 10th and 27th Streets will be permanently closed, several sections of existing I-Wall in the Butchertown neighborhood will be stabilized or replaced, and a new road will be constructed at N 31st Street to facilitate a more reliable route for emergency vehicles to access McAlpine Locks and Dam, Louisville Repair Station and Louisville Gas & Electric's Hydropower Plant on Shippingport Island.

Lands Required for Construction, Operation and Maintenance

The majority of the activities included in the proposed project will take place within the existing levee right-of-way owned in fee and easement by MSD. Sufficient access to the pump stations will be obtained through existing ingress/egress easements and public rights-of-way owned by Louisville/Jefferson County or MSD. No significant earthwork is anticipated and no borrow or spoil site is required to implement the project. The following project features are anticipated to require additional real estate interests outside of those already owned by the Sponsor to support construction:

Canal Street T-Wall (New Alignment): acquisition of a 0.32 acre Perpetual Flood Protection Floodwall Easement (RWLVE) will be required to accommodate a new T-Wall section. In addition, acquisition of a 0.96 acre Temporary Work Area Easement (TWAE) will be required for staging and construction. The owner of the site is Louisville's primary electric and gas utility provider. Although the value of these easements is included in the Real Estate cost estimate in accordance with current planning guidance, it is anticipated that the necessary easements will be provided at no cost to the Non-Federal Sponsor. (See Exhibit RE-1).

Butchertown I-Wall Stabilization: an existing section of I-Wall will be replaced in its current location on the east side of N Shelby Street, south of the Franklin Street intersection. The existing floodwall is located within MSD right-of-way. The northbound lane of Shelby Street will be utilized during construction, however, additional area on the east side of the wall will be necessary to facilitate replacement. Acquisition of a 0.06 acre Temporary Work Area Easement (TWAE) will be required for staging and construction. (See Exhibit RE-2).

New Access Road at N 31st Street: there are currently two existing access routes to McAlpine Locks and Dam and Shippingport Island. The N 26th Street access includes crossing an active railway line in which railcars are often staged due to a nearby track interchange causing the route to be blocked for indeterminate periods of time. The N 27th Street access has vehicle height restrictions due to an overhead railway bridge. The construction of a new road will provide an alternate route for emergency vehicles to reach Marine Street in the event the N 26th Street access is blocked. The 27th Street levee opening will be permanently closed as part of the project. The new road will be located partially on existing public right-of-way and partially on property currently owned in fee by the United States of America as portions of Parcel Nos. 3 and 12 of the McAlpine Locks and Dam project (7.28 acers). It is expected that the new road will be maintained by the Louisville District Operations Division and included in McAlpine Locks and Dam real property inventory. (See Exhibit RE-3).

Project Feature	**PIN**	**Estate**	**RWLVE Acres**	**TWAE Acres**
Canal Street T-Wall	005D00010000	Levee Flood Protection Easement	0.32	
Canal Street T-Wall	005D00010000	Temp Work Area Easement		0.96
I-Wall Stabilization	019F00970000	Temp Work Area Easement		0.06
		Total	**0.32**	**1.02**

Lands Owned by the non-Federal Sponsor

MSD currently owns fee simple and easement interests in all lands required to implement the project with the exceptions noted above. The existing right-of-way was provided previously as an item of cooperation to support the original construction of the flood protection system. No credit for the value of lands, easements, or rights-of-way (LER) will be afforded to the Sponsor toward their share of total project costs for any existing feature of the system.

Standard Estates

The standard estates of Flood Protection Levee/Floodwall Easement and Temporary Work Area Easement will be required to implement the project.

Flood Protection (Levee/Wall) Easement (RWLVE)

A perpetual and assignable right and easement in the land described in Exhibit(s) ___ to construct, maintain, repair, operate, patrol and replace a flood protection (levee/wall), including all appurtenances thereto; reserving, however, to the owners, their heirs and assigns, all such rights and privileges in the land as may be used without interfering with or abridging the rights and easement hereby (acquired/reserved); subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

Temporary Work Area Easement (TWAE)

A temporary easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. _____, _____ and _____), for a period not to exceed _____, beginning with date possession of the land is granted to the United States, for use by the United States, its representatives, agents, and contractors as a (borrow area) (work area), including the right to (borrow and/or deposit fill, spoil and waste material thereon) (move, store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the _____ Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

No non-standard estates are anticipated to be required to complete the project.

Existing Federal Lands or Projects

The 31st Street access road to be constructed as part of the project will be partially located on portions of McAlpine Locks and Dam Parcel Nos. 3 and 12. MSD will not be required to obtain a real property interest in Federal lands and as such, the value of those lands will not be included in total project costs and LERRD credit will not be afforded to the Sponsor.

Navigation Servitude

Navigation Servitude does not apply to this project.

Induced Flooding

The purpose of the project is to reduce damages associated with flood events. The project is not expected to induce flooding.

Public Law 91-646 Relocation Assistance

No residences or businesses require relocation assistance as a result of the proposed project.

Facility/ Utility/ Cemetery Relocations

ANY CONCLUSION OR CATEGORIZATION CONTAINED IN THIS REAL ESTATE PLAN, OR ELSEWHERE IN THIS PROJECT REPORT, THAT AN ITEM IS A UTILITY OR FACILITY RELOCATION TO BE PERFORMED BY THE NON-FEDERAL SPONSOR AS PART OF ITS LERRD RESPONSIBILITIES IS PRELIMINARY ONLY. THE GOVERNMENT WILL MAKE A FINAL DETERMINATION OF THE RELOCATIONS NECESSARY FOR THE CONSTRUCTION, OPERATION, OR MAINTENANCE OF THE PROJECT AFTER FURTHER ANALYSIS AND COMPLETION AND APPROVAL OF FINAL ATTORNEY'S OPINIONS OF COMPENSABILITY FOR EACH OF THE IMPACTED UTILITIES AND FACILITIES.

No facility or utility relocations are expected to be required as part of the project.

Baseline Cost Estimate for Real Estate

01 Lands and Damages		
Lands		
Perpetual Flood Protection Easement	0.32	$38,400
Temporary Work Area Easement (3 years)	0.96	$34,560
Temporary Work Area Easement (3 years)	0.06	$5,000
Damages	Fencing	$1,500
Contingency	25%	$19,865
Non-Federal Sponsor Admin Costs (Incidentals)		$20,000
Federal Administrative Costs		$10,000
	01 Lands & Damages Estimate Total	$130,000®
02 Relocations		$0
Real Estate Cost Estimate Total $130,000		

Acquisition Schedule

Notice to Proceed with Real Estate Acquisitions Issued	Upon Final Design
Real Estate Acquisitions	**6-9 months**
Certification of Real Estate Interests/Ready to Advertise	1 month
LERRD Crediting Preparation, Review and Certification	Within 6 months of RE Certification

Environmental Considerations

All required environmental assessments, evaluations, and documentation (National Environmental Policy Act (NEPA), Section 404, Endangered Species, Cultural Resources Section 106, Executive Order (EO) 11988) will be conducted during the Engineering & Design phase of the proposed project. The environmental compliance review will be completed prior to commencement of construction activities. An Environmental Assessment has been prepared as part of the Feasibility Study. A Finding of No Significant Impact (FONSI) statement will be executed prior to commencement of any construction activities.

Non-Federal Sponsor Responsibilities

In accordance with the Project Partnership Agreement (PPA), the non-Federal Sponsor will be required to furnish all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all utility/facility relocations (LERRDs) determined by the Government to be necessary for construction, operation, and maintenance of the project. All lands, easements and rights-of-way determined by

the Government to be necessary for work to be performed under a construction contract must be furnished prior to the solicitation of that construction contract. The non-Federal Sponsor will be required to conduct real estate acquisitions in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646), as amended. The non-Federal Sponsor will be required to document its ownership of the project's real estate requirements and provide an Authorization-for-Entry-for-Construction.

A Risk Notification letter was provided to the Non-Federal Sponsor in August, 2019.

Non-Federal Sponsor Real Estate Acquisition Capability Assessment

A detailed assessment has been completed and is attached hereto. It has been determined that the Louisville/Jefferson County Metropolitan Sewer District is moderately capable (no "quick take" authority) of performing the Real Estate acquisition requirements of the proposed project.

Prepared by:

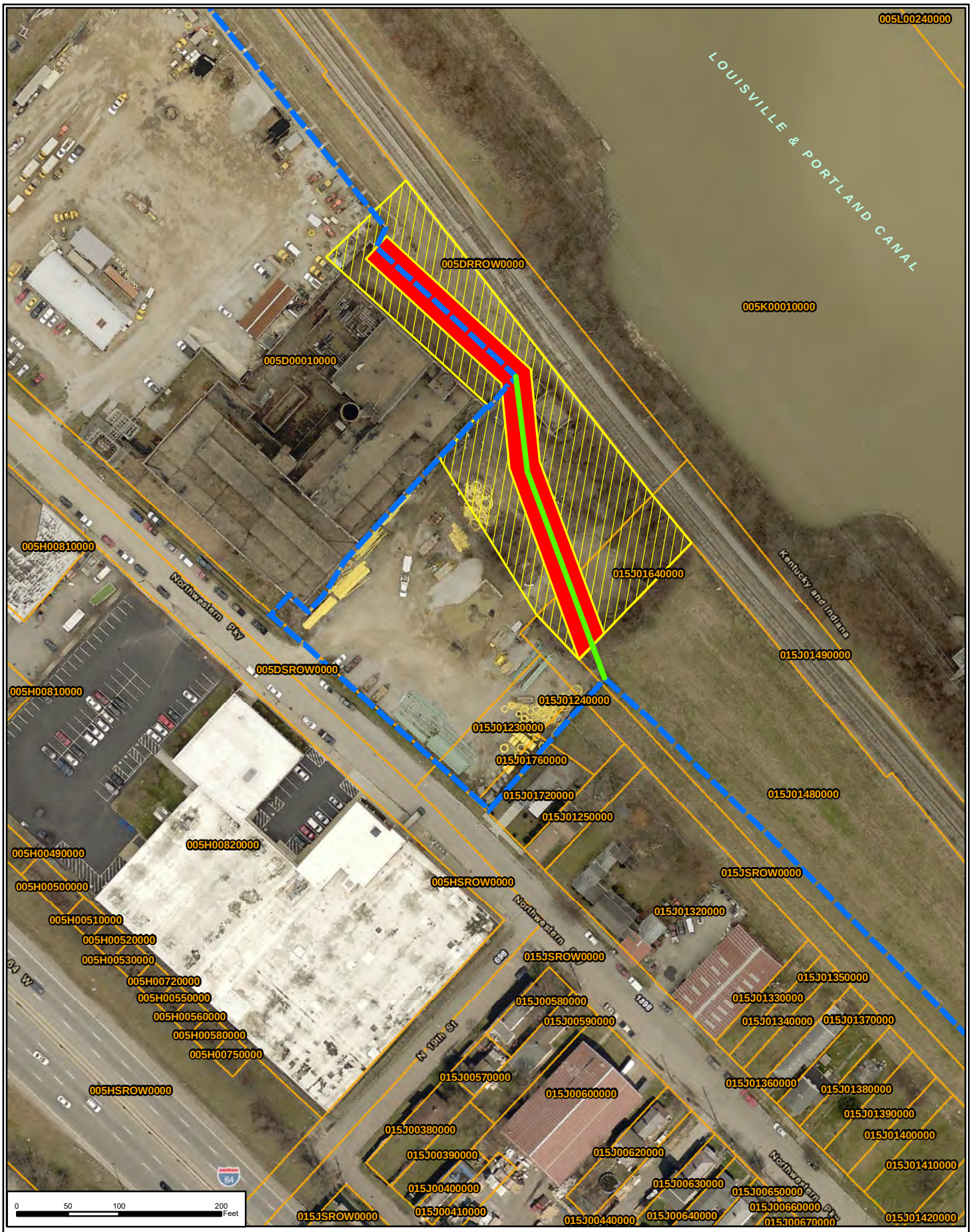
MEYER.JASON.E.1255230529 Digitally signed by MEYER.JASON.E.1255230529 Date: 2019.10.29 17:14:52 -04'00'

Jason E. Meyer
Realty Specialist
Louisville District

This REP is in compliance with applicable regulations, policy, and delegations.

Veronica A. Hiriams

Veronica A. Hiriams
Chief, Real Estate Division
Louisville District



Perpetual Flood Protection Levee Easement (0.32 Acres)
Temporary Work Area Easement (0.96 Acres)
Existing Alignment
T-Wall Alignment (New)
Jefferson County Parcel Data

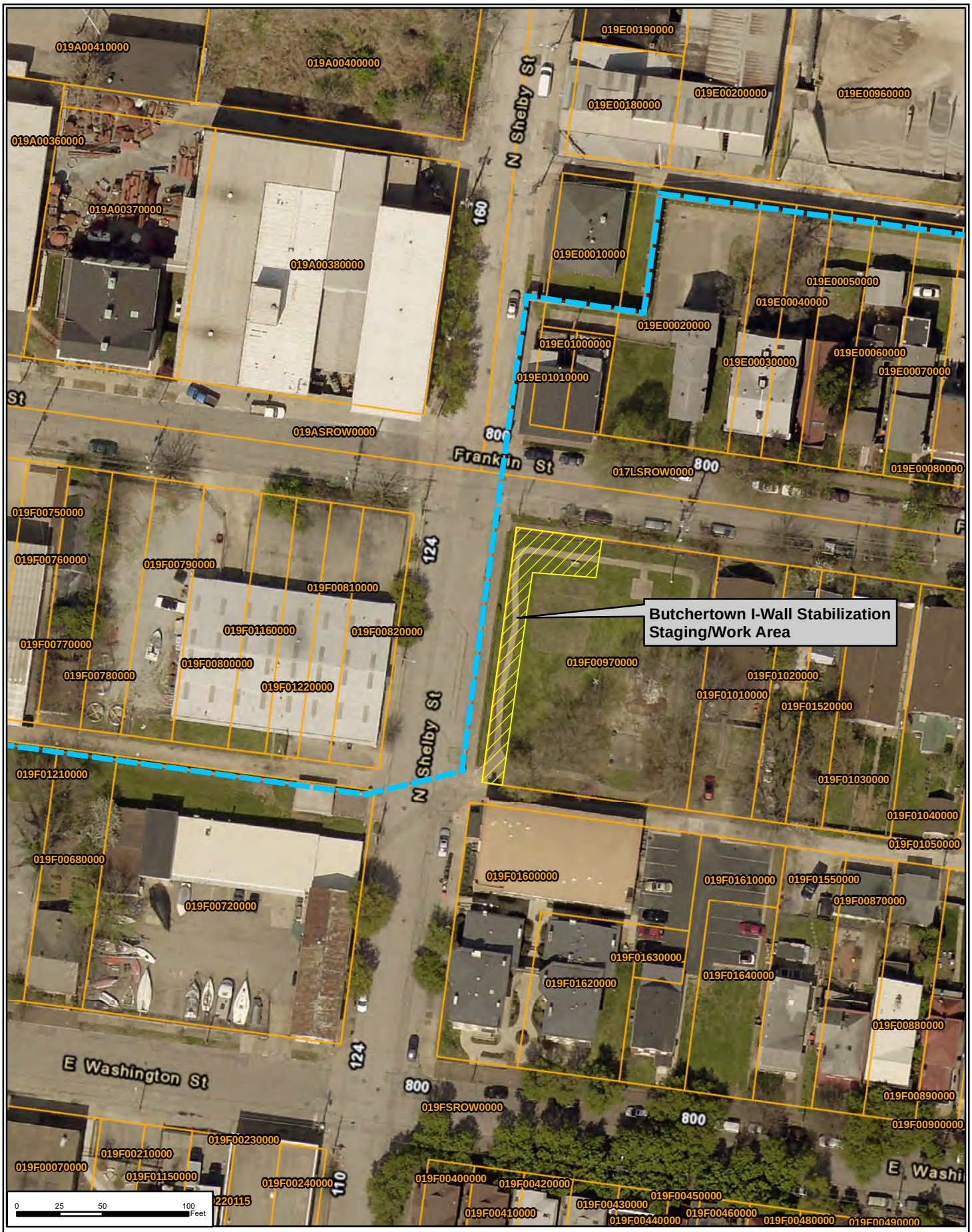
LOUISVILLE METRO EMERGENCY SUPPLEMENTAL

LOUISVILLE, JEFFERSON COUNTY KENTUCKY

US ARMY ENGINEER DISTRICT
LOUISVILLE DISTRICT CORPS OF ENGINEERS
REAL ESTATE DIVISION

DATE: AUGUST 2019

SHEET: EXHIBIT RE-1



Temporary Work Area Easement (0.06 Acres)

Existing Alignment

Jefferson County Parcel Data

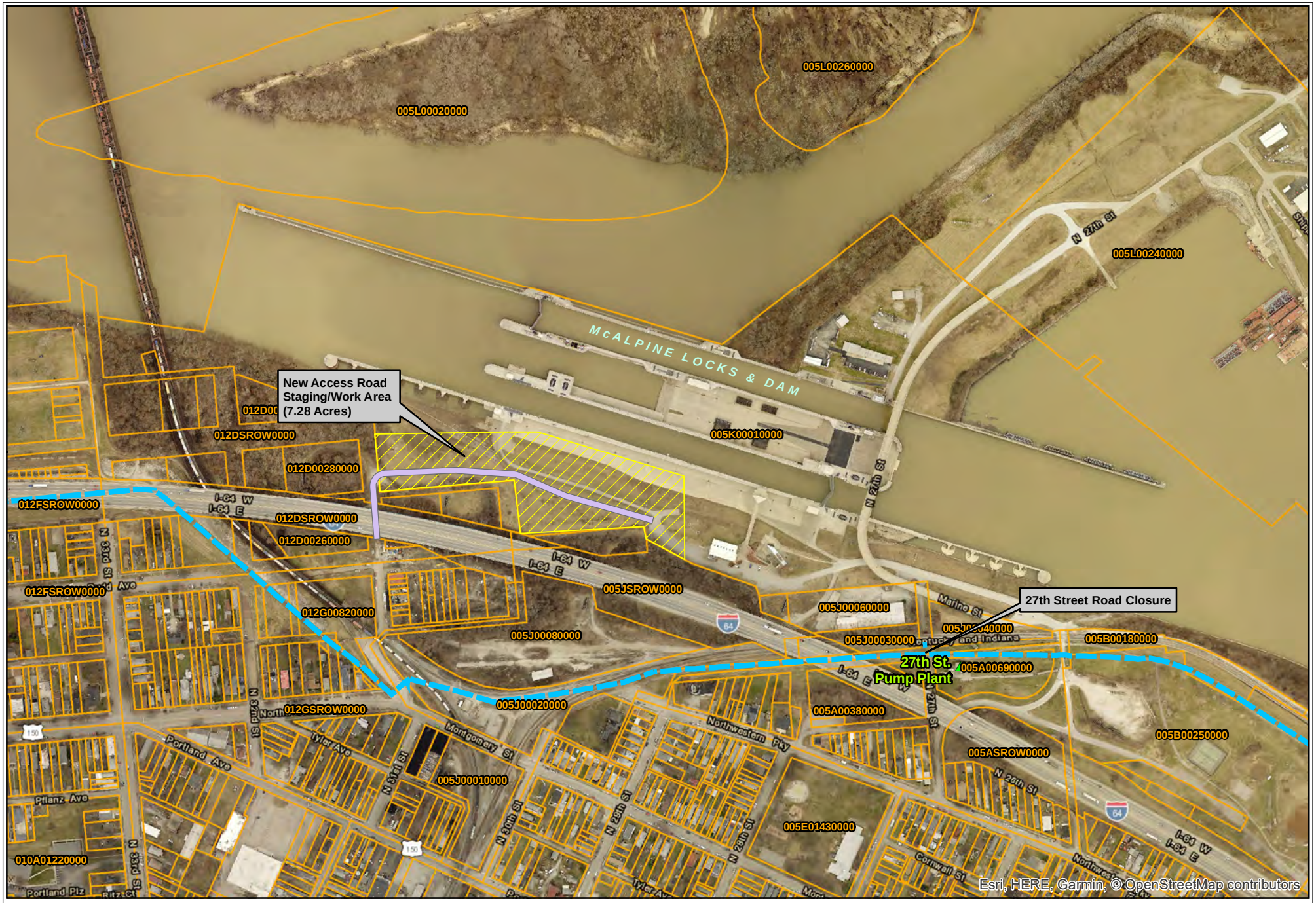
LOUISVILLE METRO EMERGENCY SUPPLEMENTAL

LOUISVILLE, JEFFERSON COUNTY KENTUCKY

US ARMY ENGINEER DISTRICT
LOUISVILLE DISTRICT CORPS OF ENGINEERS
REAL ESTATE DIVISION

DATE: AUGUST 2019

SHEET: EXHIBIT RE-2



Temporary Work Area Easement (7.28 Acres)
New Access Road
Existing Alignment
Jefferson County Parcel Data

0 250 500 1,000 Feet

LOUISVILLE METRO
EMERGENCY SUPPLEMENTAL
LOUISVILLE, JEFFERSON COUNTY
KENTUCKY

US ARMY ENGINEER DISTRICT
LOUISVILLE DISTRICT CORPS OF ENGINEERS
REAL ESTATE DIVISION

DATE: OCTOBER 2019

SHEET: EXHIBIT RE-3

LOUISVILLE/JEFFERSON COUNTY
METROPOLITAN SEWER DISTRICT
IMPROVEMENT PROJECT
ASSESSMENT OF NON-FEDERAL SPONSOR'S
REAL ESTATE ACQUISITION CAPABILITY

Sponsor: Louisville/Jefferson County Metropolitan Sewer District

Authority: Section 216 of the Flood Control Act of 1970 (Public Law 91-611)

Non-Federal Sponsor Real Estate Contact: Wolffie Miller
502-540-6626
wolffie.miller@louisvillemsd.org

I. Legal Authority

a. Does the non-Federal Sponsor have legal authority to acquire and hold title to real property for project purposes?

Yes__x__No_____

Non-Federal Sponsor is authorized to acquire and own land by authority of Kentucky Revised Statutes (KRS), Chapter 76; specifically KRS 76.080(6), whereby MSD is authorized "to acquire by purchase, gift, lease, or by condemnation, real property or any interest, right, easement, or privilege therein, as the board determines necessary, proper and convenient for the corporate purposes of the district. . ."**.**

Note: If NO; who will acquire LERRD? Who will hold title?

b. Does the non-Federal Sponsor have the power of eminent domain for this project?

Yes__x__No_____

The use of eminent domain is authorized by Kentucky Revised Statutes (KRS), Chapter 76; specifically KRS 76.080(6) (see above)**.**

Note: If NO, who will acquire tracts if condemnation is required?

c. Does the non-Federal Sponsor have "quick-take" authority for this project?

Yes_____No__x__

Non-Federal Sponsor's "quick-take" authority is authorized by _____.

Note: If NO; will lack of "quick take" authority impact the project schedule?

No impact.

d. The non-Federal Sponsor has reviewed the project maps and confirmed that all of the lands/ interests in land required for the project are located inside of their political boundary.

Yes_X_No_____

Note: If NO; what is the plan for acquiring? Can the non-Federal Sponsor hold title to land outside of their political boundary?

e. Are any of the lands/ interests in land required for the project owned by an entity whose property the non-Federal Sponsor cannot condemn?

Yes_____No_X_

Note: If YES; what is the plan for acquiring?

Section I. Kelsey Solmos Date: 08 / 12 / 19
Realty Specialist

II. Financial Capability

a. The non-Federal Sponsor has reviewed and concurs with the real estate cost estimates.

Yes_X_No_____

Note: If NO; provide the anticipated resolution.

b. It has been established by the responsible district element that the non-Federal Sponsor is financially capable of fulfilling all requirements identified in the Project Partnership Agreement (PPA).

Yes_X_No_____

Note: If NO; is another entity going to provide the non-Federal Sponsor with financial assistance?

Section II. Kelsey Solmos Date: 08 / 12 / 19
Realty Specialist

III. Willingness To Participate

a. The non-Federal Sponsor has stated in writing its general willingness to participate in the project and its understanding of the general scope of the project and its part of the project.

Yes__X__ ~~TBD~~

Letter of Intent from the NFS dated __02__/__12__/__18__.

Note: If more than one sponsor is to be involved explain the Real Estate roles of each non-Federal Sponsor.

b. The non-Federal Sponsor is agreeable to signing a project partnership agreement and supplying funding as stipulated in the agreement.

Yes__X__

c. The non-Federal Sponsor was provided the Local Sponsors Toolkit on __08__/__12__/__19__.
http://www.lrd.usace.army.mil/Portals/73/docs/RealEstate/Non-Federal_Sponsor_Package.pdf

Section III. Kelsey Solmos Date: 08 / 12 / 19
Realty Specialist

IV. Acquisition Experience and Capability

a. **Taking into consideration the project schedule and complexity, the non-Federal Sponsor has the capability with in-house staffing or contract capability, to provide the necessary services such as surveying, appraising, title, negotiating, condemnation, closings, and relocation assistance that will be required for the acquisition of properties for this project.**

   Yes_X_No_____

   Note: If work will be done in-house give brief summary, staff size, expertise, experience, etc.

b. **The non-Federal Sponsor's staff is familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended.**
   Yes_x_No_____

   Note: If NO; additional funding for USACE training/ oversight will be required.

c. **The non-Federal Sponsor can obtain contractor support and meet project schedules.**

   Yes_X_No_____

   Note: If NO; does the acquisition timeline account for this?

d. **The non-Federal Sponsor's staff is located within a reasonable proximity to the project site.**

   Yes_X_No_____

   Note: If NO; provide summary of plan to make contact; i.e., project office, travel, local contractors etc.

e. **Will USACE assistance likely be requested by the non-Federal Sponsor in acquiring real estate?**

   Yes_____No_X_

   Note: If YES; provide a summary of the level of support that will be requested. Will a Memorandum of Agreement be required in accordance with the Project Partnership Agreement?

Section IV. Kelsey Solmos Date: 08 / 12 / 19
Realty Specialist

V. Schedule Capability

The non-Federal Sponsor has approved the tentative project/ real estate schedule/ milestones and has indicated its willingness and ability to incorporate its financial, acquisition, and condemnation capability to provide the necessary project LERRDs in accordance with proposed project schedules so the Government can advertise and award the construction contract as required by overall project schedules and funding limitations.

Yes X Initials: KRS Date: 08 / 12 / 19

Note: Address risks to schedule

Section V. Kelsey Solmos Date: 08 / 12 / 19
Realty Specialist

VI. LERRD Credits

The sponsor has indicated its understanding of LERRD credits and its capability and willingness to gather the necessary information to submit as LERRD credits in within six months after possession of all real estate and completion of relocations in order that the project can be financially closed and there can be a final financial accounting with a proper settlement with the non-Federal Sponsor.

Yes X Initials: KRS Date: 08 / 12 / 19

Note: If a multi-year phased project discuss plan for interim submittals.

Section VI. Kelsey Solmos Date: 08 / 12 / 19
Realty Specialist

VII. Capability

With regard to this project, the non-Federal Sponsor is anticipated to be: MODERATELY CAPABLE.

Note: Choices are: fully capable, moderately capable, marginally capable, and insufficiently capable.

a. Fully Capable: *Previous experience. Financially capable. Authority to hold title. Can perform, with in house staff, the necessary services (survey, appraisal, title, negotiation, closing, relocation assistance, condemnation & "quick-take" authority) required to provide LERRD.*

b. Moderately Capable: *Financially capable. Authority to hold title. Can provide, with contractor support, the necessary services (survey, appraisal, title, negotiation, closing, relocation assistance and condemnation authority) required to provide LERRD. Quick-take authority will be provided by* _____.

c. Marginally Capable: *Financially capable. Authority to hold title. Will rely on approved contractors to provide the necessary services (survey, appraisal, title, negotiation, closing, and relocation assistance). Quick-take authority and authority to condemn will be provided by* _____.

d. Insufficiently Capable: *Financially capable. Will rely on approved contractors to provide the necessary services (survey, appraisal, title, negotiation, closing, and relocation assistance). Quick-take authority and authority to condemn will be provided by* _____.
Will rely on _____ *to hold title.*

Summarize what support will be provided to the non-Federal Sponsor to ensure project success.

VIII. Coordination

This assessment has been coordinated with the non-Federal Sponsor and it concurs with the assessment.

Yes X

This assessment has been coordinated with:

Name: WOLFFIE MILLER

Title: Project Manager

Prepared by:

Kelsey Solmos

Realty Specialist

Considering the capability of the non-Federal Sponsor and the ancillary support to be provided by N/A, and identified above, it is my opinion that the risks associated with LERRD acquisition and closeout have been properly identified and appropriately mitigated.

Veronica A Hurams

Chief, Real Estate Division

LOUISVILLE District

Non-Federal Sponsor Representative:

Signature: Chiffle

Name: CHRISTIAN W. MILLER II

Title: ENGINEER III, PROJECT MGR.

Date: 8 / 26 / 19

US Army Corps of Engineers
Louisville District®

Great Lakes and Ohio River Division
Louisville District

Louisville Metro Flood Protection System
Emergency Supplemental
Reconstruction Feasibility Study

VOLUME 1

APPENDIX D

REFERENCES AND SUPPORTING GUIDANCE

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

AUG 16 2005

CECW-PB

MEMORANDUM FOR COMMANDERS, MAJOR SUBORDINATE COMMANDS

SUBJECT: Reconstruction of U.S. Army Corps of Engineers Structural Flood Damage Reduction Projects for which Non-Federal Interests are Responsible for Operation, Maintenance, Repair, Rehabilitation and Replacement

1. Purpose. This memorandum provides policy guidance on reconstruction of Corps structural flood damage reduction projects for which non-Federal interests are responsible for operation, maintenance, repair, rehabilitation and replacement (OMRR&R).

2. Background. Pursuant to Section 3 of the Flood Control Act of 1936 and Section 103 of the Water Resources Development Act of 1986 (WRDA 86), non-Federal interests are required to pay 100 percent of the costs of OMRR&R of structural flood damage reduction projects. As projects age, it is recognized that the projects may not perform as intended due to long term degradation of features which have exceeded their expected service life. The term "reconstruction" applies to the measures to address the long-term degradation of project features, which have exceeded their expected service life. There are several ongoing feasibility level studies examining reconstruction of such projects.

3. Policy. This policy is applicable to Federally constructed structural flood damage reduction projects and separable elements for which non-Federal interests are responsible for OMRR&R. It does not apply to Corps activities pursuant to Public Law 84-99.

a. Authority. There is no general authority for reconstruction of projects for which non-Federal interests are responsible for OMRR&R. This lack of authority, however, does not apply to measures addressing design and construction deficiencies, which will continue to be addressed pursuant to existing project authority. Except for those specific features on which it is determined that a design or construction deficiency is involved, Congressional authorization is required to undertake reconstruction.

b. Study Authority. The authority to conduct feasibility studies examining the reconstruction of structural flood damage reduction projects and separable elements constructed by the Corps is Section 216 of the Flood Control Act of 1970 (Public Law 91-611) which states:

"The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply,

and related purposes, when found advisable due to significantly changed physical or economic conditions, and to report thereon to Congress with recommendations of the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest."

Feasibility studies may also be conducted in response to specific study resolutions.

c. Adequate Non-Federal Maintenance. In general, a Federal project or separable element will only be eligible for reconstruction when the non-Federal sponsor has adequately maintained the project or separable element by accomplishing the items provided for in the operation and maintenance manual and the Code of Federal Regulations (33 CFR 208.10 - Local flood protection works; maintenance and operation of structures and facilities) and by addressing operation and maintenance deficiencies noted in any inspection. Where a non-Federal sponsor has not adequately maintained a project, it may still be eligible for reconstruction but the non-Federal sponsor will be responsible for 100 percent of the costs of bringing the project to a fully maintained condition in accordance with the operation and maintenance manual for the project and the Code of Federal Regulations. In other words, the cost of any items recommended in a reconstruction project report that are the result of deficient maintenance will be at 100 percent non-Federal expense.

d. Design Deficiencies. Design or construction deficiencies will continue to be addressed according to ER 1165-2-119 and under the guidance presented in the annual budget EC under the original/existing project authority. Cost sharing and financing of deficiency corrections at structural flood damage reduction projects for which non-Federal interests are responsible for OMRR&R, will reflect the concepts of WRDA 86, as amended, unless the Assistant Secretary of the Army (Civil Works) grants an exception for a project implemented under pre-WRDA 1986 cost sharing or Congress directs otherwise.

e. Definition of Reconstruction. Cost shared reconstruction will be defined by elimination. Reconstruction excludes design or construction deficiencies. Further, reconstruction is limited to addressing impediments that prevent a project from performing as authorized after all maintenance, as required by the project operation and maintenance manual and the Code of Federal Regulations, has been accomplished and any deficiencies resulting from a lack of maintenance have been addressed. Reconstruction will consist of addressing the major performance deficiencies caused by a long-term degradation of the foundation, construction materials, and engineering systems that have exceeded their expected service lives and the resulting inability of the project to perform its authorized project functions. In addressing reconstruction needs, the latest design standards and efficiency improvements should be incorporated into the project.

f. Implementation Process. Reconstruction feasibility studies will be pursued under the two-phase preauthorization study process described in Chapter 4 of ER 1105-2-100. Because Corps interest in the existing structural flood damage reduction project is already established, the reconnaissance phase will concentrate on the need for and rationale for reconstruction (over and above any deficiency correction and performance of deficient maintenance) and the level of interest and support from the non-Federal sponsor. After certification of the 905 (b) report for consistency with policy, preparation of the Project Management Plan and negotiation and execution of the Feasibility Cost Sharing Agreement will take place. The cost shared feasibility study will follow the same procedures as described in Appendix H of ER 1105-2-100 leading to a Chief's Report, ASA(CW) and OMB review and transmittal to Congress for authorization.

g. Study Scope. Depending on the interest of the non-Federal sponsor, the feasibility study may be limited to examination of the reconstruction of the existing project with no change in its scope or function. Under this limited objective, evaluation would be limited to individual project features, (closure structures, pumping stations, gravity drains, relief wells, etc.) to establish the justification of reconstruction based on a comparison between the with and without reconstruction condition. Features considered for reconstruction should be evaluated as to their incremental justification in a manner similar to that used for major rehabilitation at federally maintained projects in accordance with Chapter 3 of EP 1130-2-500. The analysis should first determine whether there are any design or construction deficiencies or insufficient maintenance of the existing project. The analysis should then address the probability of a feature not performing, physical and fiscal consequences of that failure to perform, and consideration of the actions that would be taken after the failure occurred and how that would affect the likelihood of failure in the future. For levee and floodwall projects, the with and without reconstruction analysis should include consideration of both exterior and interior flooding. Reconstruction studies may also include a combination of reconstruction of an existing project with extension or expansion of flood damage reduction (change in scope or level of protection). These studies would be identical in scope to any other flood damage reduction feasibility study and include a full range of alternatives and economic evaluation to identify the plan that maximizes net benefits as well as compliance with all environmental laws and regulations. In both instances (limited and expanded scope), the report should address operation and maintenance and design deficiencies and recommend combined actions subject to the appropriate cost sharing.

h. Ecosystem Restoration. In accordance with the Chief of Engineer's Environmental Operating Principles, any project reconstruction study will include an evaluation of the environmental sustainability of the existing project. The question to be addressed in the evaluation is whether the reconstruction and continued operation and maintenance of the structural flood protection project are compatible with a healthy, diverse, and sustainable condition in the affected aquatic and riparian ecosystem. Modification of the project to add

ecosystem restoration measures would require specific authorization and should be considered in cooperation with the non-Federal sponsor and subject to cost-sharing in accordance with Section 103 of WRDA 86, as amended.

i. Cost Sharing. Costs for reconstruction will be shared in accordance with the provisions of Section 103 of WRDA 86, as amended. A non-Federal sponsor commitment to cost share will be a condition for undertaking a reconstruction project. Measures to address maintenance deficiencies may be included in a reconstruction project but will be at 100 percent non-Federal cost. The non-Federal sponsor must commit to operate, maintain, repair, rehabilitate and replace the completed reconstructed project in accordance with the provisions of Section 103 of WRDA 86, as amended.

4. Permanent Guidance. The guidance in this PGL will be incorporated into permanent guidance as it is updated.

FOR THE COMMANDER:

DON T. RILEY
Major General, USA
Director of Civil Works

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

AUG - 9 2018

MEMORANDUM FOR Deputy Commanding General for Civil and Emergency Operations

SUBJECT: Policy Guidance on Implementation of Supplemental Appropriations in the Bipartisan Budget Act of 2018

1. References:

a. Bipartisan Budget Act of 2018 (Public Law 115-123), Division B, Subdivision 1, Title IV (Enclosure 1).

b. Balanced Budget and Emergency Deficit Control Act of 1985 (Public Law 99-177), as amended.

2. General.

a. This document provides implementation guidance for supplemental appropriations in the Investigations, Construction, Mississippi River and Tributaries (MR&T), Operation and Maintenance, and Expenses appropriations. Implementation guidance for the Flood Control and Coastal Emergencies appropriation is provided separately, dated 11 May 2018. It is my expressed intent that the USACE act as expeditiously as possible to initiate and complete the projects and studies identified in the Long-term Disaster Recovery Investment Plans (LDRIPs).

b. Funds appropriated in Public Law 115-123 are designated by the Congress as being for an emergency requirement pursuant to section 251(b)(2)(A)(i) of the Balanced Budget and Emergency Deficit Control Act of 1985.

c. In accordance with Public Law 115-123, my office will provide a monthly report to the Committees on Appropriations of the House of Representatives and the Senate reflecting the allocation and obligation of all funding provided by Public Law 115-123. In accordance with standard practice, your office will consolidate this monthly report with the monthly reports on other supplemental appropriations using data as of the end of each month, and furnish each monthly report to my office for transmittal. In addition, your office will provide, at least quarterly, in-person execution updates to Office of the Assistant Secretary of the Army (Civil Works) (ASA (CW)) and Office of Management and Budget (OMB) leadership and will also provide similar relevant information to the appropriations committees.

d. In accordance with Section 20401 of Public Law 115-123, in Fiscal Year (FY) 2018, and each FY thereafter, the Chief of Engineers of the U.S. Army Corps of Engineers shall transmit to the Congress, after reasonable opportunity for comment, but

without change, by the Assistant Secretary of the Army for Civil Works, a monthly report, the first of which shall be transmitted to Congress not later than two days after the date of enactment of this subdivision and monthly thereafter, which includes detailed estimates of damages to each Corps of Engineers project, caused by natural disasters or otherwise. Please have your staff prepare the monthly reports based on data as of the end of each month, and furnish the draft reports to my office for comment not later than the 7th day of each month.

3. Long-term Disaster Recovery Investment Plans.

a. Long-term Disaster Recovery Investment Plans (LDRIPs) have been approved for each of the following accounts for Public Law 115-123: Investigations; Construction (other than the $55,000,000 for short-term repairs); and Mississippi River and Tributaries (MR&T) work. The approved LDRIPs will be updated over time as additional information is developed on other studies and projects; however, it is not necessary to update LDRIPs for changes in the costs of already-included studies and projects. Coordination with this office and clearance by OMB (as conducted for the initially approved LDRIPs) are required for updates to the LDRIPs, and, while changes in costs for approved projects are not required to be coordinated or cleared, these changes will be provided to my office as they are identified. As was done for the initial LDRIPs, this office will continue to transmit updates to the LDRIPs to the Appropriations Committees of the House of Representatives and Senate as a courtesy. The approved LDRIPs, as well as updates to the LDRIPs, for each appropriation should be posted on the Corps web site, which is available to the general public. In addition, the Corps should consider the use of various authorities (such as WRRDA 2014, Section 1043) that encourage expanded non-Federal participation in studies and projects.

b. The LDRIP for Construction will include $50,000,000 in reserve for the Continuing Authorities Program (CAP). This amount may be reduced in future updates to the plan as additional information is developed. Headquarters, U.S. Army Corps of Engineers (HQUSACE), will determine the allocation of CAP funding among CAP projects based on performance. Allocation of CAP funds should be reported to this office along with the monthly allocation and obligation report.

c. The Investment Plan for the $400,000,000 amount for MR&T will follow the guidance on Investigations and Construction, except that for mega-projects such as Channel Improvement and Mississippi River Levees, useful increments of work instead of entire projects may be included for completion.

4. Investigations.

a. Public Law 115-123 appropriates $135,000,000 in Investigations funds (Supplemental Investigations funds), to remain available until expended, for necessary expenses related to the completion, or initiation and completion, of authorized flood and storm damage reduction studies, including shore protection. It further provides that the funds are for high-priority studies of projects in States and insular areas (territories) with more than one flood-related major disaster declared pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.) in calendar years 2014, 2015, 2016, or 2017. Thirty-three states and three territories meet the criteria and are listed in Enclosure 2. Of that lump sum amount, not less than $75,000,000 is available for studies in such States and insular areas (territories) that

were impacted by Hurricanes Harvey, Irma, and Maria (HHIM). The States and territories that were also impacted by HHIM are listed in Enclosure 3.

b. Studies must be Federally authorized in order to be eligible to be undertaken using Supplemental Investigations funds. Public Law 115-123 did not provide authority for the Corps of Engineers to undertake a study that is not otherwise authorized.

c. Feasibility studies that are predominantly for flood and storm damage reduction are eligible to be considered for Supplemental Investigations funds. In addition, comprehensive and watershed studies that are predominantly for flood and storm damage reduction, even if there are other ancillary purposes, are eligible for consideration. Both structural and non-structural measures will be considered. Studies may address long-range measures to reduce exposure to risks from floods and coastal storms. In addition, studies of projects located partially in a State identified in Enclosure 2 or 3, and primarily benefitting such State, are eligible to be considered for this funding.

d. In addition to comprehensive studies and watershed studies, feasiblity studies (including General Reevaluation Studies) as well as work needed to reach a document supporting a construction decision and inclusion of the project in the Construction Investment Plan will be funded in Investigations. Types of studies are as follows:

(1) Study new starts, leading to preparation of a Chief's Report or a Director's Report or a watershed assessment or a comprehensive report. New study starts are studies that have never been funded in the Investigations appropriation, including former Continuing Authorities Program projects migrating to the Investigations account for the first time.

(2) Active studies that are currently proceeding in accordance with a vertical team aligned scope, schedule and budget, and leading to preparation of a Chief's Report for new authorization or a Director's Report, if additional authorization is not required.

(3) Study resumptions, leading to preparation of a Chief's Report for new authorization or a Director's Report, if additional authorization is not required. Study resumptions are formerly Inactive studies that become Active once the Division Commander signs a memorandum reactivating the study.

(4) Public Law 115-123 provides that a project that is studied using Supplemental Investigations funds is eligible for implementation using Construction funds provided in that Act if the Secretary determines that the project is technically feasible, economically justified, and environmentally acceptable. For the Rio Grande de Loiza, Rio Guanajibo at Mayaguez, and Rio Nigua at Salina projects, Investigations funds will be provided to verify that the scope of each project as identified in its Chief Report is the project that is being proposed for implementation using Construction funds provided in Public Law 115-123. The verification and Chief's Report for each project will be provided to the ASA(CW) for the required determination of technical feasibility, economic justification, and environmental acceptability, after which implementation of the project may be undertaken using Supplemental Construction funds.

e. Enclosure 4, dated July 5, 2018, identifies the studies that will be funded with Supplemental Investigations funds as part of the LDRIP. In accordance with paragraph 3, this list may be updated as necessary. Before Supplemental Investigations may be

used, any Federal funds previously provided for a study, including funds carried into FY 2018 as well as funds provided in the FY 2018 workplan, will be used first, with such funds remaining subject to cost sharing. In addition, for the Coastal Texas Protection and Restoration Study, the amount of Supplemental Investigations funds that will be made available for the study will be reduced by the amount provided in the FY 2019 President's Budget, with such amount subject to cost sharing. An interim accounting and cost share balancing will be undertaken to ensure that any regular funding, i.e., any funding other than Supplemental Investigations funds provided for the study, is appropriately cost shared.

f. Cost Sharing Agreement. No cost sharing agreement is required for the South Atlantic Coastal Comprehensive Study and the Houston Regional Watershed Assessment. For feasibility studies (including General Reevaluation Studies), a new feasibility cost sharing agreement (FCSA) or an amendment to the existing FCSA is required to address use of Supplemental Investigations funds at 100 percent federal expense.

(1) HQUSACE is authorized to develop and approve FCSAs, and amendments to existing FCSAs, for studies in the LDRIP and to delegate to the Division Commander authority to approve use of such FCSAs and amendments. In addition, authority to execute a FCSA or amendment, once approved, may be delegated to the District Commander.

(2) To ensure studies are being expedited, the FCSA or amendment to the FCSA, as applicable, should be executed as soon as possible. A significant delay in agreement execution may result in de-selection from the LDRIP.

g. Initial Funding of New Studies and Resumptions. To enable success for new and resuming studies approved for Supplemental Investigations funds, the Division Chief of Planning & Policy may approve the use of up to $100,000 to establish the project delivery team, hold a scoping meeting, develop a draft Project Management Plan, and negotiate the FCSA or amendment. For resumptions, the $100,000 includes any regular funding currently unobligated on the study, with the remainder, if any, being Supplemental Investigations funds. All Supplemental funding used on a study is included in the calculation of the total study cost.

h. Applicable Policies and Guidance. Except as otherwise noted, studies funded by Public Law 115-123 will be undertaken in accordance with existing Civil Works policies and guidance and incorporate SMART Planning principles. Consistent with current procedures, divisions will coordinate with HQUSACE to identify, document, and pursue opportunities to expedite completion of these studies and associated review and approval procedures in compliance with, but not limited to, Section 1001 of WRRDA 2014 and, for feasibility studies, the "3x3x3" rule and Section 1002 of WRRDA 2014.

i. Generally, feasibility studies funded by Public Law 115-123 will be conducted for not more than $3 million and will be completed within 36 months, consistent with Section 1001 of WRRDA 2014. If a cost exemption is approved for a study, those additional costs may be funded from remaining Supplemental Investigations funds. However, if available remaining Supplemental Investigations funds are exhausted, then the additional costs will be cost shared and the Federal portion of those remaining costs

will compete for funding from annual Investigations funding. If additional cost sharing is required, the FCSA will need to be amended..

5. Construction.

a. Public Law 115-123 provides $15,055,000,000 in Construction funding (Supplemental Construction funds) to address emergency situations at Corps of Engineers projects, and to construct, and to rehabilitate and repair damages caused by natural disasters to, Corps projects. Of that amount, $15,000,000,000 is available to construct flood and storm damage reduction projects in States and insular areas (territories) with more than one flood-related major disaster declared pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.) in calendar years 2014, 2015, 2016, or 2017. Thirty-three states and three territories meet the criteria and are listed in Enclosure 2. Additionally, not less than $10,425,000,000 of the $15,000,000,000 is available for projects within such States and insular areas (territories) that were also impacted by HHIM. The States and territories that meet the criteria and also were also impacted by HHIM are listed in Enclosure 3. Further, Public Law 115-123 provides that all repair, rehabilitation, study, design, and construction of Corps of Engineers projects in Puerto Rico and the United States Virgin Islands (USVI), using the Supplemental Construction funds, shall be conducted at full federal expense.

b. Within the lump sum Construction appropriation, $55,000,000 is available to repair to pre-storm condition Corps projects nation-wide that are under construction and that were damaged by natural disasters. This amount will be used only for damage repairs on projects not listed in the LDRIP for Construction (see paragraph 5.c.). Damage repairs include emergency dredging of shoaled material resulting from floods and storms. Projects receiving these repair funds are not limited to flood and coastal storm damage reduction projects. Funding will be distributed for the highest priority dredging and repairs based on risks and consequences. Repairs to damages not resulting from natural events are not eligible for this funding. Repairs funded from this amount in Puerto Rico and USVI will be undertaken at full federal expense. Other repairs funded from this amount will be cost shared normally. For projects included in LDRIP for Construction, repairs will be undertaken as part of construction of the project in accordance with paragraph 5.c., with cost sharing depending on whether construction of the project will be undertaken using Public Law 115-123 funds as "ongoing construction" or not "ongoing construction".

c. Long-term Flood and Storm Damage Reduction

(1) $15,000,000,000 of the Construction funds is for flood and storm damage reduction projects, including shore protection projects, in the States and territories listed in Enclosure 2. Of that amount, not less than $10,425,000,000 is for such projects in the HHIM-impacted States and territories listed in Enclosure 3. Only projects that are predominantly for flood and storm damage reduction are eligible for this funding; in addition, separable elements of such projects that are not for flood and storm damage reduction are not eligible for this funding.

(a) The flood and storm damage reduction projects eligible for the funding include: 1) currently authorized projects; 2) projects that are authorized in the future; 3) projects that have signed Chief's Reports as of February 9, 2018, but have not yet been

authorized; and 4) projects that are not yet authorized, but that were studied using funds provided in Public Law 115-123 under the "Investigations" heading. For the last two categories of projects (not yet authorized projects), the ASA(CW) must also find that the project is technically feasible, economically justified, and environmentally acceptable. For this purpose, the Chief's Report or the verification required under paragraph 4.d(4),will be submitted to this office to support such a determination. A project partially located in a State identified in Enclosure 2 or 3 and primarily benefitting that State is eligible to be considered for inclusion in the LDRIP for Construction.

(b) Enclosure 5, dated July 5, 2018, identifies the projects that will be funded with Supplemental Construction funds as part of the LDRIP. In accordance with paragraph 3, this list may be updated as necessary. Before Supplemental Construction funds may be used, any Federal Construction funds previously provided for the project, including funds carried into FY 2018, as well as funds provided in the FY 2018 workplan, will be used first, with work funded with non-Supplemental Construction funds remaining subject to cost sharing. In addition, the amount of Supplemental Construction funds that will be made available for each of the following projects will be reduced by the amount provided in the FY 2019 President's Budget for that project, with such amount subject to cost sharing: Herbert Hoover Dike, FL; Buffalo Bayou and Tributaries, TX; Lewisville Dam, TX; Isabella Lake, CA; Santa Anna River Mainstem, CA; Yuba River Basin, CA; and Bluestone Lake, WV. In the case of construction being performed by a non-Federal sponsor under an executed reimbursement PPA, costs eligible for reimbursement using Supplemental Construction funds are those costs incurred after February 9, 2018, i.e., when the obligation takes place, such as the date of award of a construction contract.

(c) Any costs of a locally preferred plan that are in excess of the cost of the National Economic Development Plan for a project remain the responsibility of the non-Federal sponsor, which must pay such costs during construction of the project.

(2) The LDRIP for Construction for long-term flood and coastal storm damage reduction will fund projects of the following types, leading to completion of the projects:

(a) New construction starts, with a commitment to the completion of the projects. New construction starts are projects that have never been funded in the Construction appropriation. Documentation supporting a new start decision includes the Chief's Report and the determination, if required, by the ASA(CW) that the project is technically feasible, economically justified, and environmentally acceptable. All work needed to complete that project, including engineering and design, will be funded in Construction.

(b) "Ongoing construction projects," with a commitment to the completion of the projects. An "ongoing construction project" includes all separable elements of that project.

(i) "Ongoing construction projects" include authorized Corps projects that have received Construction account appropriations (an initial work allowance from a Statement of Managers, work plan, or supplemental appropriation) in any of the previous three fiscal years (FY 2015, 2016, or 2017). A shore protection project that has received funding for initial construction, or for a cycle of periodic renourishment, in one of these fiscal years, is eligible for funding to complete that initial construction, or

that particular cycle of periodic renourishment, respectively, as an "ongoing construction project".

(ii) "Ongoing construction projects" also include authorized projects with an executed agreement providing for non-Federal sponsor construction, with potential reimbursement (such as section 211 for flood damage reduction or section 206 for shore protection), if the project was under construction during FY 2015, 2016, or 2017, even if no reimbursements have been provided previously for the project. It also includes a cycle of periodic renourishment to be completed prior to the end of calendar year 2020 for a project that is under construction by the non-federal sponsor during one of these fiscal years as eligible for reimbursement as an "ongoing construction project".

(iii) "Construction account appropriations for monitoring of the performance of renourishments do not count as appropriations for physical construction.

(iv) Of the projects listed in the LDRIP for Construction, Enclosure 5 identifies those projects that meet the requirements to be considered an "ongoing construction project". This list will be revised or updated as needed.

(c) Other projects that were funded in the Construction appropriation previously but that are not "ongoing construction projects," with a commitment to completion of the projects. If the latest economic update was not within five years, the district with responsibility should use available or reprogrammed funds to perform an economic update, then submit the project for consideration for Supplemental Construction funding. Existing policy on cost certification also should be followed.

(3) Cost Sharing and Real Estate Requirements - Ongoing Construction Projects, and Projects in Puerto Rico and USVI. Public Law 115-123 provides that the completion of "ongoing construction projects" and all repair, rehabilitation, study, design, and construction of Corps of Engineers projects in Puerto Rico and USVI, using Construction funding provided in Public Law 115-123, shall be conducted at full Federal expense.

(a) The non-Federal sponsors remain responsible for the provision of lands, easements, and rights-of-way (LER). Subject to the availability of Public Law 115-123 funds and the following conditions, the value of LER acquired by the non-Federal sponsors for work that will be performed at full Federal expense will be eligible for reimbursement by the Government. For a project with an existing Project Partnership Agreement (PPA), the Corps will reimburse non-Federal sponsors for the value of LER acquired from private owners after the date of execution of an amendment to the PPA providing for completion of construction at full Federal expense. For a project for which no PPA has been executed, the Corps will reimburse non-federal sponsors for the value of required LER acquired from private owners after the date of execution of the PPA.

(b) As discussed in paragraph 5c3(a), the non-Federal sponsors remain responsible for the provision of LER. If any acquisition assistance is requested by the non-Federal sponsor, the District will promptly notify HQUSACE (including the RIT and CEMP-CR) of the request. Acceptance of requests will be at the sole discretion of the Corps and reviewed and processed in accordance with the procedure outlined in ER 405-1-12, para.,12-34. A non-Federal sponsor must formally request assistance in writing no later than 30 calendar days after the Corps provides the non-Federal sponsor with

written descriptions of the real property interests required for a project. Under no circumstances will the Corps agree to acquire any real property interest on behalf of a non-Federal sponsor if the non-Federal sponsor has initiated negotiations with the owner of the real property interest.

(c) Among other requirements of Sections 210 and 305 of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4630 and 4655), non-Federal sponsors must observe the land acquisition policies in Section 4651 of Title 42 of the U.S. Code when acquiring real property interests. These policies include, but are not limited to, appraising real property interests before initiating negotiations with landowners, offering an amount no less than the appraised value as just compensation, not requiring landowners to surrender possession of real property interests before paying the agreed upon purchase price or depositing with the court an amount not less than the approved appraised value, not taking any coercive actions to compel an agreement on the price to be paid for real property interests, and instituting formal condemnation proceedings in the event real property interests are to be acquired by exercise of the power of eminent domain.

(4) Cost Sharing and Real Estate Requirements - Projects Outside of Puerto Rico and USVI That Are Not "Ongoing Construction Projects," including new starts and projects that had previously received Construction funds but did not receive Federal funds in FY 2015, 2016, or 2017.

(a) For projects that are neither "ongoing construction projects" nor located in Puerto Rico or the USVI, normal cost sharing applies, except that the non-Federal sponsor may, but is not required to, finance its cash contribution, including the 5 percent cash contribution for flood damage reduction projects, for costs funded by Public Law 115-123 for up to 30 years after completion of the project in accordance with Section 103(k) of WRDA 1986. The financing provisions apply only to the work that is undertaken with Supplemental Construction funds, and do not apply, for instance, to future periodic renourishments that are not funded with these funds.

(b) For such projects, the non-Federal sponsors remain responsible for the provision of LER and utility/facility relocations. The value of the LER acquired from private owners after the date of PPA execution and utility/facility relocations provided by the non-Federal sponsor will be credited towards the non-Federal share of project costs in accordance with the terms of the PPA.

(c) As discussed in paragraph 5c4(b), the non-Federal sponsors remain responsible for the provision of LER and performance of utility/facility relocations. If any acquisition assistance is requested by the non-Federal sponsor, the District will promptly notify HQUSACE (including the RIT and CEMP-CR) of the request. Acceptance of requests will be at the sole discretion of the Corps and reviewed and processed in accordance with the procedure outlined in ER 405-1-12, para.,12-34. A non-Federal sponsor must formally request assistance in writing no later than 30 calendar days after the Corps provides the non-Federal sponsor with written descriptions of the real property interests required for a project. Under no circumstances will the Corps agree to acquire any real property interest on behalf of a non-Federal sponsor if the non-Federal sponsor has initiated negotiations with the owner of the real property interest.

(d) Among other requirements of Sections 210 and 305 of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4630 and 4655), non-federal sponsors must observe the land acquisition policies in Section 4651 of Title 42 of the U.S. Code when acquiring real property interests. These policies include, but are not limited to, appraising real property interests before initiating negotiations with landowners, offering an amount no less than the appraised value as just compensation, not requiring landowners to surrender possession of real property interests before paying the agreed upon purchase price or depositing with the court an amount not less than the approved appraised value, not taking any coercive actions to compel an agreement on the price to be paid for real property interests, and instituting formal condemnation proceedings in the event real property interests are to be acquired by exercise of the power of eminent domain.

(5) The non-Federal sponsor is responsible for the costs of cleanup and response to hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (42 U.S.C. 9601-9675), that exist in, on, or under any of the real property interests required for construction, operation, maintenance, repair, replacement, and rehabilitation of a project. Such costs shall be paid solely by the non-Federal sponsor without reimbursement or credit by the Government.

(6) Public Law 115-123 did not change the responsibilities for operation, maintenance, repair, replacement, and rehabilitation (OMRR&R). Non-Federal sponsors remain responsible for all costs of OMRR&R.

(7) The provisions of section 902 of the Water Resources Development Act of 1986 do not apply to the Public Law 115-123 funding, and therefore, these funds are not included in calculating the total project cost to be compared to the section 902 limit for a project.

(8) Project Partnership Agreements and Amendments.

(a) No separate design agreement is required for projects included in the approved LDRIP for Construction. Once a project is included in the approved Construction Investment Plan, except as provided in paragraph 5.c.(1)(b) regarding use of previously provided Federal funds, Supplemental Construction funding may be used, at full Federal financing, for engineering and design, as well as for negotiation and processing of the PPA or PPA amendment, as applicable. However, the PPA or PPA amendment should be executed as soon as possible and in all cases must be executed prior to solicitation of the first construction contract using Public Law 115-123 Construction funds. All costs funded with Supplemental Construction funds will be included in total project costs and cost shared and / or financed in accordance with the applicable PPA or PPA amendment.

(b) For a project or separable element with an existing PPA, an interim accounting and cost share balancing will be undertaken to ensure that any regular funding, i.e., any funding other than Supplemental Construction funding provided for the project, is appropriately cost shared.

(c) HQUSACE will work with my office to develop basic model PPAs and PPA

Amendments. Once these basic models are approved, HQUSACE may approve non-substantial variations to such models based on experience as well as specific requirements associated with projects. In addition, HQUSACE may delegate to the Division Commander authority to approve use of a model PPA or PPA amendment, or a PPA or PPA Amendment with variations approved by HQUSACE. In addition, authority to execute a PPA or PPA amendment, once approved, may be delegated to the District Commander.

(9) Separate guidance will be developed to address a non-Federal sponsor request for Supplemental Construction funds to implement a project utilizing Section 1043 of the Water Resources Development Act of 2014.

(10) Continuing Authorities Program (CAP) Projects. Up to $50,000,000 of the $15,000,000,000 in Construction funds is available for Continuing Authority Program (CAP) projects for flood and storm damage reduction. Consistent with delegation of the CAP, HQUSACE is authorized to determine which CAP projects will be funded by Public Law 115-123 in accordance with the following guidance.

(a) In general, an individual CAP project will be considered for completion as an "ongoing construction project" at full federal expense if the project received funding in FY 2015, 2016, or 2017 for the Design and Implementation (D&I) phase. In addition, study, design and construction of CAP projects in Puerto Rico and USVI using Public Law 115-123 funds will be undertaken at full Federal expense. For CAP projects in the Feasibility phase and CAP projects in the D&I phase that are neither "ongoing construction projects" nor located in Puerto Rico or USVI, the non-federal cash contribution may be financed in accordance with Section 103(k) of WRDA 1986.

(b) Public Law 115-123 funding is included in calculating the Federal per-project limit for a project. Public Law 115-123 did not modify or waive the Federal per-project limits. D&I agreements will include the normal requirement that the non-Federal sponsor is responsible for any costs over the Federal per-project limit.

(c) For a discussion of converting a CAP project to an Investigations study, see paragraph 4.d.1.

6. Mississippi River and Tributaries.

a. Public Law 115-123 provided $770,000,000 to address emergency situations at Corps of Engineers projects, and to construct, and rehabilitate and repair damages to Corps of Engineers projects, caused by natural disasters. Normal cost sharing, if any, and non-federal sponsor responsibilities apply.

b. $400,000,000 is available to construct flood and storm damage reduction projects that were authorized as of the date of enactment of Public Law 115-123, and such projects that are authorized subsequently, once authorized. This funding may be used for feasibility studies leading to authorization and a construction decision, in which case Investigations guidance in paragraph 3 will be followed, as well as for engineering and design and construction, including rehabilitation costs normally funded from the Construction subdivision of the appropriation, in which case the Construction guidance in paragraph 4 will be followed. Channel improvement revetments and Mississippi River

levee construction was cleared on July 5, 2018 for mutiple authorized states.

c. $370,000,000 is available to address emergency situations at Corps of Engineers projects, and to construct, and rehabilitate and repair damages to Corps of Engineers projects, caused by natural disasters. Based on estimates provided to Appropriations Subcommittee staff, this amount is intended to be used for damage repairs only, including emergency dredging of shoaled material resulting from floods and storms. Funding will be distributed for the highest priority dredging and repairs based on risks and consequences. Dredging and repairs to damages not caused by natural events are not eligible for this funding.

7. Operation and Maintenance.

a. $608,000,000 is provided to dredge Federal navigation projects in response to, and repair damages to Corps of Engineers federal projects caused by, natural disasters. Dredging and repairs to damages not caused by natural events are not eligible for this funding. Funding will be distributed for the highest priority dredging and repairs based on risks and consequences.

b. This appropriation provides that such sums as are necessary to cover the Federal share of eligible operation and maintenance costs for coastal harbors and channels, and for inland harbors shall be derived from the Harbor Maintenance Trust Fund (HMTF). Care should be taken that the proper accounting codes are used to identify funding for costs eligible to be derived from the HMTF.

8. Expenses. $20,000,000 is provided to administer and oversee the obligation and expenditure of amounts provided in Public Law 115-123 for the Corps of Engineers. HQUSACE will distribute the funding based on Public Law 115-123 workload.

8. Funding of Studies and Projects.

a. Although the LDRIP reflects a commitment to complete all work leading to a construction decision and the LDRIP for Construction reflects a commitment to complete construction projects, funding will be provided to approved projects in increments based on need. This will help to avoid reprogramming difficulties in the event of cost savings, changes in non-Federal participation, or termination of project studies found to be no longer justified. Funding for CAP projects will also be incremental.

b. Repair and emergency dredging work funded in the Construction, Operation and Maintenance, and MR&Tappropriations will be funded in increments, for instance, once for plans and specifications and once for the contract. This will help to avoid reprogramming difficulties in the event of cost savings or if higher priority repair and dredging work arises.

c. Expenses funding will be distributed based on the underlying Public Law 115-123 workload.

R. D. James
Assistant Secretary of the Army
(Civil Works)

Encls

TITLE IV

CORPS OF ENGINEERS--CIVIL

DEPARTMENT OF THE ARMY

Investigations

For an additional amount for ``Investigations" for necessary expenses related to the completion, or initiation and completion, of flood and storm damage reduction, including shore protection, studies which are currently authorized or which are authorized after the date of enactment of this subdivision, to reduce risk from future floods and hurricanes, at full Federal expense, $135,000,000, to remain available until expended: Provided, That of such amount, not less than $75,000,000 is available for such studies in States and insular areas that were impacted by Hurricanes Harvey, Irma, and Maria: Provided further, That funds made available under this heading shall be for high-priority studies of projects in States and insular areas with more than one flood-related major disaster declared pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.) in calendar years 2014, 2015, 2016, or 2017: Provided further, That such amount is designated by the Congress as being for an emergency requirement pursuant to section 251(b)(2)(A)(i) of the Balanced Budget and Emergency Deficit Control Act of 1985: Provided further, That the Assistant Secretary of the Army for Civil Works shall provide a monthly report to the Committees on Appropriations of the House of Representatives and the Senate detailing the allocation and obligation of these funds, including new studies selected to be initiated using funds provided under this heading, beginning not later than 60 days after the enactment of this subdivision.

Construction

For an additional amount for ``Construction" for necessary expenses to address emergency situations at Corps of Engineers projects, and to construct, and rehabilitate and repair damages caused by natural disasters, to Corps of Engineers projects, $15,055,000,000, to remain available until expended: Provided, That of such amount, $15,000,000,000 is available to construct flood and storm damage reduction, including shore protection, projects which are currently authorized or which are authorized after the date of enactment of this subdivision, and flood and storm damage reduction, including shore protection, projects which have signed Chief's Reports as of the date of enactment of this subdivision or which are studied using funds provided under the heading ``Investigations" if the Secretary determines such projects to be technically feasible, economically justified, and environmentally acceptable, in States and insular

areas with more than one flood-related major disaster declared pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.) in calendar years 2014, 2015, 2016, or 2017: Provided further, That of the amounts in the preceding proviso, not less than $10,425,000,000 shall be available for such projects within States and insular areas that were impacted by Hurricanes Harvey, Irma, and Maria: Provided further, That all repair, rehabilitation, study, design, and construction of Corps of Engineers projects in Puerto Rico and the United States Virgin Islands, using funds provided under this heading, shall be conducted at full Federal expense: Provided further, That for projects receiving funding under this heading, the provisions of section 902 of the Water Resources Development Act of 1986 shall not apply to these funds: Provided further, That the completion of ongoing construction projects receiving funds provided under this heading shall be at full Federal expense with respect to such funds: Provided further, That using funds provided under this heading, the non-Federal cash contribution for projects eligible for funding pursuant to the first proviso shall be financed in accordance with the provisions of section 103(k) of Public Law 99-662 over a period of 30 years from the date of completion of the project or separable element: Provided further, That up to $50,000,000 of the funds made available under this heading shall be used for continuing authorities projects to reduce the risk of flooding and storm damage: Provided further, That any projects using funds appropriated under this heading shall be initiated only after non-Federal interests have entered into binding agreements with the Secretary requiring, where applicable, the non-Federal interests to pay 100 percent of the operation, maintenance, repair, replacement, and rehabilitation costs of the project and to hold and save the United States free from damages due to the construction or operation and maintenance of the project, except for damages due to the fault or negligence of the United States or its contractors: Provided further, That such amount is designated by the Congress as being for an emergency requirement pursuant to section 251(b)(2)(A)(i) of the Balanced Budget and Emergency Deficit Control Act of 1985: Provided further, That the Assistant Secretary of the Army for Civil Works shall provide a monthly report to the Committees on Appropriations of the House of Representatives and the Senate detailing the allocation and obligation of these funds, beginning not later than 60 days after the enactment of this subdivision.

Mississippi River and Tributaries

For an additional amount for ``Mississippi River and Tributaries" for necessary expenses to address emergency situations at Corps of Engineers projects, and to construct, and rehabilitate and repair damages to Corps of Engineers projects, caused by natural disasters, $770,000,000, to remain available until expended: Provided, That of such amount, $400,000,000 is available to construct flood and storm damage reduction projects which are currently authorized or which are authorized after the date of enactment of this subdivision: Provided further, That such amount is designated by the Congress as being for an emergency requirement pursuant to section 251(b)(2)(A)(i) of the Balanced Budget and Emergency Deficit Control Act of 1985: Provided further, That the Assistant Secretary of the Army for Civil Works shall provide a monthly report to the Committees on Appropriations of the House of Representatives and the Senate detailing the allocation and obligation of these funds, beginning not later than 60 days after the enactment of this subdivision.

Operation and Maintenance

For an additional amount for ``Operation and Maintenance" for necessary expenses to dredge Federal navigation projects in response to, and repair damages to Corps of Engineers Federal projects caused by, natural disasters, $608,000,000, to remain available until expended, of which such sums as are necessary to cover the Federal share of eligible operation and maintenance costs for coastal harbors and channels, and for inland harbors shall be derived from the Harbor Maintenance Trust Fund: Provided, That such amount is designated by the Congress as being for an emergency requirement pursuant to section 251(b)(2)(A)(i) of the Balanced Budget and Emergency Deficit Control Act of 1985: Provided further, That the Assistant Secretary of the Army for Civil Works shall provide a monthly report to the Committees on Appropriations of the House of Representatives and the Senate detailing the allocation and obligation of these funds, beginning not later than 60 days after the enactment of this subdivision.

Flood Control and Coastal Emergencies

For an additional amount for ``Flood Control and Coastal Emergencies", as authorized by section 5 of the Act of August 18, 1941 (33 U.S.C. 701), for necessary expenses to prepare for flood, hurricane and other natural disasters and support emergency operations, repairs, and other activities in response to such disasters, as authorized by law, $810,000,000, to remain available until expended: Provided, That funding utilized for authorized shore protection projects shall restore such projects to the full project profile at full Federal expense: Provided further, That such amount is designated by the Congress as being for an emergency requirement pursuant to section 251(b)(2)(A)(i) of the Balanced Budget and Emergency Deficit Control Act of 1985: Provided further, That the Assistant Secretary of the Army for Civil Works shall provide a monthly report to the Committees on Appropriations of the House of Representatives and the Senate detailing the allocation and obligation of these funds, beginning not later than 60 days after the enactment of this subdivision.

Expenses

For an additional amount for ``Expenses" for necessary expenses to administer and oversee the obligation and expenditure of amounts provided in this title for the Corps of Engineers, $20,000,000, to remain available until expended: Provided, That such amount is designated by the Congress as being for an emergency requirement pursuant to section 251(b)(2)(A)(i) of the Balanced Budget and Emergency Deficit Control Act of 1985: Provided further, That the Assistant Secretary of the Army for Civil Works shall provide a monthly report to the Committees on Appropriations of the House of Representatives and the Senate detailing the allocation and obligation of these funds, beginning not later than 60 days after enactment of this subdivision.

GENERAL PROVISIONS--THIS TITLE

Sec. 20401. In fiscal year 2018, and each fiscal year thereafter, the Chief of Engineers of the U.S. Army Corps of Engineers shall transmit to the Congress, after reasonable opportunity for comment, but without change, by the Assistant Secretary of the Army for Civil Works, a monthly report, the first of which shall be transmitted to Congress not later than 2 days after the date of enactment of this subdivision and monthly thereafter,

which includes detailed estimates of damages to each Corps of Engineers project, caused by natural disasters or otherwise.

Sec. 20402. From the unobligated balances of amounts made available to the U.S. Army Corps of Engineers, $518,900,000 under the heading ``Corps of Engineers--Civil, Flood Control and Coastal Emergencies" and $210,000,000 under the heading ``Corps of Engineers--Civil, Operations and Maintenance" in title X of the Disaster Relief Appropriations Act, 2013 (Public Law 113-2; 127 Stat. 25) shall be transferred to ``Corps of Engineers--Civil, Construction", to remain available until expended, to rehabilitate, repair and construct Corps of Engineers projects: Provided, That those projects may only include construction expenses, including cost sharing, as described under the heading ``Corps of Engineers--Civil, Construction" in title X of that Act or other construction expenses related to the consequences of Hurricane Sandy: Provided further, That amounts transferred pursuant to this section that were previously designated by the Congress as an emergency requirement pursuant to the Balanced Budget and Emergency Deficit Control Act are designated by the Congress as an emergency requirement pursuant to section 251(b)(2)(A)(i) of the Balanced Budget and Emergency Deficit Control Act of 1985: Provided further, That the Assistant Secretary of the Army for Civil Works shall provide a monthly report to the Committees on Appropriations of the House of Representatives and the Senate detailing the allocation and obligation of these funds, beginning not later than 60 days after the enactment of this subdivision.

States and Territories with More than One Flood-Related Major Disaster Declaration in Calendar Years 2014, 2015, 2016, or 2017

Alabama
Alaska
Arkansas
California
Florida
Georgia
Guam
Hawaii
Idaho
Iowa
Kansas
Kentucky
Louisiana
Michigan
Minnesota
Mississippi
Missouri
Montana
Nebraska
New Mexico
Nevada
New York
North Dakota
Oklahoma
Oregon
Puerto Rico
South Carolina
South Dakota
Tennessee
Texas
U.S. Virgin Islands
Vermont
Washington
Wisconsin
West Virginia
Wyoming

Enclosure 2

States and Territories with More than One Flood-Related Major Disaster Declaration in Calendar Years 2014, 2015, 2016, or 2017 That Were Impacted by Hurricanes Harvey, Irma, and Maria

Florida
Georgia
Louisiana
Puerto Rico
South Carolina
Texas
U.S. Virgin Islands

Bipartisan Budget Act of 2018 (Public Law 115-123)	
Long Term Disaster Recovery Investment Plan	
Investigations Account	
As of July 5, 2018	
STUDY NAME	**STATE**
Selma, AL	AL
Valley Creek, AL	AL
LA County Flood Control System, CA	CA
Westminster (East Garden Grove) Watershed, CA	CA
Collier County Beach Erosion Control, FL	FL
Dade County, FL	FL
Miami Back Bay, FL	FL
Monroe County, FL	FL
Okaloosa County, FL	FL
Pinellas County, FL	FL
South Atlantic Coastal Study, FL, PR & USVI	FL, PR, USVI
Proctor, Fulton County, GA	GA
Metro Louisville Flood Protection System, KY	KY
Amite River & Tributaries East of the Mississippi River, LA	LA
Lake Pontchartrain and Vicinity, LA (General Reevaluation Report)	LA
South Central Coast, LA	LA
Upper Barataria Basin, LA	LA
West Bank and Vicinity, New Orleans, LA (General Reevaluation Report)	LA
Nassau County Back Bays, NY	NY
Tulsa West Tulsa Levees, OK	OK
Portland Metro Levee System, OR	OR
Puerto Rico Study, PR	PR
Rio Culebrinas, PR	PR
Rio Grande de Manati, PR (Ciales)	PR
Rio Guayanilla, PR	PR
San Juan Metro Area Study, PR	PR
Charleston Peninsula, SC	SC
Folly Beach, SC	SC
Memphis Wolf River Backwater Levee System, TN	TN
Brazos River, Fort Bend County, TX	TX
Buffalo Bayou and Tributaries Resiliency Study, TX	TX
Coastal Texas Protection and Restoration Study, TX	TX
Houston Regional Watershed Assessment, TX	TX
Guadalupe and San Antonio River Basins, TX	TX
Savan Gut Phase II, St. Thomas, USVI	USVI
Turpentine Run, St. Thomas, USVI	USVI
Upper Connecticut River, VT	VT
Mill Creek, Walla Walla County, WA	WA

Enclosure 4

Bipartisan Budget Act of 2018 (Public Law 115-123)		
Long Term Disaster Recovery Investment Plan		
Construction Account		
Cleared/Public Release Date - July 5, 2018		
PROJECT NAME	STATE	Ongoing Construction Project (Y/N)
American River - Common Features, CA	CA	NO
American River Watershed (Folsom Dam Raise), CA	CA	YES
Isabella Lake, CA	CA	YES
Santa Ana River Mainstem, CA	CA	YES
South San Francisco Shoreline, CA	CA	NO
Tule River/Lake Success Enlargement (Success Dam), CA	CA	YES
Yuba River Basin, CA	CA	YES
Brevard County, FL	FL	YES
Broward County, FL	FL	YES
Dade County, FL	FL	YES
Duval County, FL	FL	YES
Flagler County, FL	FL	NO
Herbert Hoover Dike, FL	FL	YES
Lee County, FL	FL	YES
Manatee County, FL	FL	YES
Nassau County, FL	FL	YES
Palm Beach County (Mid-Town Beach Segment), FL	FL	NO
Palm Beach County, FL	FL	YES
Sarasota County (Venice), FL	FL	YES
St John's County, FL	FL	YES
St Lucie County (South Segment), FL	FL	YES
St. John's County (Villano Segment), FL	FL	YES
Tybee Island, GA	GA	YES
Ala Wai Canal, Oahu, HI	HI	NO
Cedar River, Cedar Rapids , IA	IA	NO
Kansas Citys, KS & MO **	KS & MO	YES
Amourdale, KS & MO **	KS & MO	NO
Section 202 (Johnson County), KY	KY	YES
Section 202 (Town of Martin), KY	KY	YES
Comite River, LA	LA	YES
East Baton Rouge Flood Control, LA	LA	NO
Grande Isle, LA	LA	NO
West Shore, Lake Pontchartrain, LA	LA	NO
Bois Brule, MO	MO	YES
Alamogordo, NM	NM	YES
Rio de La Plata, PR	PR	YES
Rio Grande de Arecibo, PR	PR	YES
Rio Grande de Loiza, PR	PR	NO
Rio Guanajibo at Mayaguez, PR	PR	NO
Rio Nigua at Salinas, PR	PR	NO
Rio Puerto Nuevo, PR	PR	YES
Colleton County (Edisto Island), SC	SC	NO
Folly Beach, SC	SC	YES
Pawleys Island, SC	SC	NO
Mill (Seven Mile) Creek, TN	TN	NO
Brays Bayou, TX	TX	YES
Buffalo Bayou and Tributaries, TX	TX	YES
Clear Creek, TX	TX	NO
Dallas Floodway Extension, TX	TX	YES
Dallas Floodway, TX	TX	NO
Hunting Bayou, TX	TX	YES
Lewisville Dam, TX	TX	YES
Lower Colorado River Phase 1 (Wharton), TX	TX	YES
Sabine Pass to Galveston Bay, TX	TX	NO
White Oak Bayou, TX	TX	YES
Bluestone Lake, WV	WV	YES
Lower Mud River, Milton, WV	WV	NO
Section 202 (McDowell County), WV	WV	YES
** Original cleared as one project; split into two projects based upon separate authorizations		

Enclosure 5

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
P.O. BOX 59
LOUISVILLE, KENTUCKY 40201-0059

REPLY TO
ATTENTION OF:

CELRL-PMC-PL

MEMORANDUM FOR RECORD

SUBJECT: Metropolitan Louisville LFP, KY Supplemental Feasibility Study – Alternative Milestone Briefing

1. The Louisville District (LRL) conducted an Alternatives Milestone Meeting (AMM) Briefing with the Great Lakes and Ohio River Division (LRD) and vertical team on 28 February 2019.

2. A read ahead package was provided to the Great Lakes and Ohio River Division (LRD) on 21 February 2019.

3. Participants in the meeting included the following individuals:
    a. LRD –Noel Clay (PL), Hank Jarboe (PL), Ryan Albrecht (OC), Zafar Hyder (WM), Phil Tilly (DSPM), Don Johantges (PG). Phil Johnson (PG), Ron Sadri (PL), Mark Hammond (PL), Phil Johnson (PM), (RE), Ryan Jeffries (BTD), Dan Linkowski (PL), Jacob Nienaber (ED), LTC Aaron Hill
    b. LRL – Amy Babey (PL), Barry Schueler (PM), Nate Moulder (PL), Matt Whelan (ED), Dan Vogler (PL), Ken Meffert (PL), Sarah Mattingly (PL), Roger Setters (PL), Matt Schueler (PM), Drew Russell (PL), Jared Barrett (PL), Allison Guzman (PL), Jason Meyer (RE), Jake Allgeier (ED), Trey Richardson (OC), John Bock (ED), Sharon Bond (PL), Juan Emmanuel Afable (ED), Adam Connelly (ED), Mark Robertson (ED), Keenan Burns (ED), Jay Thomas (ED), Richard Morrison (ED), Adam Connelly (ED)
    c. FRM PCX -Karen Miller, Nick Applegate,
    d. HQS – Janet Cote (RIT), Mark Matusiak (OWPR)
    e. Sponsor – Wolffie Miller, Stephanie Laughlin, Brian Bingham, John Loechle, Dane Anderson, Marc Thomas

4. LRL welcomed group and stated intent of meeting was to seek concurrence on the alternatives array and the proposed path to the Tentatively Selected Plan (TSP) as well as validation as use of the 2005 Reconstruction Guidance.

5. LRL PM, PEA, and Lead Planner provided a summary of the project site description and history including history of flood conditions.

6. LRL PDT presented as series of base structural measures considered associated with reconstruction of floodwalls, closure structure, levees, and pumps as well as measures considered associated with pump capacity increases. The PDT outlined which measures

should be screened and summarized the alternatives generated from the measures carried forward.

7. LRL PDT recommended concurrence with the application of the 2005 Reconstruction Guidance, approval of the alternatives array outlined during the AMM, and continuation of the feasibility study toward the TSP milestone.

8. LRD concurred with the alternatives array, the proposed path to the TSP, the District's application of the 2005 Reconstruction Guidance, and continuation of the feasibility study.

9. Any questions regarding this submittal should be directed to Nate Moulder, Lead Planner at 502.315.6776 or nathan.a.moulder@usace.army.mil

AMY S. BABEY
Chief, Civil Works -
Planning, Programs, and Project
Management Branch

NOEL C. CLAY
Chief, Planning and Policy Division
Great Lakes and Ohio River
Division

Notes and Q&A

- 15 of the 16 pump stations in the system were federally constructed. The system also includes approximately 21 miles of levee, 4 miles of floodwall, 79 closure structures and 152 gates. 1964 was largest flood experienced. 1997 was largest flood experienced with both reaches in place. The system has performed well from Ohio River flooding.
- PROBLEMS: Key performance issues related to interior drainage include: 1) out of date pumps and failing equipment at pump stations, and 2) the system's ability to convey current and future interior drainage. Some of the system components that have exceeded their expected service life include 1) closure structures at 27th and 10th streets, and 2) floodwall segments at Canal Street and Butchertown (all are located in the Louisville Reach of the system).
- FRM-PCX requested more feedback and explanation of the extent of flooding due to pump station failure. They also suggested the PDT massage problem statements as we move forward – each pump station has varied consequences – Beargrass Creek failure results in flooding of a large urban area. LRL PEA presented the Semi-Quantitative Risk Assessment (SQRA), which included a failure mode associated with a pump station failure.
- FRM PCX recommended updating the problem statement to document some of the specific consequences of the listed problems – life loss and structure damages – work with PCX on this comment.
- Explanation of preliminary SQRA results was used to help explain the likelihood and consequence of the six risk driving failure modes. Total Risk is plotted as cumulative risk of the six risk drivers. Total Risk plotted above the USACE Levee Safety (LS) Societal Risk Line with Breach from Overtopping and I-Wall failure at Pond Creek Pump Station being the leading risk drivers. Loss of 50% of the Beargrass Creek Pump Station pumping capacity during a 100 yr. rainfall event plotted on the LS Societal Risk Line.
- LRD Planning asked if the SQRA was based on present day rainfall and does not include climate change. LRL staff confirmed that stated SQRA was based on a present snapshot in time.
- OPPORTUNITIES, OBJECTIVES and CONSTRAINTS were stated. LRD asked if changed conditions were used in Plan Formulation. PDT stated land use, rainfall, pump and floodwall conditions, hydrology (due to Corps-constructed reservoirs), climate change variables, and design standards. LRD OC asked that we verify the changed conditions used are reflecting the implementing authority (Section 216).
- Structural and non-structural measures were stated along with screening and screening criteria. LRD PL asked for clarification on local planning objectives. Eight structural measures were carried forward and three were screened. Three non-structural measures were screened and three carried forward.

- Initial array of alternatives – 10 alternatives with pump capacity increase and 4 with no pump capacity increase, including no action resulted in 15 alternatives. 5 alternatives were initially screened with three remaining to be screened with a sensitivity analysis. FRM-PCX asked for elaboration on screening for completeness for alternatives 2,3,7,8, and 9. PDT answered that those alternatives did not include all necessary measures to achieve the Objectives (completeness criteria). For example, Alternatives 2 and 3 would need to consider both Structural and Electrical/Mechanical repairs at pump stations in order to fully restore the system performance (Objective #1). The PDT will work with PCX to flesh this discussion out in draft report.
- Focused Array of Measures were presented with capacity and no capacity increase. LRD asked for clarification on Alternative E. The PDT explained sensitivity runs will be used to pick the most efficient version of alternatives.
- Sensitivity analysis will also be used to choose if a potential betterment may be available for non-federal sponsor.
- FRM-PCX asked which pumps are under consideration for pump capacity increases. PDT answered that the sensitivity analysis is being applied to determine which pump station will undergo further evaluation. The initial list of pump stations that will undergo the sensitivity analysis were identified by the non-federal sponsor.
- FRM-PCX asked if annual benefit data could be used to screen alternatives to help optimize additional data collection needed to validate and choose best performing alternative. The PDT clarified that annual benefits for the system are only being used for evaluation of repair recommendations that do not include a capacity increase at pump stations.
- Key assumptions were shared: BCR will only be calculated on system basis, incremental analysis will only be applied to potential pumping capacity increase, study limited to existing protected area footprint.
- FRM-PCX asked if a sensitivity analysis is still part of the PDT's strategy to identify potential capacity increases. The PDT confirmed and explained that if a potential increase is identified, reductions in damages will then be evaluated at individual pump stations using current structure inventories from HAZUS.
- The PDT also clarified that they are spot-checking the original (1962) depth/damage curve for the overall system which is used to calculate the annual benefits reported to Congress. LRD concurred.
- LRD asked for a clarification of incremental analysis. PDT explained using existing depth damage curves with annual benefits as sensitivity analysis. LRL PDT stated if it shows up in the sensitivity analysis, a more detailed analysis will be conducted. LRD ED asked if the sensitivity analysis is intended to evaluate if the damage curve shifts in response to increased capacity (reducing stages and increasing benefits increase). LRL PDT confirmed that that was correct.

- Non certified model (Infoworks) is being coordinated with FRM-PCX for one time use. The damage evaluation for in-line pump stations does not follow typical Corps evaluation procedures. Alternative evaluation using OSE/RED, Incorporation of Climate Change forecasts, further incorporation of SQRA recommendations were also identified as Key Risks and Uncertainties.
- The study schedule was presented and the PDT is on track. It was noted that the schedule is tight and has very little float. If a capacity increase is identified at any pump stations, an IPR will be scheduled on the evaluation criteria.
- Vertical team concurrence is sought for Focused Array, concurrence on path to TSP, successful completion of AMM, and concurrence on the District's application of the 2005 Reconstruction Guidance.
- LRD asked about the timing of the IPR on the sensitivity analysis. PDT stated it should be scheduled in early April. There will be subsequent IPRs prior to the TSP.
- LRD PL asked when the SQRA will be completed. PDT stated the project will go to LSOG in August – October 2019 time frame.
- LRD PL asked when the next IPR will be and LRL PDT responded that it would likely be in April.
- LRD PL asked if Review Plan and PMP are generated. LRL PM stated that documents are currently under PDT review.
- LRL PDT asked if LRD concurs with Focused Array and concurrence with successful AMM. LRD Chief of Planning and Policy concurs and agrees with path to TSP and successful implementation of 2005 guidance.
- LRD PL asked if there are time/cost savings in the schedule or budget to ensure successful completion. PDT stated there are no savings to be sought as scheduled is already compressed to two years, but that the PDT would continue to explore.

Public Law 90-483

AN ACT

August 13, 1968
[S. 3710]

Authorizing the construction, repair, and preservation of certain public works on rivers and harbors for navigation, flood control, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

TITLE I—RIVERS AND HARBORS

River and Harbor Act of 1968.

SEC. 101. That the following works of improvement of rivers and harbors and other waterways for navigation, flood control, and other purposes are hereby adopted and authorized to be prosecuted under the direction of the Secretary of the Army and supervision of the Chief of Engineers, in accordance with the plans and subject to the conditions recommended by the Chief of Engineers in the respective reports hereinafter designated. The provisions of section 1 of the River and Harbor Act approved March 2, 1945 (Public Law Numbered 14, Seventy-ninth Congress, first session), shall govern with respect to projects authorized in this title; and the procedures therein set forth with respect to plans, proposals, or reports for works of improvement for navigation or flood control and for irrigation and purposes incidental thereto, shall apply as if herein set forth in full.

59 Stat. 10.

NAVIGATION

Ipswich River, Massachusetts: House Document Numbered 265, Ninetieth Congress, at an estimated cost of $616,000;

Fall River Harbor, Massachusetts and Rhode Island: House Document Numbered 175, Ninetieth Congress, at an estimated cost of $8,762,000;

Bristol Harbor, Rhode Island: House Document Numbered 174, Ninetieth Congress, at an estimated cost of $873,000;

Port Jefferson Harbor, New York: House Document Numbered 277, Ninetieth Congress, at an estimated cost of $2,455,000;

Hempstead Harbor, New York: House Document Numbered 101, Ninetieth Congress, at an estimated cost of $703,000;

Cooper River, Charleston Harbor, South Carolina: Senate Document Numbered 88, Ninetieth Congress, at an estimated cost of $35,381,000;

Miami Harbor, Florida: Senate Document Numbered 93, Ninetieth Congress, at an estimated cost of $6,476,000;

Gulf Intracoastal Waterway, St. Marks to Tampa Bay, Florida: Chief of Engineers' Report dated June 6, 1968, except that (1) not to exceed $40,000,000 is authorized for initiation of such project, and (2) construction of this project shall not be initiated until such plan is approved by the Secretary of the Army and the President;

Atchafalaya River and Bayous Chene, Boeuf, and Black, Louisiana: House Document Numbered 155, Ninetieth Congress, at an estimated cost of $8,645,000;

Red River Waterway, Louisiana, Texas, Arkansas, and Oklahoma: House Document Numbered 304, Ninetieth Congress, except that not to exceed $50,000,000 is authorized for initiation of such project;

Mississippi River-Gulf Outlet, Michoud Canal, Louisiana: Senate Document Numbered 97, Ninetieth Congress, at an estimated cost of $1,300,000;

Mississippi River Outlets, Venice, Louisiana: House Document Numbered 361, Ninetieth Congress, at an estimated cost of $4,520,000;

Yazoo River, Mississippi: House Document Numbered 342, Ninetieth Congress, at an estimated cost of $52,147,000;

Corpus Christi Ship Canal, Texas: Senate Document Numbered 99, Ninetieth Congress, at an estimated cost of $19,042,000;

Mouth of the Colorado River, Texas: Senate Document Numbered 102, Ninetieth Congress, at an estimated cost of $8,000,000;

Wilson Harbor, New York: House Document Numbered 112, Ninetieth Congress, at an estimated cost of $198,000;

Cattaraugus Creek Harbor, New York: House Document Numbered 97, Ninetieth Congress, at an estimated cost of $1,315,000;

Hamlin Beach State Park, New York: House Document Numbered 358, Ninetieth Congress, at an estimated cost of $500,000;

Forestville Harbor, Michigan: House Document Numbered 183, Ninetieth Congress, at an estimated cost of $538,000;

Tawas Bay Harbor, Michigan: House Document Numbered 189, Ninetieth Congress, at an estimated cost of $466,000;

Detroit River, Trenton Channel, Michigan: House Document Numbered 338, Ninetieth Congress, at an estimated cost of $31,300,000;

Snohomish River (Everett Harbor), Washington: House Document Numbered 357, Ninetieth Congress, at an estimated cost of $1,108,000;

Humboldt Harbor and Bay, California: House Document Numbered 330, Ninetieth Congress, at an estimated cost of $2,430,000;

Port Hueneme, California: House Document Numbered 362, at an estimated cost of $1,000,000;

Ventura Marina, California: House Document Numbered 356, at an estimated cost of $1,540,000;

San Diego Harbor, California: House Document Numbered 365, Ninetieth Congress, at an estimated cost of $5,360,000;

Kake Harbor, Alaska: Senate Document Numbered 70, Ninetieth Congress, at an estimated cost of $1,760,000;

King Cove Harbor, Alaska: Senate Document Numbered 13, Ninetieth Congress, at an estimated cost of $522,000;

Sergius and Whitestone Narrows, Alaska: Senate Document Numbered 95, Ninetieth Congress, at an estimated cost of $3,030,000;

Coasts of Hawaiian Islands, Harbors for Light Draft Vessels: House Document Numbered 353, Ninetieth Congress, at an estimated cost of $1,256,000.

BEACH EROSION

Brevard County, Florida: House Document Numbered 352, Ninetieth Congress, at an estimated cost of $680,000.

SEC. 102. The project for beach erosion control, Fort Pierce, Florida, authorized by the River and Harbor Act of 1965 (79 Stat. 1089, 1092) in accordance with the recommendations of the Chief of Engineers in House Document Numbered 84, Eighty-ninth Congress, is hereby modified to provide for construction of the project and periodic nourishment for ten years by the Secretary of the Army, acting through the Chief of Engineers. In addition to applicable requirements of local cooperation set forth in the aforementioned report of the Chief of Engineers, local interests shall, prior to construction, give assurances satisfactory to the Secretary of the Army that they will—

(1) contribute in cash, either in a lump sum prior to initiation of construction or in installments prior to the start of pertinent work items in accordance with construction or nourishment schedules, as determined by the Chief of Engineers, all costs of initial construction and periodic nourishment for ten years exclusive of costs assigned to the Federal Government in the aforementioned recommendations of the Chief of Engineers; and

(2) hold and save the United States free from damages due to the construction works.

Marmet, W. Va., conveyance.

SEC. 103. (a) That section 2 of the Act entitled "An Act authorizing the Secretary of War to sell and convey to the town of Marmet,

West Virginia, two tracts of land to be used for municipal purposes", approved July 8, 1942 (56 Stat. 651) is hereby amended by deleting the period after the words "related municipal purposes" and inserting thereafter the phrase "including firefighting facilities and structures".

(b) The Secretary of the Army is authorized and directed to issue to the town of Marmet, West Virginia, without monetary consideration therefor, such written instruments as may be necessary to carry out the provisions of this section.

State of West Virginia, conveyance.

SEC. 104. (a) That notwithstanding any other provision of law, the Secretary of the Army or his designee, is authorized and directed to convey to the State of West Virginia, subject to the terms and conditions hereinafter stated, and to such other terms and conditions as the Secretary of the Army, or his designee, shall deem to be in the public interest, all right, title, and interest of the United States in and to certain real property, together with improvements thereon, located at Ohio River locks and dams numbered 16, 19, 20, and 21 in West Virginia as described in subsection (b) of this section. No property shall be conveyed under authority of this section until these locks and dams have been determined by the Secretary to be in excess to the requirements of the Department of the Army and suitable replacement facilities are in operation under the Ohio River navigation modernization program. The Secretary may make such prior disposition of such facilities and improvements on such lands as he deems to be in the best interest of the United States.

(b) The real property authorized for conveyance by subsection (a) of this section comprise all or portions of such lands and improvements as may be determined excess of four lock and dam projects on the Ohio River in the State of West Virginia and designated as, number 16 (Willow Island Pool) in Tyler County, numbers 19 and 20 (Belleville Pool) in Wood County, and number 21 (Racine Pool) in Jackson County. The exact descriptions and acreage to be determined by the Secretary by accurate surveys, the cost of which is to be borne by the State of West Virginia.

Public use.

(c) The conveyance authorized herein shall provide that said property shall be used only for public park and recreation purposes and such other uses directly related to the programs of the West Virginia Department of Natural Resources, and if it ever ceases to be used for such purposes, title to said property shall immediately revert to the United States. Any deed of conveyance shall also be subject to and include the following additional terms and conditions:

Terms and conditions.

(1) The State of West Virginia shall pay the United States as consideration for the conveyance 50 per centum of the current fair market value of the property as determined by the Secretary of the Army.

(2) There shall be reserved to the United States such flowage easements and rights-of-way for roads and utility lines as the Secretary determines may be required for other navigation projects.

(3) Such other restrictions, terms, and conditions as the Secretary deems necessary to protect the interests of the United States.

(d) Any moneys paid for the conveyances referred to herein shall be covered into the United States Treasury as miscellaneous receipts.

Buffalo, N.Y., conveyance.

SEC. 105. (a) That the Secretary of the Army shall convey, without monetary consideration, to the city of Buffalo, New York, all right, title, and interest of the United States in and to certain real property underlying Lake Erie containing approximately 46.01 acres and more particularly described in subsection (b) of this section, on condition that such real property be used for public park and recreational development purposes and if such property shall ever cease to be used for such purposes, title thereto shall revert to the United States.

(b) The real property referred to in this section is more particularly described as follows:

(1) PARCEL E.—Beginning at the point of intersection of the south line of outer lot 39 prolonged and the shoreline of Lake Erie as established in 1846, which point bears south 68 degrees 28 minutes west, a distance of 140 feet, more or less, from United States Monument numbered 7, which monument is the southeasterly corner of the said outer lot 39;

thence southwesterly at right angles with the established harbor line 1,140 feet, more or less, to the said harbor line;

thence northwesterly along said harbor line, 1,310 feet, more or less, to the point of intersection of said harbor line and a line at right angles thereto passing through the point of intersection of the shoreline of Lake Erie in 1846 and a line 330 feet northerly at right angles from and parallel with the south line of outer lot 36;

thence northeasterly at right angles with said harbor line 1,115 feet, more or less, to the shoreline of Lake Erie in 1846;

thence southeasterly along said shoreline of Lake Erie 1,320 feet, more or less, to the point of beginning containing 34.04 acres, more or less.

(2) PARCEL C–B.—Beginning at the point of intersection of the shoreline of Lake Erie with the northerly line of land deeded to the United States Government, October 21, 1846, said line also extending in a due east and west direction and passing through the northwest corner of outer lot 36 (United States Monument No. 2), said point of beginning being also 480 feet, more or less, west of the said northwest corner of outer lot 36;

thence southeasterly along said shoreline of Lake Erie in 1846 a distance of 470 feet, more or less, to the intersection with a line 330 feet northerly at right angles from and parallel with the south line of lot 36, said line being also the north line of lands deeded to the United States Government, September 25, 1847;

thence southwesterly at right angles to established harbor line 1,115 feet, more or less, to the established harbor line;

thence northwesterly along said harbor line 465 feet, more or less, to the point of intersection of said harbor line and a line at right angles thereto passing through the point of intersection of the shoreline of Lake Erie in 1846 and the line extending in a due east and west direction and passing through the northwest corner of outer lot 36;

thence easterly at right angles to established harbor line 1,115 feet, more or less, to the shoreline of Lake Erie in 1846, which is the above referenced point of beginning, containing 11.97 acres, more or less.

(c) Any deed of conveyance made pursuant to this section shall reserve to the United States, for a period not to exceed seven years, the right to use such lands for a spoil disposal area for materials dredged from the Buffalo Harbor Project, including the right to place structures thereon and to perform all other actions incident to such use, together with the rights of ingress and egress thereto. Such deed shall contain such additional terms and conditions as may be determined by the Secretary of the Army to be necessary to protect the interest of the United States.

U.S. coastal areas, study and appraisal.

SEC. 106. (a) The Chief of Engineers, Department of the Army, under the direction of the Secretary of the Army, shall make an appraisal investigation and study, including a review of any previous relevant studies and reports, of the Atlantic, Gulf, and Pacific coasts of the United States, the coasts of Puerto Rico and the Virgin Islands, and the shorelines of the Great Lakes, including estuaries and bays thereof, for the purpose of (1) determining areas along such coasts

and shorelines where significant erosion occurs; (2) identifying those areas where erosion presents a serious problem because the rate of erosion, considered in conjunction with economic, industrial, recreational, agricultural, navigational, demographic, ecological, and other relevant factors, indicates that action to halt such erosion may be justified; (3) describing generally the most suitable type of remedial action for those areas that have a serious erosion problem; (4) providing preliminary cost estimates for such remedial action; (5) recommending priorities among the serious problem areas for action to stop erosion; (6) providing State and local authorities with information and recommendations to assist the creation and implementation of State and local coast and shoreline erosion programs; (7) developing recommended guidelines for land use regulation in coastal areas taking into consideration all relevant factors; and (8) identifying coastal areas where title uncertainty exists. The Secretary of the Army shall submit to the Congress as soon as practicable, but not later than three years after the date of enactment of this Act, the results of such appraisal investigation and study, together with his recommendations. The views of concerned local, State, and Federal authorities and interests will be taken into account in making such appraisal investigation and study.

Report to Congress.

(b) There are authorized to be appropriated such amounts, not to exceed $1,000,000, as may be necessary to carry out the provisions of this section.

Appropriation.

SEC. 107. That the projects for the Illinois Waterway and Grand Calumet River, Illinois and Indiana (Calumet-Sag navigation project), authorized by the River and Harbor Act of July 24, 1946, are hereby modified substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 45, Eighty-fifth Congress, insofar as such recommendations apply to existing highway bridges in Part II: Grand Calumet River and Indiana Harbor Canal, at an estimated cost of $33,265,000.

60 Stat. 634.

SEC. 108. (a) Steele Bayou, in Warren, Issaquena, Sharkey, and Washington Counties, Mississippi, Washington Bayou, in Issaquena and Washington Counties, Mississippi, and Lake Washington, in Washington County, Mississippi, are hereby declared to be nonnavigable within the meaning of the laws of the United States.

(b) The project for navigation on Steele Bayou, Washington Bayou, and Lake Washington, authorized by the Rivers and Harbors Acts of July 5, 1884, August 5, 1886, and June 25, 1910, is hereby deauthorized.

23 Stat. 133; 24 Stat. 310; 36 Stat. 630.

SEC. 109. Section 313 of the Act approved October 27, 1965 (79 Stat. 1073), is amended by deleting the date "June 30, 1968" and substituting in lieu thereof "June 30, 1969".

SEC. 110. The Secretary of the Army, acting through the Chief of Engineers, is authorized and directed to review the requirements of local cooperation for the Ouachita and Black Rivers navigation projects, authorized by the River and Harbor Act of 1950, as amended, with particular reference to Federal and non-Federal cost sharing, and he shall report the findings of such review to Congress within one year after the date of enactment of this Act.

Ouachita and Black Rivers.

64 Stat. 163.

Report to Congress.

SEC. 111. The Secretary of the Army, acting through the Chief of Engineers, is authorized to investigate, study, and construct projects for the prevention or mitigation of shore damages attributable to Federal navigation works. The cost of installing, operating, and maintaining such projects shall be borne entirely by the United States. No such project shall be constructed without specific authorization by Congress if the estimated first cost exceeds $1,000,000.

Shore damage prevention study.

SEC. 112. Section 111 of the River and Harbor Act of 1966 (80 Stat. 1417) is amended by adding at the end thereof the following:

Washington Channel, D.C., study.

"(g) The Secretary of the Interior shall conduct a study of those areas in the vicinity of the Washington Channel in the District of

Columbia suitable for public visitor parking facilities. Such study shall, among others, consider existing and future visitation, multiple and alternative areas, methods for providing such facilities, and estimated costs and revenues to be derived therefrom. Not later than one hundred and eighty days after the date funds are appropriated to carry out such study, the Secretary shall submit to the President and Congress a report thereon together with his recommendations, including necessary legislation, if any. There is authorized to be appropriated not to exceed $100,000 to carry out this subsection."

Report to President and Congress.

East and Hudson Rivers, N.Y.

SEC. 113. Those portions of the East and Hudson Rivers in New York County, State of New York, lying shoreward of a line within the United States Pierhead Line as it exists on the date of enactment of this Act, and bounded on the north by the north side of Spring Street extended westerly and the south side of Robert F. Wagner, Senior Place extended eastwardly, are hereby declared to be nonnavigable waters of the United States within the meaning of the laws of the United States. This declaration shall apply only to portions of the above-described area which are bulkheaded and filled. Plans for bulkheading and filling shall be approved by the Secretary of the Army, acting through the Chief of Engineers, on the basis of engineering studies to determine the location and structural stability of the bulkheading and filling in order to preserve and maintain the remaining navigable waterway. Local interests shall reimburse the Federal Government for any engineering costs incurred under this section.

Northern Embarcadero area, San Francisco, Calif.

SEC. 114. That portion of the Northern Embarcadero area, beginning at the intersection of the northwesterly line of Bryant Street with the southwesterly line of Spear Street, which intersection lies on the line of jurisdiction of the San Francisco Port Authority; following thence westerly and northerly along said line of jurisdiction as described in the State of California Harbor and Navigation Code Section 1770, as amended in 1961, to its intersection with the easterly line of Van Ness Avenue produced northerly; thence northerly along said easterly line of Van Ness Avenue produced to its intersection with the United States Government pier-head line; thence following said pierhead line easterly and southerly to its intersection with the northwesterly line of Bryant Street produced northeasterly; thence southwesterly along said northwesterly line of Bryant Street produced to the point of beginning, is hereby declared to be nonnavigable waters within the meaning of the laws of the United States, and the consent of Congress is hereby given for the filling in of all or any part of the described area. This declaration shall apply only to portions of the above-described area which are bulkheaded and filled or are occupied by permanent pile-supported structures. Plans for bulkheading and filling and permanent pile-supported structures shall be approved by the Secretary of the Army, acting through the Chief of Engineers, on the basis of engineering studies to determine the location and structural stability of the bulkheading and filling and permanent pile-supported structures in order to preserve and maintain the remaining navigable waterway. Local interests shall reimburse the Federal Government for any engineering costs incurred under this section.

Patapsco River, Md.

SEC. 115. That portion of the Northwest Branch of the Patapsco River located generally south of Pratt Street, east of Light Street, north of Key Highway, in the city of Baltimore, State of Maryland, and being more particularly described as all of that portion of the Northwest Branch of the Patapsco River lying west of a series of lines beginning at the point formed by the intersection of the south side of Pratt Street, as now laid out, and the west side of Pier 3 and running thence binding on the west side of Pier 3, south 04 degrees 19 minutes 47 seconds east 726.59 feet to the southwest corner of Pier 3; thence crossing the Northwest Branch of the Patapsco River, south

23 degrees 01 minutes 15 seconds west 855.36 feet to the point formed by the intersection of the existing pierhead and bulkhead line and the east side of Battery Avenue, last said point of intersection being the end of the first line of the fourth parcel of land conveyed by J. and F. Realty, Incorporated to Allegheny Pepsi-Cola Bottling Company by deed dated December 22, 1965, and recorded among the Land Record of Baltimore City in Liber J. F. C. numbered 2006 folio 345, the location of said pierhead and bulkhead line is based upon the Corps of Engineers, Baltimore District, Baltimore, Maryland, coordinate value for station LIV of said pierhead and bulkhead line, the coordinate value as referred to the Lambert grid plane coordinate system for the State of Maryland of said station LIV being east 2,111,161.40, north 527,709.27 and thence binding on the east side of Battery Avenue, south 03 degrees 09 minutes 07 seconds east 568 feet, more or less, to intersect the north side of Key Highway as now laid out and located is hereby declared to be not a navigable stream of the United States within the meaning of the laws of the United States, and the consent of Congress is hereby given for the filling in of all or any part of the described area.

Potomac River, abandoned ships, etc.

SEC. 116. (a) The Secretary of the Army is authorized and directed to remove from the Potomac River and to destroy the abandoned ships, ships' hulls, and pilings, located in Mallow's Bay, between Sandy Point and Liverpool Point, Charles County, Maryland, and at Wide Water, south of Quantico, Virginia, and any other abandoned ships formerly among those in Mallow's Bay or at Wide Water which have drifted from those locations. Local interests shall contribute 50 percent of the cost of such work.

Appropriation.

(b) There is authorized to carry out this section, not to exceed $175,000.

SEC. 117. The Chief of Engineers, under the direction of the Secretary of the Army, is hereby authorized to maintain authorized river and harbor projects in excess of authorized project depths where such excess depths have been provided by the United States for defense purposes and whenever the Chief of Engineers determines that such waterways also serve essential needs of general commerce.

Bridge at Clinton, Iowa and Fulton, Ill.

SEC. 118. (a) Section 5 of the Act entitled "An Act creating the City of Clinton Bridge Commission and authorizing said commission and its successors to acquire by purchase or condemnation and to construct, maintain, and operate a bridge or bridges across the Mississippi River at or near Clinton, Iowa, at or near Fulton, Illinois", approved December 21, 1944, as revised, amended, and reenacted, is hereby amended by inserting "(a)" immediately after "SEC. 5." and by adding at the end of such section the following new subsection:

58 Stat. 846; 72 Stat. 851.

"(b) In addition to the method of payment provided in subsection (a) of this section, the commission and its successors and assigns are hereby authorized to provide for the payment of the cost of dismantling one bridge and of constructing as a replacement therefor a new bridge (including necessary approaches and approach highways) either entirely from a construction fund created in accordance with section 6 of this Act or from both such construction fund and from bonds issued and sold in accordance with subsection (a) of this section. The cost of any bridge constructed under this subsection (together with approaches and approach highways) shall include all costs and expenses included in the case of a bridge constructed under authority of subsection (a) of this section (including its approaches and approach highways)."

(b) The first sentence of section 6 of such Act of December 21, 1944, is amended by striking out the period at the end thereof and inserting

in lieu thereof a comma and the following: "and, if the Commission determines it advisable to do so, to provide a construction fund specifically to pay the cost of dismantling one bridge and constructing a new bridge to replace it as authorized by subsection (b) of section 5 of this Act."

(c) Section 6 of such Act of December 21, 1944, is further amended by adding immediately following the third sentence of such section the following new sentence: "If no bonds or notes are outstanding or if a sinking fund specifically for payment of all outstanding bonds and notes shall have been provided, the remainder of such tolls may, if the Commission determines it advisable to do so, be placed in a construction fund for use in accordance with subsection (b) of section 5 of this Act."

(d) The first sentence of subsection (a) of section 8 of such Act of December 21, 1944, is amended by inserting immediately after "solely for that purpose," the following: "and after any bridge constructed under authority of section 5(b) of this Act shall have been paid for, or sufficient funds are available in the construction fund authorized by section 6 to pay for such bridge,".

(e) The amendments made by this section shall be inapplicable insofar as they authorize the construction of a bridge or bridges unless actual construction thereof is commenced within five years from the date of enactment of this section and such construction is completed by January 1, 1980.

Surveys.

SEC. 119. The Secretary of the Army is hereby authorized and directed to cause surveys to be made at the following locations and subject to all applicable provisions of section 110 of the River and Harbor Act of 1950:

64 Stat. 168.

Back River, Maryland, from Chesapeake Bay to the city of Baltimore's waste water treatment plants.

Savannah and Tennessee Rivers, with a view to determining the advisability of providing a waterway connecting the rivers by canals and appurtenant facilities and a waterway connecting Charleston and Port Royal, South Carolina, with the lower Savannah River.

Lake Superior, with a view to determining the advisability of a waterway connecting the lake and the Mississippi River.

SEC. 120. (a) The Secretary of the Army, acting through the Chief of Engineers, is authorized and directed to make studies of:

Streambank erosion, etc.

(1) The nature and scope of the damages which result from streambank erosion throughout the United States, with a view toward determining the need for, and the feasibility of, a coordinated program of streambank protection in the interests of reducing damages from the deposition of sediment in reservoirs and waterways, the destruction of channels and adjacent lands, and other adverse effects of streambank erosion.

(2) The need for and the feasibility of a program for the removal and disposal of drift and other debris, including abandoned vessels, from public harbors and associated channels under the jurisdiction of the Department of the Army.

Report to Congress.

(b) The Secretary shall report to Congress, not later than one year after the date of enactment of this Act, the results of such studies together with his recommendations in connection therewith, including an appropriate division of responsibility between Federal and non-Federal interests.

Citation of title.

SEC. 121. Title I of this Act may be cited as the "River and Harbor Act of 1968".

TITLE II—FLOOD CONTROL

Flood Control Act of 1968.

SEC. 201. Section 3 of the Act approved June 22, 1936 (Public Law Numbered 738, Seventy-fourth Congress), as amended by section 2 of the Act approved June 28, 1938 (Public Law Numbered 761, Seventy-fifth Congress), shall apply to all works authorized in this title except that for any channel improvement or channel rectification project, provisions (a), (b), and (c) of section 3 of said Act of June 22, 1936, shall apply thereto, except as otherwise provided by law. The authorization for any flood control project herein authorized by this Act requiring local cooperation shall expire five years from the date on which local interests are notified in writing by the Secretary of the Army or his designee of the requirements of local cooperation, unless said interests shall within said time furnish assurances satisfactory to the Secretary of the Army that the required cooperation will be furnished.

49 Stat. 1571.
33 USC 701c.
52 Stat. 1215.
33 USC 701c-1.

SEC. 202. The provisions of section 1 of the Act of December 22, 1944 (Public Law Numbered 534, Seventy-eighth Congress, second session), shall govern with respect to projects authorized in this Act, and the procedures therein set forth with respect to plans, proposals, or reports for works of improvement for navigation or flood control and for irrigation and purposes incidental thereto shall apply as if herein set forth in full.

58 Stat. 887.
33 USC 701-1.

SEC. 203. The following works of improvement for the benefit of navigation and the control of destructive floodwaters and other purposes are hereby adopted and authorized to be prosecuted under the direction of the Secretary of the Army and supervision of the Chief of Engineers in accordance with the plans in the respective reports hereinafter designated and subject to the conditions set forth therein. The necessary plans, specifications, and preliminary work may be prosecuted on any project authorized in this title with funds from appropriations hereafter made for flood control so as to be ready for rapid inauguration of a construction program. The projects authorized in this title shall be initiated as expeditiously and prosecuted as vigorously as may be consistent with budgetary requirements. Penstocks and other similar facilities adapted to possible future use in the development of hydroelectric power shall be installed in any dam authorized in this Act for construction by the Department of the Army when approved by the Secretary of the Army on the recommendation of the Chief of Engineers and the Federal Power Commission.

Projects.

LOWER CHARLES RIVER, MASSACHUSETTS

The project for flood control on the Lower Charles River, Massachusetts, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 370, Ninetieth Congress, at an estimated cost of $18,620,000.

CONNECTICUT RIVER BASIN

The project for the Beaver Brook Dam and Reservoir, Beaver Brook, New Hampshire, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in Senate Document Numbered 68, Ninetieth Congress, at an estimated cost of $1,185,000.

The project for flood protection on Park River, Connecticut, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in Senate Document Numbered 43, Ninetieth Congress, at an estimated cost of $30,300,000.

LONG ISLAND SOUND

The project for flood protection on Norwalk River, Connecticut and New York, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in Senate Document Numbered 51, Ninetieth Congress, at an estimated cost of $2,700,000.

DELAWARE-ATLANTIC COASTAL AREA

The project for hurricane-flood protection and beach erosion control along the Delaware Coast from Cape Henlopen to Fenwick Island, at the Delaware-Maryland State Line is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers, in Senate Document Numbered 90, Ninetieth Congress, at an estimated cost of $5,584,000.

RAPPAHANNOCK RIVER BASIN

The project for the Salem Church Dam and Reservoir Rappahannock River, Virginia, is hereby modified substantially in accordance with the recommendations of the Chief of Engineers in Senate Document Numbered 37, Ninetieth Congress, at an estimated cost of $79,500,000.

CAPE FEAR RIVER BASIN

The project for the Randleman Dam and Reservoir, Deep River, North Carolina, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 343, Ninetieth Congress, at an estimated cost of $19,463,000.

The project for the Howards Mill Dam and Reservoir, Deep River, North Carolina, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 343, Ninetieth Congress, at an estimated cost of $12,460,000.

SOUTH ATLANTIC COASTAL AREA

The project for beach erosion control and hurricane flood protection of Dade County, Florida, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 335, Ninetieth Congress, at an estimated cost of $11,805,000.

HILLSBOROUGH BAY, FLORIDA

The project for hurricane-flood control protection on Hillsborough Bay, Florida, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 313, Ninetieth Congress, at an estimated cost of $9,909,000, except that construction of the barrier across Hillsborough Bay shall not be undertaken until the Chief of Engineers completes further detailed studies covering related water resource problems, including a comprehensive model study of the entire Tampa Bay area, and until sixty days after the date of submission of a report on such studies to the Committees on Public Works of the Senate and House of Representatives.

CENTRAL AND SOUTHERN FLORIDA

62 Stat. 1171.
33 USC 701b-8, etc.

The project for Central and Southern Florida, authorized by the Flood Control Act of June 30, 1948, is further modified in accordance with the recommendations of the Chief of Engineers in Senate Docu-

ment Numbered 101, Ninetieth Congress, at an estimated cost of $8,072,000, and in accordance with House Document Numbered 369, Ninetieth Congress, at an estimated cost of $58,182,000.

PASCAGOULA RIVER BASIN

The project for the Tallahala Creek Dam and Reservoir, Tallahala Creek, Mississippi, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 143, Ninetieth Congress, at an estimated cost of $16,360,000.

LOWER MISSISSIPPI RIVER BASIN

Project modification.

33 USC 702a-702m.

The project for flood control and improvement of the lower Mississippi River, adopted by the Act of May 15, 1928 (45 Stat. 534), as amended and modified, is hereby further modified and expanded to include the following items:

(1) The project for the St. Francis River Basin, Arkansas and Missouri, authorized by the Flood Control Act approved June 15, 1936 (Public Law 74-678), as modified by subsequent Acts of Congress, including the Flood Control Act of 1965. Public Law 89-298 is hereby further modified to provide that the requirements of local cooperation for the improvements authorized in the Flood Control Act of 1965, shall conform to those requirements for local cooperation in the Saint Francis River Basin authorized in previous Acts of Congress, substantially as recommended by the Chief of Engineers in Senate Document Numbered 11, Ninetieth Congress.

49 Stat. 1508.

79 Stat. 1073.

(2) Improvements in the Boeuf and Tensas Rivers and Bayou Macon Basin to divert flows that would otherwise enter Lake Chicot, Arkansas, substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 168, Ninetieth Congress, at an estimated cost of $15,240,000, except that prior to initiation of construction of the project, local interests shall agree that no fees shall be charged for admission to Lake Chicot and to public recreation areas adjoining Lake Chicot and that user fees at such lake and areas shall be devoted to recreation purposes.

(3) Improvements in the Belle Fountain ditch and tributaries, Missouri, and Drainage District Number 17, Arkansas, substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 339, Ninetieth Congress, at an estimated cost of $4,638,000.

WHITE RIVER BASIN

The project for flood protection on Crooked Creek at and in the vicinity of Harrison, Arkansas, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in Senate Document Numbered 28, Ninetieth Congress, at an estimated cost of $2,840,000.

BRAZOS RIVER BASIN

The project for the Aquilla Dam and Reservoir, Aquilla Creek, Texas, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in Senate Document Numbered 52, Ninetieth Congress, at an estimated cost of $23,612,000.

NAVASOTA RIVER BASIN

The project for the Navasota River, Texas, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 341, Ninetieth Congress, at an estimated cost of $119,707,000.

CLEAR CREEK, TEXAS

The project for flood protection on Clear Creek, Texas, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 351, Ninetieth Congress, at an estimated cost of $12,600,000.

PECAN BAYOU, TEXAS

The project for flood protection on Pecan Bayou, Texas, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 350, Ninetieth Congress, at an estimated cost of $24,861,000.

GULF OF MEXICO

The project for hurricane-flood control at Texas City and vicinity, Texas, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 187, Ninetieth Congress, at an estimated cost of $10,990,000.

UPPER MISSISSIPPI RIVER BASIN

The project for flood protection on the Mississippi River from Cassville, Wisconsin, to mile 300, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 348, Ninetieth Congress, at an estimated cost of $21,300,000.

The project for flood protection of State Road and Ebner Coulees, city of La Crosse and Shelby Township, Wisconsin, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 360, Ninetieth Congress, at an estimated cost of $6,849,000.

RED RIVER OF THE NORTH

The project for flood protection on the South Branch of the Wild Rice River and Felton Ditch, Minnesota, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 98, Ninetieth Congress, at an estimated cost of $1,230,000.

OHIO RIVER BASIN

The project for flood protection on the Ohio River in Southwestern Jefferson County, Kentucky, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 340, Ninetieth Congress, at an estimated cost of $19,800,000.

The project for the Utica Dam and Reservoir and flood protection at Newark, Licking River Basin, Ohio, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 337, Ninetieth Congress, at an estimated cost of $32,953,000.

WABASH RIVER BASIN

The project for flood control and related purposes in the Wabash River Basin, Indiana, Illinois, and Ohio, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in Senate Document Numbered 96, Ninetieth Congress, and

[PUBLIC—NO. 761—75TH CONGRESS]

[CHAPTER 795—3D SESSION]

[H. R. 10618]

AN ACT

Authorizing the construction of certain public works on rivers and harbors for flood control, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, hereafter, Federal investigations and improvements of rivers and other waterways for flood control and allied purposes shall be under the jurisdiction of and shall be prosecuted by the War Department under the direction of the Secretary of War and supervision of the Chief of Engineers, and Federal investigations of watersheds and measures for run-off and waterflow retardation and soil erosion prevention on watersheds shall be under the jurisdiction of and shall be prosecuted by the Department of Agriculture under the direction of the Secretary of Agriculture, except as otherwise provided by Act of Congress.

SEC. 2. That section 3 of the Act of June 22, 1936 (Public, Numbered 738, Seventy-fourth Congress), as heretofore amended and as herein further modified, shall apply to all flood control projects, except as otherwise specifically provided by law.

That in case of any dam and reservoir project, or channel improvement or channel rectification project for flood control, herein authorized or heretofore authorized by the Act of June 22, 1936 (Public, Numbered 738, Seventy-fourth Congress), as amended, and by the Act of May 15, 1928 (Public, Numbered 391, Seventieth Congress) as amended by the Act of June 15, 1936 (Public, Numbered 678, Seventy-fourth Congress), as amended, title to all lands, easements, and rights-of-way for such project shall be acquired by the United States or by States, political subdivisions thereof or other responsible local agencies and conveyed to the United States, and provisions (a), (b), and (c) of section 3 of said Act of June 22, 1936, shall not apply thereto. Notwithstanding any restrictions, limitations, or requirement of prior consent provided by any other Act, the Secretary of War is hereby authorized and directed to acquire in the name of the United States title to all lands, easements, and rights-of-way necessary for any dam and reservoir project or channel improvement or channel rectification project for flood control, with funds heretofore or hereafter appropriated or made available for such projects, and States, political subdivisions thereof, or other responsible local agencies, shall be granted and reimbursed, from such funds, sums equivalent to actual expenditures deemed reasonable by the Secretary of War and the Chief of Engineers and made by them in acquiring lands, easements, and rights-of-way for any dam and reservoir project, or any channel improvement or channel rectification project for flood control heretofore or herein authorized: *Provided*, That no reimbursement

shall be made for any indirect or speculative damages: *Provided further*, That lands, easements and rights-of-way shall include lands on which dams, reservoirs, channel improvements, and channel rectifications are located; lands or flowage rights in reservoirs and highway, railway, and utility relocation.

SEC. 3. That in any case where the construction cost of levees or flood walls included in any authorized project can be substantially reduced by the evacuation of a portion or all of the area proposed to be protected and by the elimination of that portion or all of the area from the protection to be afforded by the project, the Chief of Engineers may modify the plan of said project so as to eliminate said portion or all of the area: *Provided*, That a sum not substantially exceeding the amount thus saved in construction cost may be expended by the Chief of Engineers, or in his discretion may be transferred to any other appropriate Federal agency for expenditure, toward the evacuation of the locality eliminated from protection and the rehabilitation of the persons so evacuated: *And provided further*, That the Chief of Engineers may, if he so desires, enter into agreement with States, local agencies, or the individuals concerned for the accomplishment by them, of such evacuation and rehabilitation and for their reimbursement from said sum for expenditures actually incurred by them for this purpose.

SEC. 4. That the following works of improvement for the benefit of navigation and the control of destructive floodwaters and other purposes are hereby adopted and authorized to be prosecuted under the direction of the Secretary of War and supervision of the Chief of Engineers in accordance with the plans in the respective reports hereinafter designated: *Provided*, That penstocks or other similar facilities adapted to possible future use in the development of hydroelectric power shall be installed in any dam herein authorized when approved by the Secretary of War upon the recommendation of the Chief of Engineers and of the Federal Power Commission.

MERRIMACK RIVER BASIN

The general comprehensive plan for flood control and other purposes, as approved by the Chief of Engineers pursuant to preliminary examinations and surveys authorized by the Act of June 22, 1936, is approved and the project for flood control in the Merrimack River Basin, as authorized by the Flood Control Act approved June 22, 1936, is modified to provide, in addition to the construction of a system of flood control reservoirs, related flood control works which may be found justified by the Chief of Engineers.

CONNECTICUT RIVER BASIN

The general comprehensive plan for flood-control and other purposes as set forth in House Document Numbered 455, Seventy-fifth Congress, second session, is approved, and there is hereby authorized $11,524,000 for the construction of local flood-protection works in said plan: *Provided*, That the flood-protection project for East Hartford, Connecticut, authorized by the River and Harbor Act of August 30, 1935, is hereby abandoned; all as set forth in House Document Numbered 455, Seventy-fifth Congress, second session.

MARSHY HOPE CREEK, MARYLAND

The protection of the city of Federalsburg, Maryland, by a system of levees and flood walls in combination with channel improvement, in accordance with the report of the Chief of Engineers dated June 7, 1938, made pursuant to a preliminary examination and survey authorized by the Act of June 22, 1936 (Public, Numbered 738, Seventy-fourth Congress), is hereby authorized at an estimated cost of $220,000.

HUDSON AND MOHAWK RIVERS

The protection of the city of Waterford, New York, by a system of levees and flood walls in accordance with plans approved by the Chief of Engineers pursuant to preliminary examinations and surveys authorized by resolution adopted March 19, 1937, by the Committee on Flood Control of the House of Representatives, United States, is hereby authorized at an estimated cost of $315,000.

SAVANNAH RIVER

In view of the flood control and other general benefits to accrue from the project known as the Clark Hill Project on the Savannah River, Georgia-South Carolina, described in the "Report To The President," Through the Secretary of War, The Secretary of the Interior, and The Federal Power Commission, by The Savannah River Special Board, and dated at Washington, District of Columbia, February 29, 1936, The Secretary of War is hereby authorized to reimburse out of flood control appropriations not to exceed $1,700,000 to the State of South Carolina, or to a local political subdivision thereof for the actual costs to it of the lands, easements and rights of way needed and acquired for this project.

OHIO RIVER BASIN

The general comprehensive plan for flood control and other purposes in the Ohio River Basin, as set forth in Flood Control Committee Document Numbered 1, Seventy-fifth Congress, first session, with such modifications thereof as in the discretion of the Secretary of War and the Chief of Engineers may be advisable, is approved and for the initiation and partial accomplishment of said plan there is hereby authorized $75,000,000 for reservoirs and $50,300,000 for local flood-protection works; the reservoirs and local protection projects to be selected and approved by the Chief of Engineers: *Provided*, That this authorization shall include the diversion of Cache River above Cairo, Illinois, from its outlet into the Ohio River to an outlet into the Mississippi River, and the protection of the area north of the Cairo drainage district by levees extending from said drainage district along the Ohio and Mississippi Rivers to high ground, with an estimated cost of $2,000,000: *Provided further*, That the provisions of Executive Order Numbered 7183A, dated September 12, 1935, are approved, and the acquisition at the cost of the United States of all lands, easements, and rights-of-way needed for the Bluestone Reservoir project are hereby authorized: *Provided further*, That the Secretary of War is hereby authorized and directed to reimburse the

Muskingum Conservancy District in Ohio a sum not to exceed the actual expenditures made by it in acquiring lands, easements and rights-of-way for reservoirs in the Muskingum River Valley, but such reimbursement shall not exceed $4,500,000, nor include any expenditures for lands, easements and rights-of-way heretofore or hereafter purchased from said District by the United States.

UPPER MISSISSIPPI RIVER BASIN

The general comprehensive plan for flood control and other purposes in the Upper Mississippi River Basin, described in Flood Control Committee Document Numbered 1, Seventy-fifth Congress, first session, with such modifications thereof as in the discretion of the Secretary of War and the Chief of Engineers may be advisable, is approved and there is hereby authorized $6,600,000 for reservoirs and $2,700,000 for local flood-protection works on the Upper Mississippi and Illinois Rivers; the reservoirs and local protection projects to be selected and approved by the Chief of Engineers: *Provided*, That this authorization shall include the enlargement and extension of a system of levees located on the south side of the Sangamon River east of the town of Chandlerville, Illinois, as set forth in House Document Numbered 604, Seventy-fifth Congress, third session.

MISSOURI RIVER BASIN

The general comprehensive plan for flood control and other purposes in the Missouri River Basin, as set forth in Flood Control Committee Document Numbered 1, Seventy-fifth Congress, first session, with such modifications thereof as in the discretion of the Secretary of War and the Chief of Engineers may be advisable, is approved and for the initiation and partial accomplishment of said plan there is hereby authorized $9,000,000 for reservoirs; the reservoirs to be selected and approved by the Chief of Engineers.

WHITE RIVER BASIN

The general comprehensive plan for flood control and other purposes in the White River Basin, as set forth in Flood Control Committee Document Numbered 1, Seventy-fifth Congress, first session, with such modifications thereof as in the discretion of the Secretary of War and the Chief of Engineers may be advisable, is approved and for the initiation and partial accomplishment of said plan there is hereby authorized $25,000,000 for reservoirs; the reservoirs to be selected and approved by the Chief of Engineers.

ARKANSAS RIVER BASIN

The general comprehensive plan for flood control and other purposes in the Arkansas River Basin, as set forth in Flood Control Committee Document Numbered 1, Seventy-fifth Congress, first session, with such modifications thereof as in the discretion of the Secretary of War and the Chief of Engineers may be advisable, is approved, and for the initiation and partial accomplishment of said plan there is hereby authorized $21,000,000 for reservoirs; the reservoirs to be selected and approved by the Chief of Engineers: *Pro-*

US Army Corps of Engineers
Louisville District®

Great Lakes and Ohio River Division
Louisville District

Louisville Metro Flood Protection System
Emergency Supplemental
Reconstruction Feasibility Study

VOLUME 1

APPENDIX E

ECONOMICS

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1 Economics

1.1 Background

This appendix presents and describes the economic considerations that were part of the Louisville Metro Flood Protection System Emergency Supplemental Feasibility Study (LMFPS Feasibility Study). The Metro Louisville Flood Protection system is composed of two distinct reaches which were authorized by two separate acts of Congress:

1) Louisville Reach: Flood Control Act – approved 28 June 1938, as amended
2) Southwestern Jefferson Reach: Flood Control Act – approved 13 August 1968, as amended

Construction of the Louisville Reach occurred between 1947 and 1956 and construction of the Southwestern Jefferson Reach occurred between 1973 and 1989. The local sponsor, the Louisville and Jefferson County Metropolitan Sewer District (MSD), reports that the aging infrastructure is increasingly unreliable and that project benefits are at-risk should particular features fail to perform. The system is currently rated as an LSAC 2, largely due to the high population at-risk and the potential for high life loss and economic consequences.

1.2 Guidance

The authorities to conduct this study are Section 216 of the Flood Control Act of 1970 (Public Law 91-611) and the Bipartisan Budget Act of 2018 (Public Law 115-123). The evaluation framework of this study is guided by procedures outlined in CECW-PB Memorandum, Subject: Reconstruction of U.S. Army Corps of Engineers Structural Flood Damage Reduction Projects for which Non-Federal Interests are Responsible for Operation, Maintenance, Repair, Rehabilitation, and Replacement, dated August 16, 2005 (August 2005 Reconstruction Guidance). This policy guidance outlines the decision logic for evaluating the existing project for potential reconstruction, which consists of addressing impediments and performance deficiencies caused by a long term degradation of the foundation, construction materials, and engineering systems that have exceeded their expected service lives and the resulting inability of the project to perform its authorized and intended functions.

According to Section G of the August 2005 Reconstruction Guidance, depending on the interest of the non-Federal sponsor, the feasibility study may be limited to examination of the reconstruction of the existing project with no change in its scope or function. Under this limited objective, evaluation would be limited to individual project features to establish the justification of reconstruction based on a comparison between the with and without reconstruction conditions. The August 2005 Reconstruction Guidance also outlines an expanded scope which includes a combination of reconstruction of an existing project and with the extension or expansion of flood damage reduction with a change in scope or level or protection. This expanded scope involves efforts identical in scope to any other flood damage reduction feasibility study and include a full range of alternatives and economic evaluation to identify the plan that maximized net benefits as well as compliance with all environmental laws and regulations.

The economic evaluation efforts associated with the LMFPS Feasibility Study were conducted primarily around the limited reconstruction objective which produces no change in the original project's scope or function. As such, traditional economic evaluation procedures were not utilized and the PDT and vertical team decided to evaluate the benefits of the LMFPS on a system wide basis, based on annualized flood

damages reduced by the project since its construction. It should be noted that the PDT did, however, engage in a preliminary evaluation of scope changes to the existing project via expanded capacities amongst numerous pump stations and potential changes in condition due to climate change. If any of the particular pump stations warranted serious review upon the preliminary inspection, the intent of the PDT was to then study each pump station on an individual and incremental basis, as directed by the expanded scope. Ultimately, no such analysis was necessary.

The methodology and evaluation framework established and utilized for the LMFPS Feasibility Study was vetted through the vertical chain (LRD, FRM-PCX, HQUSACE, and OWPR) throughout the duration of the study. It was presented and agreed upon after the LMFPS Scoping Charrette (December 12 2018), IPR with Division (February 15 2019), and the Alternative Milestone Meeting (February 28 2019).

1.3 Existing Conditions

The existing conditions of this effort, as presented, were established by the Semi-Quantitative Risk Assessment (SQRA) in 2019, which included consequences modeling completed by the Modeling, Mapping, and Consequence (MMC) Production Center in 2018. The following text reflects the economic considerations represented by consequences as identified in the SQRA.

1.3.1 Background

USACE has established a national standard of modeling procedures to support the estimation of consequences for breach and non-breach flood inundation scenarios over the full range of loading conditions. The Modeling, Mapping and Consequence (MMC) Production Center is charged with producing scalable hydrologic and hydraulic levee breach models, flood inundation maps, and consequence estimations to support risk assessments.

The MMC Production Center developed baseline consequence estimates for breach and non-breach inundation scenarios, uncertainty statistics for life loss estimates, and inundation mapping products. The difference between breach and non-breach consequences for a particular loading condition is the incremental consequences (i.e., those directly attributable to the levee breach for that loading condition). This information was used by the risk assessment team to assign an appropriate order-of-magnitude estimate for the risk-driver potential failure modes. Specific details and assumptions associated with the modeling, mapping, and consequences are provided with the various MMC Production Center products.

1.3.2 Breach Locations

In order to analyze a range of possible flood scenarios, three breach locations are typically included in MMC levee models.

Table 1-1 below discusses each breach location in detail with project specific information.

Table 1-1: Breach Locations

Levee Failure Locations	Short Name	Station	Justification for Selection
Levee Control Location	LCL	573 +15 (SWJ)	An approximately 8 mile stretch of the Southwest Jefferson County levee, ranging between stations 300+05 and 730+00, would experience significant overtopping first. Levee station 573 +15 is the location in that reach that would overtop first. This location has a landside levee toe that is lower than all of the water surface profiles.
Maximum Hydraulic Loading	MHL	699+40 (SWJ)	The average highest hydraulic loading on the levee occurs at Southwest Jefferson County station 699+40.This location was chosen because the high hydraulic load would result in a large maximum breach width.
Potential Highest Consequences	PHC	(LOU) 14+40	Based on NLD Cross Sections, the largest hydraulic loading in the area occurs on the section of levee ranging from Station 10+65 to 18+00. It is bounded on the upstream end by Beargrass Creek Pumping Station and ties into floodwall on the downstream end. The MMC chose this breach location in the Louisville Levee because it's location at the upstream end of the levee system near the densely populated downtown area suggested it would produce the highest consequences; however, modeling of this breach scenario demonstrated that it did not produce higher consequences than the other levee breach locations.

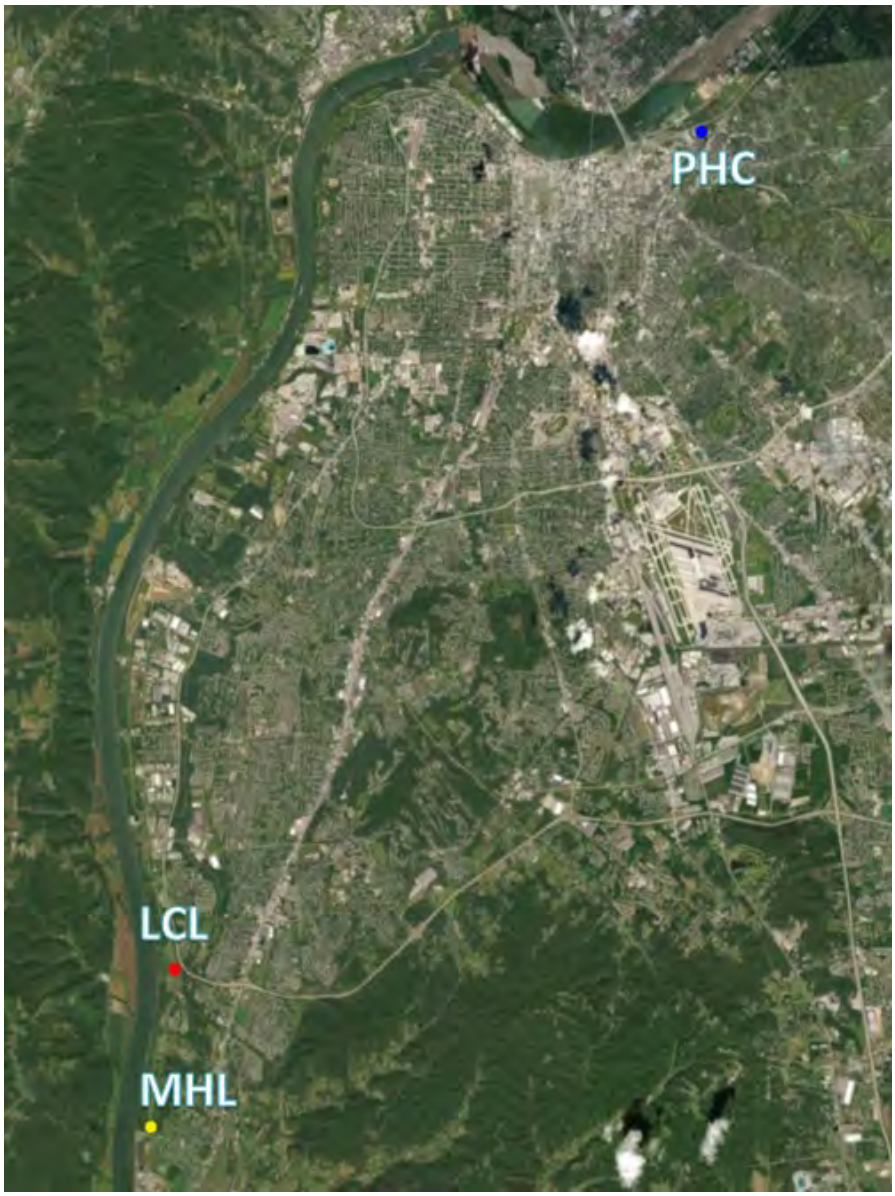

Figure 1-1: Breach Locations

An additional failure mode to emerge from the risk assessment was the failure of a pumping station during an interior rain event that induces consequences in the leveed area. This interior flooding event was entirely different from the previously modeled levee breach scenarios and so required additional hydraulic modeling. The Beargrass Creek pumping station was chosen for this purpose as shown in Table 1-2, because among all the pumping stations in the system its location and capacity create potential for the highest life loss.

Table 1-2: Pump Station Failure Location

Failure Locations	Justification for Selection
Beargrass Creek Pumping Station	Beargrass Creek pumping station was considered the critical location for the highest incremental risk for any failure at a pump station where the pumps become inoperable leading to increased

	interior flooding due to the potential for the highest incremental consequences, as compared to other pumping stations in the system.

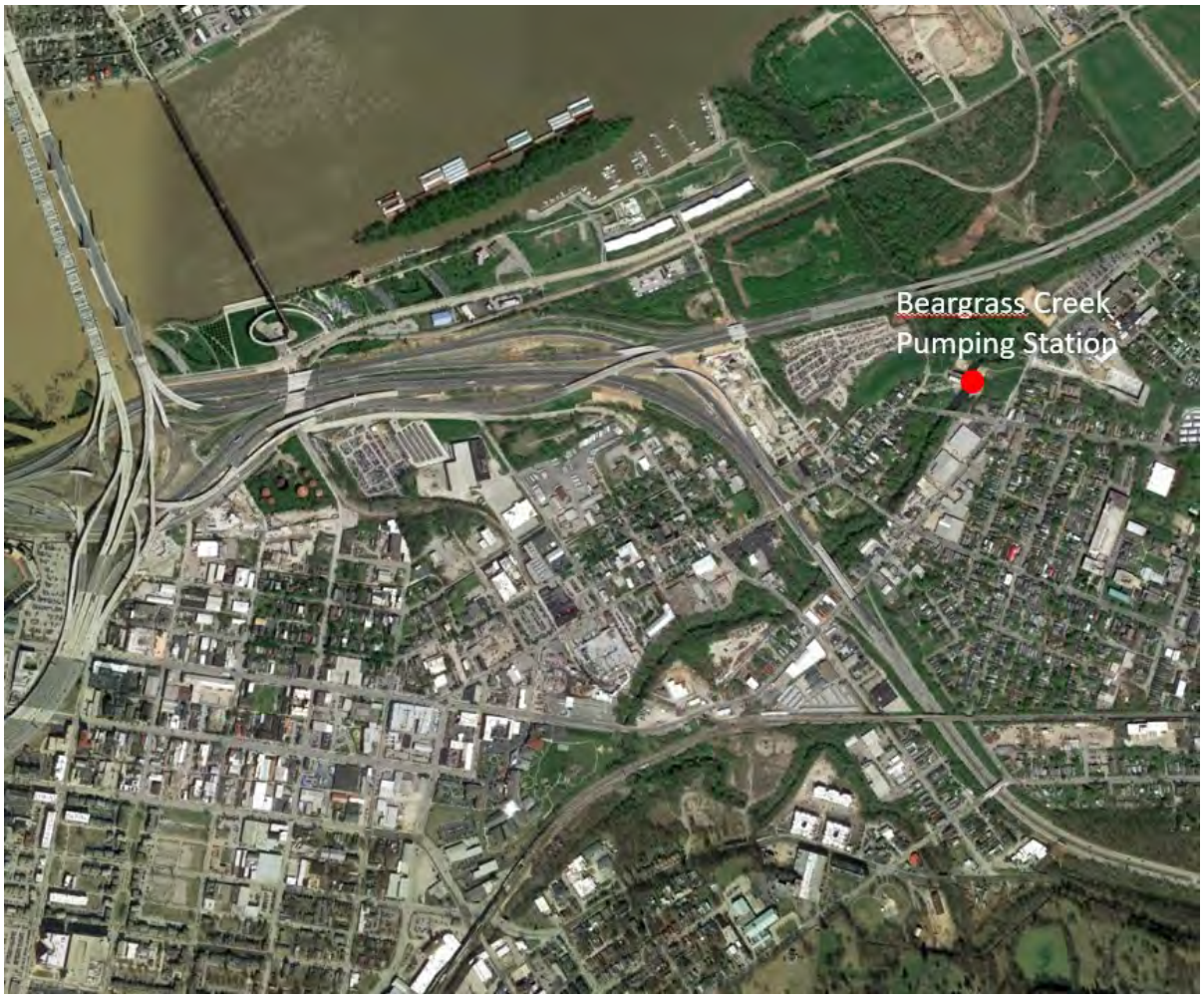

Figure 1-2: Pumping Station Failure Location

1.3.3 Hydraulic Loading Scenarios

For all the failure scenarios except the failure at Beargrass Creek Pump Station, flood loading scenarios were developed using a scaled inflow flood hydrograph (e.g., flood of record or a recent significant flood event) producing the desired maximum water surface elevations at the Levee Control Location (LCL). An example graphic of hydrologic loading scenarios is shown below in Figure 1-3.

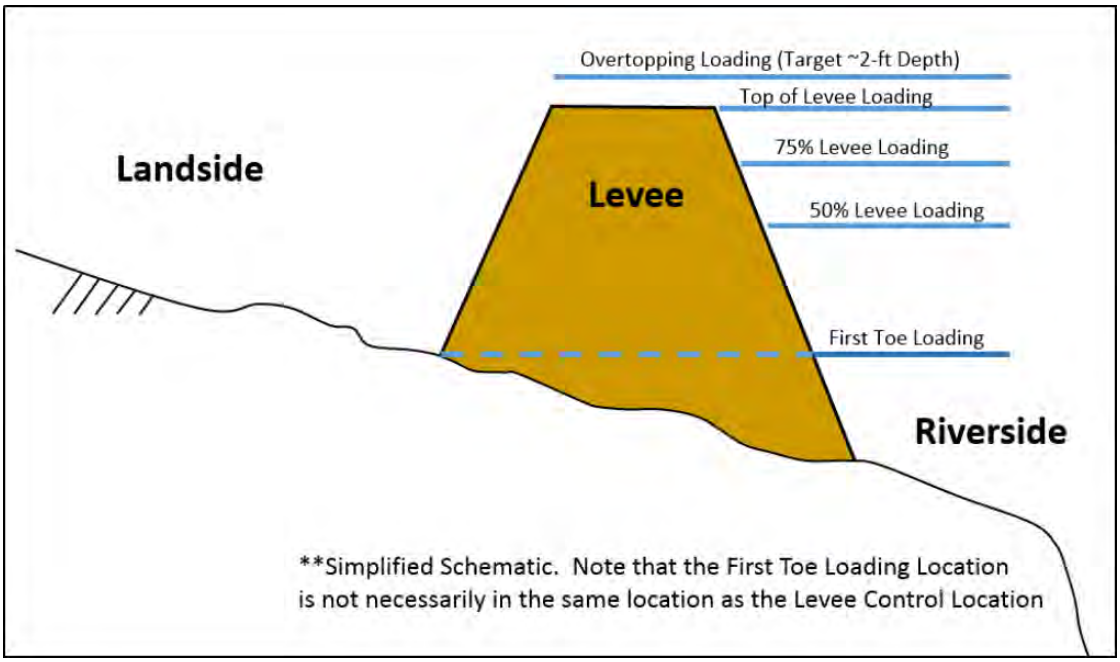

Figure 1-3: Flood Loading Scenarios

The LCL maximum water surface elevation and ratio of the inflow hydrograph used are shown for each loading scenario in Table 1-3 below.

Table 1-3: Hydrologic Loading Event Parameters

Scenario Name	Water Surface Elevation at LCL (ft, NAVD 88)	Ratio of Inflow Hydrograph
Base Inflow Hydrograph Pattern*	455.0	1.00
Maximum Flood Load	461.1	1.2
2 ft Overtopping	458.7	1.1
1 ft Overtopping	457.8	1.1
0.53 ft Overtopping Levee Load	457.3	1.0
Top of Levee	456.8	1.0
75% Levee Height	454.0	1.0
50% Levee Height	451.3	0.9
Levee Toe	445.80	0.8
***Base Inflow Hydrograph is the 1937 Flood**		

1.3.4 Breach Assumptions

The assumed breach parameters and the resulting estimated breach dimensions are summarized in the following tables. Erosion rates were determined based on the latest results from U.S. Army Engineer

Research and Development Center (ERDC) geotechnical models on erosion widening rates for clay and differ from the values currently included in the SOP Technical Manual for Levees Standard Operating Procedures (SOP). The values correspond to a moderately resistant clay material. Breach characteristics (size and development time) were estimated for each levee breach scenario within HEC-RAS by utilizing the simplified physical breach method. The method allows for varied breach parameters based on the modeled hydraulic conditions at the breach location.

Table 1-4: Simplified Physical Breach Parameters

Erosion Rates for Downcutting		**Erosion Rates for Widening**	
Velocity (ft/s)	Downcutting Rate (ft/hr)	Velocity (ft/s)	Widening Rate (ft/hr)
1.5	0.1	2	0
2	0.2	3	1.07
3	0.4	4	4
4	0.6	6	12.3
6	1.2	8	23.3
8	2.0	10	36.8
10	3.0	15	82.9
15	6.1	20	149.4
30	20.4		

The maximum possible breach width for each modeled scenario was dependent upon the hydraulic loading at the breach location. The Technical Memorandum for Levee Breach Characteristics, dated May 31, 2013, proposes that the ratio of maximum breach width to hydraulic loading for moderately resistant levees is 39. To obtain the maximum breach width for each scenario, the hydraulic loading was multiplied by this ratio.

Table 1-5: Breach Dimensions

Scenario (Location - Hydraulic Load)	**Final Breach Bottom Elevation (ft, NAVD 88)**	**Final Breach Width (ft, NAVD 88)**
LCL - Maximum Flood Overtopping	445.8	428
LCL - 2 ft Overtopping	445.8	448
LCL - 1 ft Overtopping	445.8	428
LCL - Top of Levee	445.8	428
LCL – <2ft Overtopping Breach	445.8	448
LCL - 75% Levee Height	445.8	321
LCL - 50% Levee Height	445.8	214
MHL - Top of Levee	429.5	820
MHL - 75% Levee Height	429.5	746

MHL - 50% Levee Height	429.5	661
PHC - Top of Levee	440.5	269
PHC - 75% Levee Height	440.5	230
PHC - 50% Levee Height	440.5	195

A more detailed discussion of the breach parameters can be found in Appendix E.

1.3.5 Description of Impacted Area

The Louisville-Metro Levee System is federally authorized and constructed, non-federally operated and maintained. It is located predominantly in Jefferson County with a very small section in Bullitt County, Kentucky, along the left bank of the Ohio River; extending from river mile 602.0 to 628.6. The Louisville-Metro Levee System provides a reduced risk of flooding to Louisville and portions of Jefferson and Bullitt Counties. As of the 2010 census, the total population of Jefferson County was 741,096.

The leveed area is heavily developed. The portion of the city east of downtown and in the Beargrass Creek area consists of mixed one to two story commercial and residential structures as well as a few historic religious buildings. The downtown central business area, which extends from Baxter Avenue in the east to 18th Street in the west, is densely developed with multi-story commercial structures and multi-family homes. From 18th Street west to the river, older, mostly one-story single family homes comprise the majority of the development. The population in this section tends to consist of lower-income residents. South of Algonquin Parkway along the levee, there is significant chemical, industrial, and commercial development mixed with neighborhoods of one-story, single-family homes.

Throughout the leveed area, several pieces of infrastructure of regional significance could be flooded in the event of a levee breach, including several local governmental headquarters and emergency management facilities. Regional power plants, the University of Louisville, and Louisville's Airport (including UPS Worldport) may also experience severe impacts in the event of a breach.

1.3.6 Life Loss Methodology

Consequence modeling for this assessment was performed using the Hydrologic Engineering Center's Loss of Life Simulation software, HEC-LifeSim 1.0.1. The HEC-LifeSim software generates estimates for life loss and population at risk (PAR) for breach and non-breach inundation scenarios. PAR is defined as the number of people in the protected area behind a levee that would be subject to inundation risk. HEC-LifeSim uses Monte Carlo analysis and computes multiple iterations in order to obtain a range of possible life loss outcomes.

The life loss methodology in HEC-LifeSim is based on the LIFESim methodology developed by Utah State University's Institute for Dam Safety Risk Management (Aboelata and Bowles 2005). A version of LIFESim has been integrated into HEC-LifeSim and performs following steps to estimate life loss for a selected hazard event-exposure scenario, a given structure inventory, and a given road network.

Estimate the levee-failure flood wave arrival times at each structure or road segment. Arrival times are defined for structures as the time at which the depth of flooding at the location of the structure or road is estimated to be large enough that the inhabitants will choose to remain in the structure and evacuate vertically instead of risk leaving the structure. Arrival times are estimated for each road segment as well, defining the scenarios in which an evacuating car or truck can become immobilized. HEC-LifeSim

estimates the arrival times of flood waters for each structure and road segment by utilizing 2D gridded hydraulic output.

Estimate when the warning is issued to the population in the Emergency Planning Zone(s) relative to a breach of the levee embankment or floodwall. Relative Warning Issuance is defined as the time when the evacuation order is issued relative to the breach occurring after communication delays. That is, Relative Warning Issuance = Hazard Identification Time (time relative to breach that the hazard is recognized) + Hazard Communication Delay (time from hazard recognition until the Emergency Management Agency is aware of the breach) + Warning Issuance Delay (time between when the EMA is told of the hazard and when a public notification is issued).

Estimate when PAR in each structure receives the warning by sampling a warning diffusion curve. Warning Diffusion Time is the time it takes emergency managers to alert the entire PAR of the hazard.

Estimate the PAR in each structure that takes protective action (mobilization). Protective Action Initiation is the rate at which PAR responds to the warning alert.

Estimate the PAR in each evacuation outcome category at the flood wave arrival time for each structure: mobilized-cleared; mobilized-caught; and not mobilized. (PAR results are integers).

Assign a lethality zone based on the evacuation outcome category for each structure: none, safe, compromised, or chance. PAR that mobilized but was caught evacuating is assigned to a lethality zone based on the hydraulic conditions for the particular road segment that the PAR is caught on. PAR that did not mobilize is assigned a lethality zone based on the hydraulic conditions at the structure considering the foundation height (FH): cleared zone (depth < 2 feet or depth < FH); safe zone (2 feet or FH ≤ depth < FH + 13 feet); compromised zone (FH + 13 feet ≤ depth < FH + 15 feet); and chance zone (depth ≥ FH + 15 feet). For multiple-story structures, an additional 9 feet are added per additional story. Foundation heights are assigned based on occupancy type (1 foot for commercial/industrial structures, 2 feet for residential structures, and 3 feet for mobile homes). If the structure response criteria (based on occupancy type and construction type) is exceeded, PAR is placed in the chance zone (high lethality zone). If PAR mobilizes, but is caught (PAR immobilized) while evacuation, PAR is placed in the chance zone if the vehicle stability criteria is exceeded; D*V > 9.688 ft2/s (Cars), D*V > 14.53 ft2/s (SUVs/Trucks), V > 6.562 ft/s (all vehicles). PAR is placed in the chance zone if an immobilized vehicle's depth of flooding exceeds six feet (D > 6 ft). If these conditions are not exceeded, exposed PAR is placed in the safe zone.

Estimate the life loss for PAR in structures and PAR immobilized in vehicles by multiplying the exposed PAR (PAR in structure or vehicle when water arrives) by the fatality rate corresponding to the lethality zone (chance zone = high lethality zone, compromised zone = low lethality zone, safe zone = rare case fatality in mild flood conditions).

Estimate the total life loss as the sum of the life loss estimates for all structures and vehicles caught while evacuating.

To determine the percentage of PAR within a structure that is warned and mobilized over time, several parameters are used within HEC-LifeSim to estimate the probable values of warning and mobilization percentages at each time step. These include when warnings will be issued (hazard identification and delays), how long they will take to become effective (warning diffusion), and the rate at which PAR will

mobilize in response (mobilization). The Emergency Preparedness parameters are further described in the sections that follow. Figure 1-4 represents an example levee breach warning and mobilization timeline.

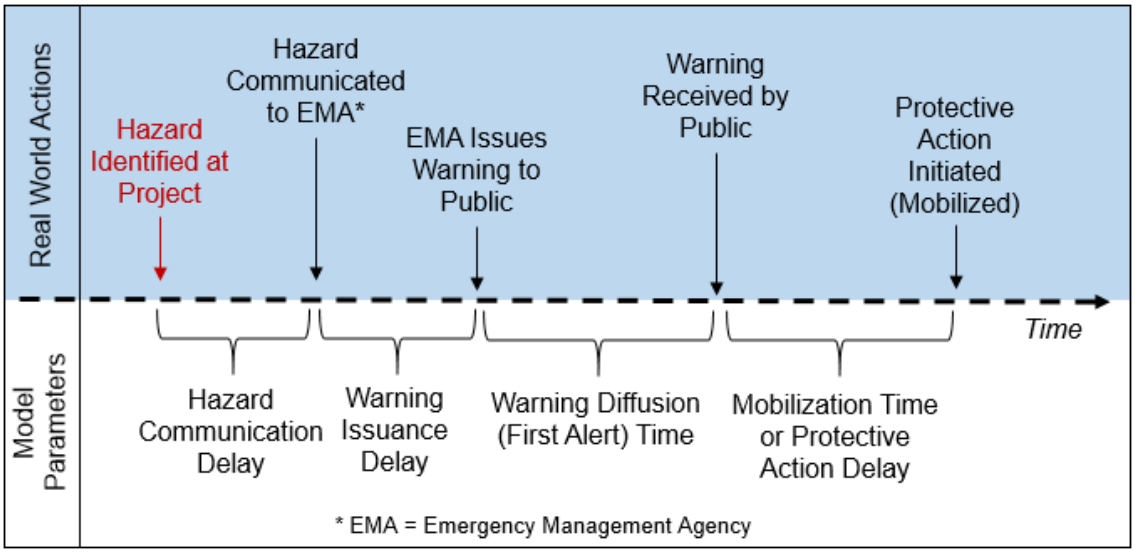

Figure 1-4: Warning and Response Timeline

1.3.7 Population at Risk

PAR is defined as the number of people within a levee system's study area that would be subject to inundation during a flood hazard event. PAR and life loss estimates were generated using HEC's HEC-LifeSim software for breach and non-breach inundation scenarios. The estimated PAR by event is summarized in the following table.

Table 1-6: Estimated Population at Risk – Breach/Failure

Location	Scenario Name	Structures Inundated	Daytime PAR	Nighttime PAR
LCL	Maximum Flood Overtopping	84,789	200,934	209,593
	2 ft Overtopping	74,300	172,413	179,158
	1 ft Overtopping	34,343	77,630	79,746
	<2ft Overtopping Breach	15,134	34,644	35,777
	Top of Levee	15,553	35,653	36,789
	75% Levee Height	4,436	10,332	10,431
	50% Levee Height	1,641	4,009	3,779
MHL	Top of Levee	33,832	76,633	78,700
	75% Levee Height	21,242	48,705	50,344
	50% Levee Height	15,280	35,096	36,145
PHC	Top of Levee	29,422	71,351	71,663
	75% Levee Height	14,768	36,504	35,987
	50% Levee Height	2,952	7,782	7,657
Beargrass Creek	100-year Interior Rain Event	7,752	46,346	21,385
	25-year Interior Rain Event	1,147	34,365	12,482

Table 1-7: Estimated Population at Risk – Non-breach/Non-Failure

Location	Scenario Name	Structures Inundated	Daytime PAR	Nighttime PAR
LCL	Maximum Flood Overtopping	84,789	200,934	209,593
	2 ft Overtopping	74,302	172,426	179,198
	1 ft Overtopping	12,073	27,245	27,957
	<2ft Overtopping Breach	424	740	946
	Top of Levee	0	0	0
	75% Levee Height	0	0	0
	50% Levee Height	0	0	0
Beargrass Creek	100-year Interior Rain Event	823	2,306	1,816
	25-year Interior Rain Event	232	942	482

Table 1-8: Estimated Population at Risk - Incremental

Location	Scenario Name	Structures Inundated	Daytime PAR	Nighttime PAR
LCL	Maximum Flood Overtopping	0	0	0
	2 ft Overtopping	(2)	(13)	(41)
	1 ft Overtopping	22,270	50,385	51,789
	<2ft Overtopping Breach	14,710	33,904	34,831
	Top of Levee	15,553	35,653	36,789
	75% Levee Height	4,436	10,332	10,431
	50% Levee Height	1,641	4,009	3,779
MHL	Top of Levee	33,832	76,633	78,700
	75% Levee Height	21,242	48,705	50,344
	50% Levee Height	15,280	35,096	36,145
PHC	Top of Levee	29,422	71,351	71,663
	75% Levee Height	14,768	36,504	35,987
	50% Levee Height	2,952	7,782	7,657
Beargrass Creek	100-year Interior Rain Event	6,709	44,040	19,568
	25-year Interior Rain Event	3,915	33,423	12,000

1.3.8 Life Loss Model Inputs and Parameters

Structure Inventory

The structure inventory was developed using the National Structure Inventory (NSI) data created by HEC from the 2010 HAZUS database and other sources. Structure, content, and vehicle values were updated to 2014 prices and the population was updated to 2014. The structure mix is shown in below.

Table 1-9: Structure count in leveed area

Category	Structure count
Residential	110,841
Commercial	9,150
Industrial	2,182

Public	1,668
Total	123,841

Road Network and Destination Points

The road network was developed using data from OpenStreetMaps. The data contains information about road type, bridges and directional attributes (one way). The road network was modified in order to properly account for all overpasses and bridges in order for each road segment to have the appropriate vertical offset relative to the ground elevation. The road network and destination points are shown in Figure 1-5.

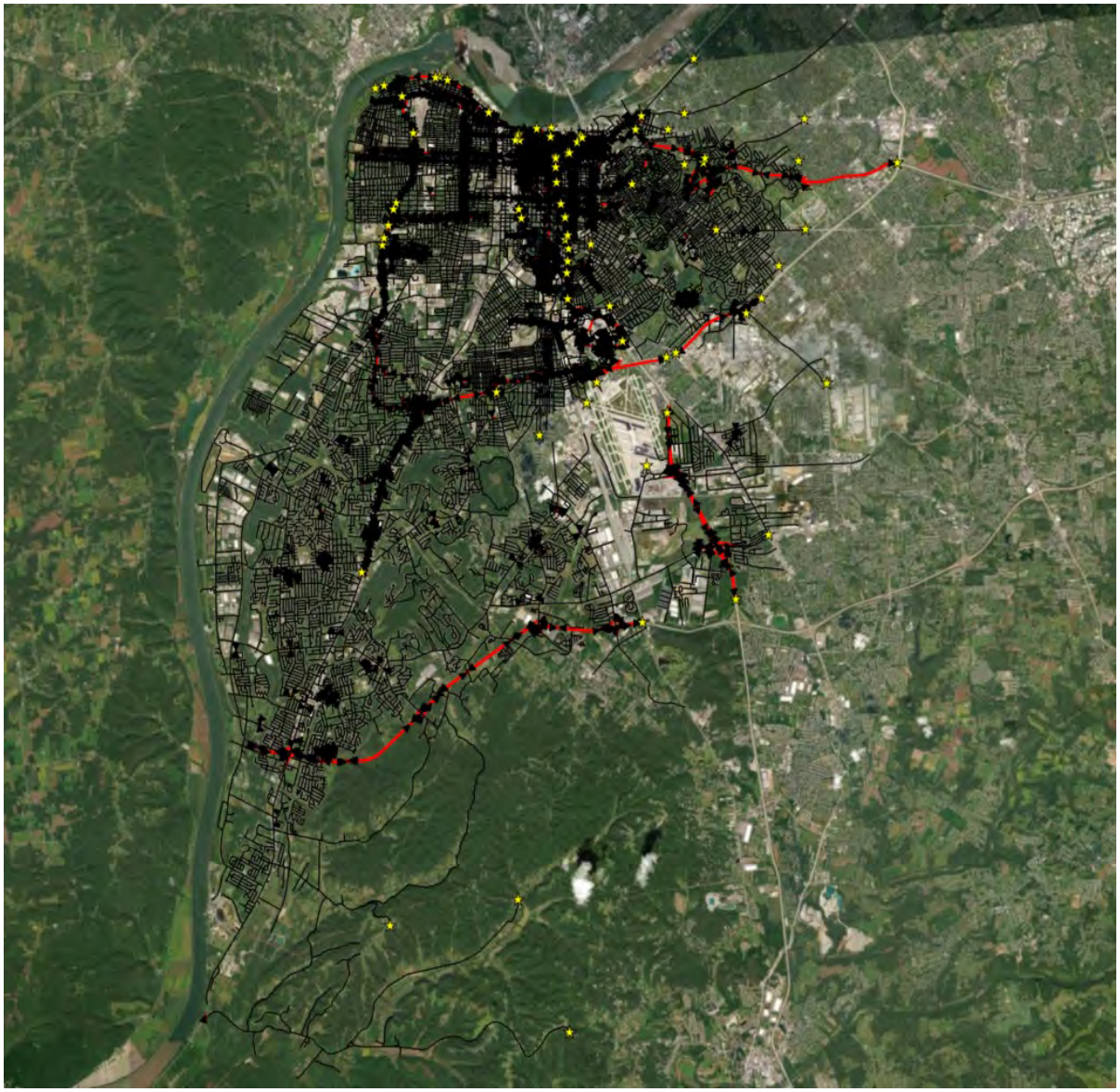

Figure 1-5: Road Network and Destination Points

Emergency Preparedness

A consequences elicitation was not conducted for this assessment. Because of uncertainty associated with emergency operations and response during a flood event, it was necessary to account for a wide

range of possible warning and evacuation outcomes. A series of preset curves are included in the HEC-LifeSim 1.0.1 software. These curves were developed using the latest research from Mileti and Sorensen (2014)1. For this study, the "Preparedness Unknown" curves were chosen for the warning parameters (Warning Issuance Delay and Warning Diffusion). The Emergency Preparedness parameters are described in the sections that follow.

Relative Hazard Identification

The Hazard Identification time is the time at which a hazard is identified (levee breach or major flooding) relative to when it actually occurs (actual breach time). The MMC uses two different warning scenarios with different ranges of hazard identification time: minimal warning and ample warning. Minimal warning scenarios have the hazard identification relative time set as a uniform distribution between 3 hours prior to breach and one half hour after the breach (-3 to 0.5 hours). Ample warning scenarios have the hazard identification relative time set as 24 hours prior to the breach (-24). For overtopping scenarios, warning is relative to the time that overtopping begins, not breach time. The Relative Hazard Identification Times used for all the failures except the failure at the Beargrass Creek Pump Station in this study are discussed below.

Table 1-10: Relative Hazard Identification Times – Levee Breach

Warning Scenario	Distribution Type	Minimum (hours)	Maximum (hours)
Minimal	Uniform	-3	0.5
Ample	None	-24	

For the pumping station failure mode the imminent hazard time was the beginning of the rainfall event simulation. Similar to the breach scenarios, the pumping station failure was modeled with minimal and ample warning times. In addition a late warning scenario was introduced that assumed the pumping station failure would be identified many hours after the beginning of the event. This was to account for the length of time it would take from the start of the simulated rainfall event until the flood depths increased to a point at which the pumping station operators would need to operate the pumps and thereafter identify the failure.

Table 1-11: Relative Hazard Identification Times – Pumping Station Failure

Warning Scenario	Distribution Type	Minimum (hours)	Maximum (hours)
Minimal	Uniform	-3	0.5
Ample	None	-24	
Late	Uniform	14	17.5

Hazard Communication Delay

The Hazard Communication Delay is the time that it would take from when the hazard is identified to when the EPZ representatives would be notified. For example, if a breach occurs when no one is observing the project then the emergency managers could be notified after the hazard is identified. The

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2 Sorensen, J. and D. Mileti (2014a). First Alert and/or Warning Issuance Time Estimation for Dam Breaches, Controlled Dam Releases, and Levee Breaches or Overtopping. Draft paper prepared for U.S. Army Corps of Engineers. Institute for Water Resources, Risk Management Center. Davis, CA.

hazard communication delay is set as a uniform uncertainty distribution between .01 hours and .5 hours.

Warning Issuance Delay

The Warning Issuance Delay is the time it takes from when the emergency managers receive the notification of the imminent hazard to when they issue the first evacuation order to the public. In the case of this levee system, the preset "Preparedness Unknown" curve was chosen. Although the range of possible warning issuance delay possibilities is between 0 minutes and 300 minutes, the most likely outcome is warning issuance 30 minutes after officials are notified of the flood hazard.

Warning Diffusion

The "Preparedness Unknown" preset curves were considered most appropriate for this study. The curves utilize a uniform uncertainty distribution and the warning diffusion curves are sampled during each Monte Carlo iteration in HEC-LifeSim. It should be noted that the unknown curves do not dictate that warnings will be disseminated slowly as the upper bound represents a well-prepared warning delivery system and the lower bound represents a poorly prepared system.

Protective Action Initiation

The Protective Action Initiation (PAI) Curve is shown in Figure 6.15. PAI is the rate at which PAR take action after receiving an evacuation order (warning). Unlike the curves presented for warning above, the PAI "Preparedness Unknown" curve includes a perception element as well. The perception element describes a PAR as being aware of their flood risk (Perception = Likely to Impact) or generally unaware that they're at risk of being flooded (Perception = Unlikely to Impact. Because of the dynamic nature of the perception element during an event that takes time to develop, the "Preparedness Unknown: Perception Unknown" curve was considered the most appropriate and is depicted in the figure below.

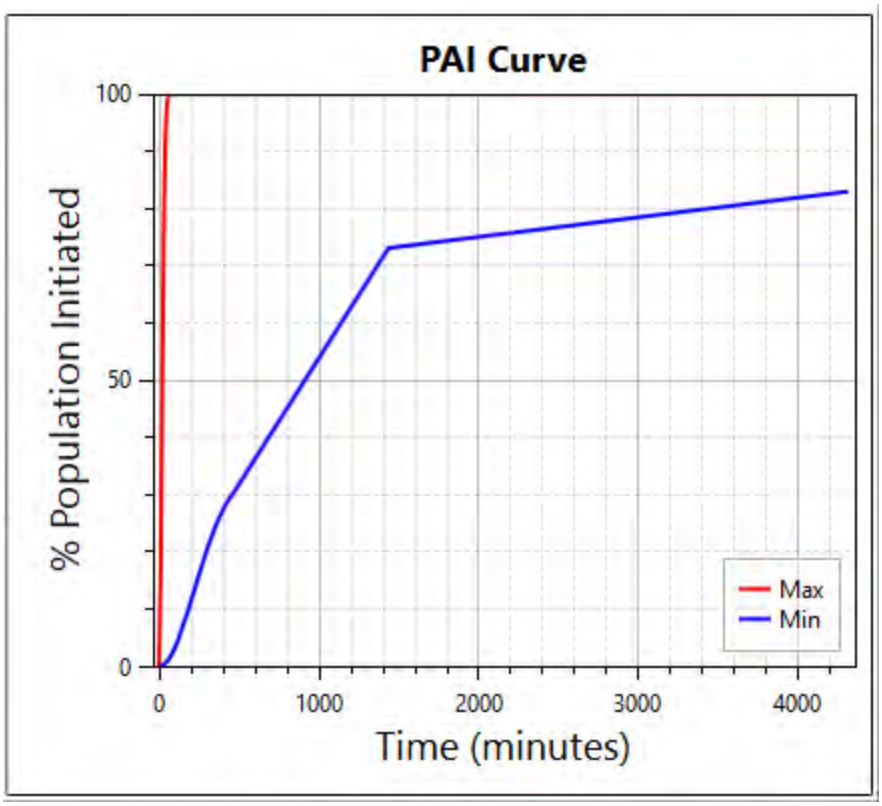

Figure 1-6: PAI Curve

1.3.9 Life Loss Estimates

Table 1-12: Median Life Loss for Minimal Warning Scenario

Scenario Name	Breach Life Loss		Non-Breach Life Loss		Incremental Life Loss	
	Day	Night	Day	Night	Day	Night
LCL MAX OT	7,437	8,459	7,512	8,533	-75	-74
LCL 2FT OT	4,141	4,713	4,141	4,715	-1	-3
LCL 1FT OT	719	829	49	62	670	767
LCL <2ft OT	90	121	0	0	90	121
LCL Top of Levee	219	274	0	0	219	274
LCL 75p	34	29	0	0	34	29
LCL 50p	6	2	0	0	6	2
MHL TOL	1,434	1,830	0	0	1,434	1,830
MHL 75p	660	925	0	0	660	925
MHL 50p	342	444	0	0	342	444
PHC TOL	417	503	0	0	417	503
PHC 75p	49	74	0	0	49	74
PHC 50p	5	17	0	0	5	17
Beargrass100	32	15	2	0	30	15
Beargrass25	16	5	0	0	16	5

Table 1-13: Median Life Loss for Ample Warning Scenario

Scenario Name	Breach Life Loss		Non-Breach Life Loss		Incremental Life Loss	
	Day	Night	Day	Night	Day	Night
LCL MAX OT	3,004	3,436	3,009	3,457	-5	-21
LCL 2FT OT	1,622	1,855	1,622	1,855	0	0
LCL 1FT OT	394	458	32	40	362	418
LCL <2ft OT	60	85	0	0	60	85
LCL Top of Levee	105	136	0	0	105	136
LCL 75p	15	18	0	0	15	18
LCL 50p	0	1	0	0	0	1
MHL TOL	374	464	0	0	374	464
MHL 75p	187	261	0	0	187	261
MHL 50p	96	130	0	0	96	130
PHC TOL	72	108	0	0	72	108
PHC 75p	12	20	0	0	12	20
PHC 50p	0	3	0	0	0	3
Beargrass100	29	14	3	1	26	13
Beargrass25	14	28	0	0	14	28

Table 1-14: Median Life Loss for Late Warning Scenario

Scenario Name	Breach Life Loss		Non-Breach Life Loss		Incremental Life Loss	
	Day	Night	Day	Night	Day	Night
Beargrass100	80	92	2	0	78	92
Beargrass25	44	50	0	0	44	50

The life loss statistics for each run are shown below using bar charts on a logarithmic scale to demonstrate the potential order-of-magnitude of breach life loss for each flood loading scenario. It should be noted that the uncertainty ranges only reflect the uncertainty parameters for life loss as modeled in the HEC-LifeSim scenarios and do not include uncertainties around breach parameters or other hydraulic/hydrologic factors.

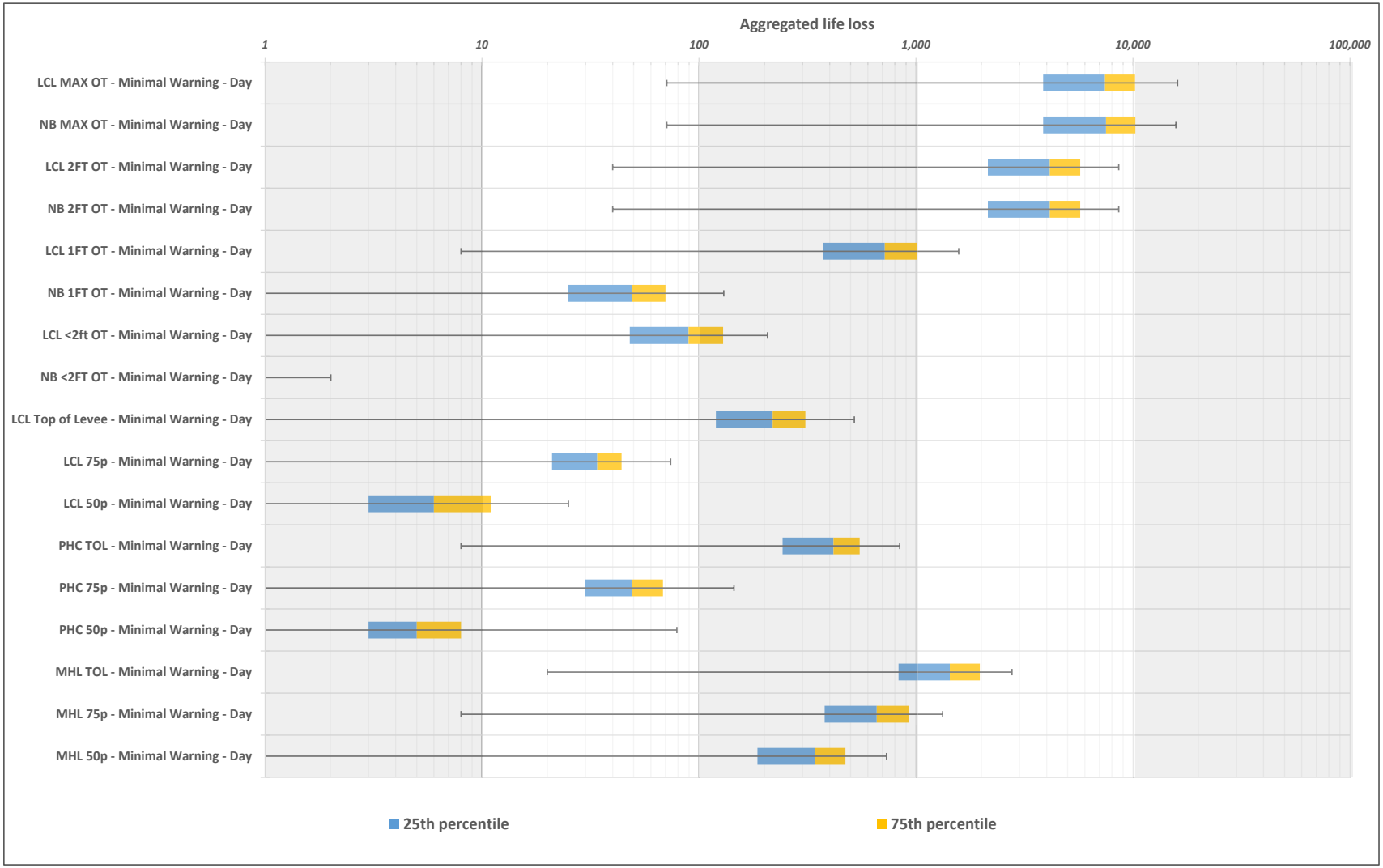

Figure 1-7: Order-of-Magnitude Breach Life Loss for Minimal Warning Scenario

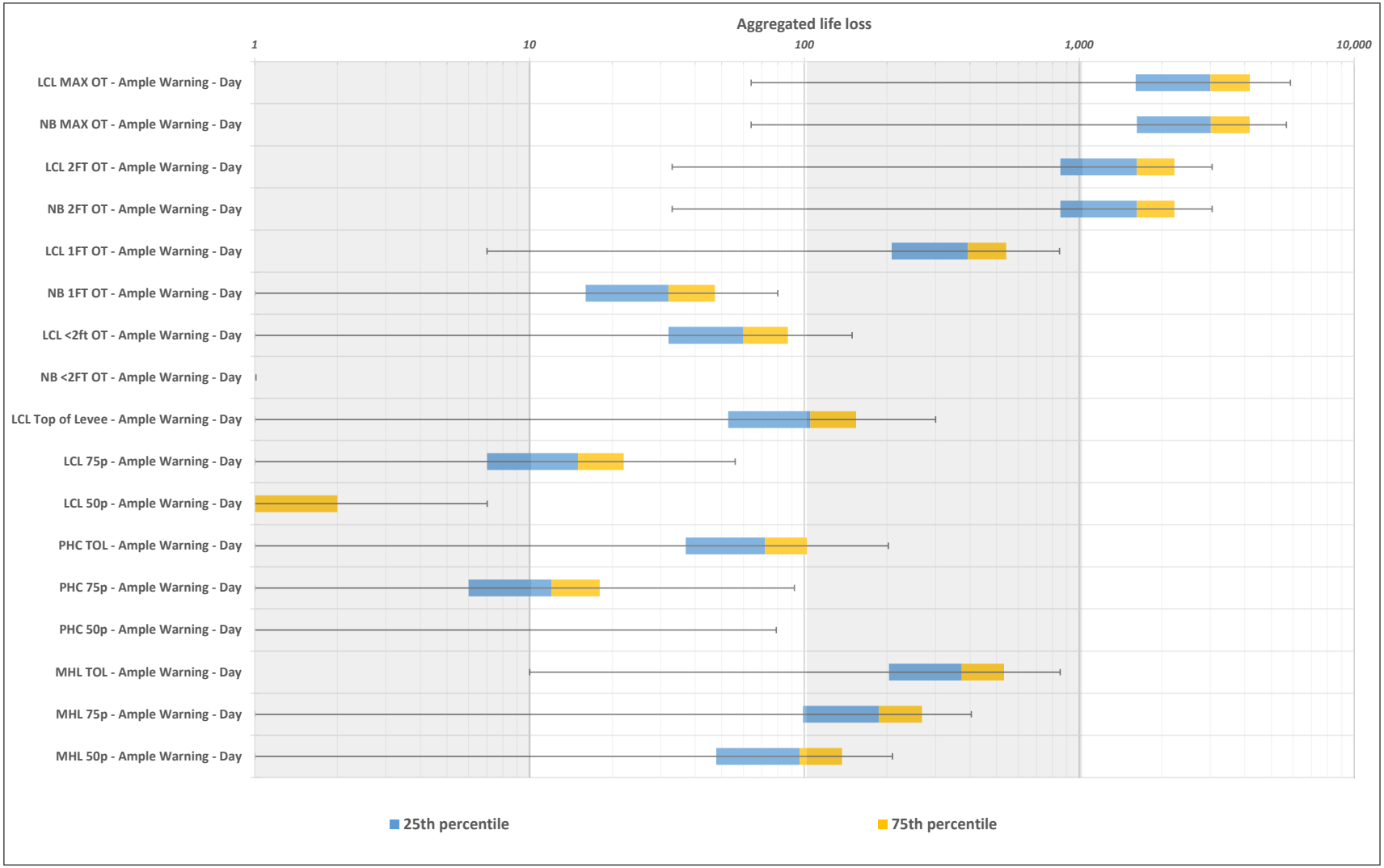

Figure 1-8: Order-of-Magnitude Breach Life Loss for Ample Warning Scenario

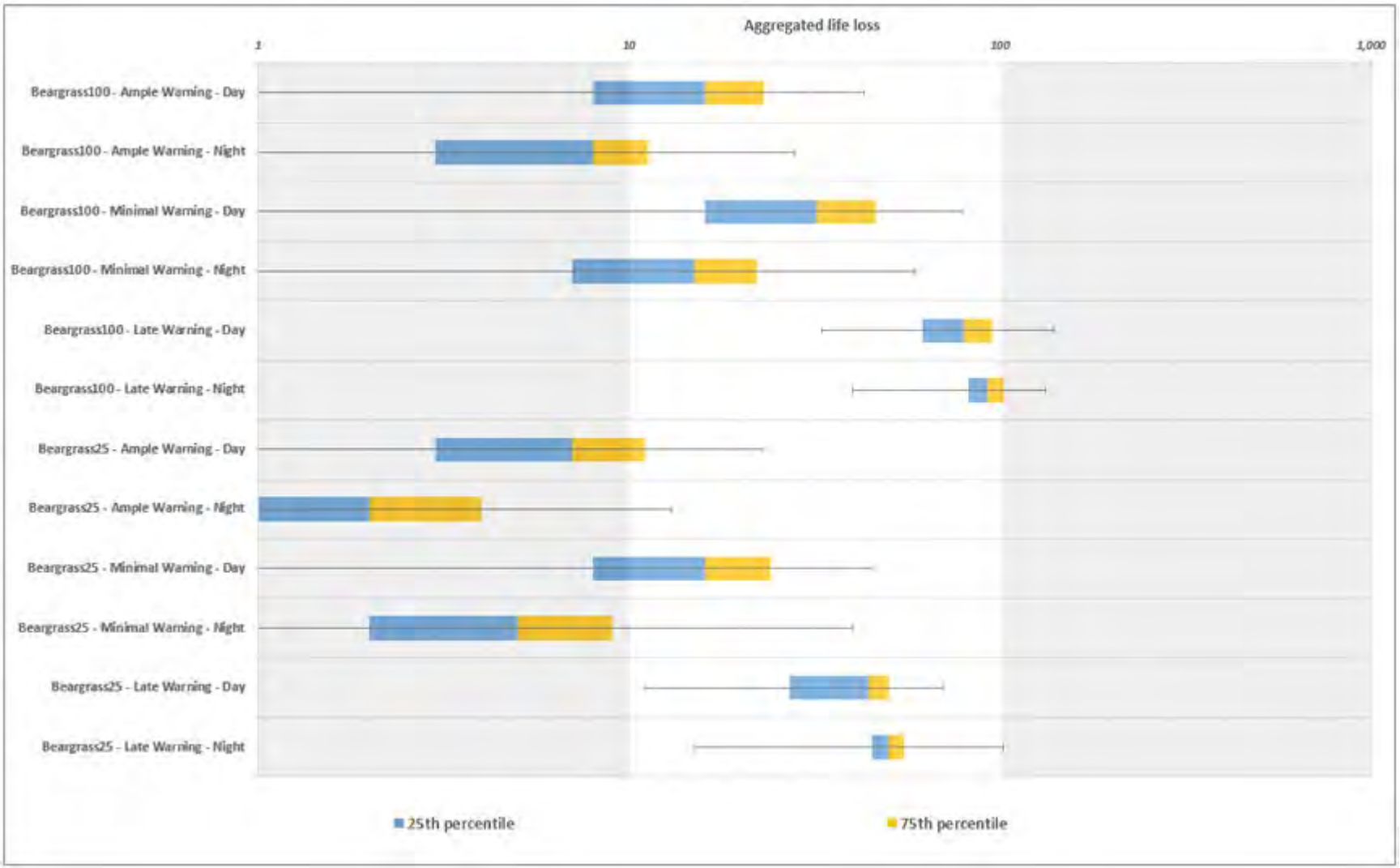

Figure 1-9: Order-of-Magnitude Pumping Station Failure Life Loss for All Warning Scenarios

Total Life Loss by Arrival Time

The tables below show total life loss from selected scenarios broken down according to flood wave arrival times at structures. Arrival time is the time in hours relative to the hazard initiation (breach or initiation of overtopping flow) at which a threshold depth of 2 feet is exceeded at a specific structure.

Table 1-15: LCL 1-Foot Overtopping Breach – Life Loss by Arrival Time

Arrival Time from Hazard Initiation	**Depth Ranges (feet)**	**Life Loss**					
		Day			Night		
		5th%	Median	95th%	5th%	Median	95th%
0 to 1 hours	0 - 0	0	0	0	0	0	0
1 to 2 hours	0 - 0	0	0	0	0	0	0
2 to 4 hours	8 - 22	0	0	0	0	0	0
4 to 8 hours	9 - 15	0	2	6	0	8	17
8 to 24 hours	8 - 16	28	235	416	24	261	473
Over 24 hours	3 - 10	43	470	846	48	545	973
Total		71	707	1,268	72	813	1,463

Table 1-16: LCL Top of Levee Breach – Life Loss by Arrival Time

Arrival Time from Hazard Initiation	**Depth Ranges (feet)**	**Life Loss**					
		Day			Night		
		5th%	Median	95th%	5th%	Median	95th%
0 to 1 hours	0 - 0	0	0	0	0	0	0
1 to 2 hours	6 - 13	0	0	0	0	0	0
2 to 4 hours	13 - 21	1	12	18	1	7	11
4 to 8 hours	15 - 18	0	3	6	1	9	18
8 to 24 hours	6 - 12	14	87	157	12	117	213
Over 24 hours	2 - 9	10	112	211	11	135	239
Total		25	214	392	25	268	481

Table 1-17: MHL Top of Levee Breach – Life Loss by Arrival Time

Arrival Time from Hazard Initiation	**Depth Ranges (feet)**	**Life Loss**					
		Day			Night		
		5th%	Median	95th%	5th%	Median	95th%
0 to 1 hours	0 - 0	0	0	0	0	0	0
1 to 2 hours	0 - 0	0	0	0	0	0	0
2 to 4 hours	10 - 15	40	216	312	79	294	411
4 to 8 hours	9 - 18	60	403	709	94	460	730
8 to 24 hours	5 - 12	123	734	1,260	197	973	1,549
Over 24 hours	2 - 7	4	64	125	7	78	150
Total		227	1,417	2,406	377	1,804	2,840

1.3.10 Life Loss on Roads

A potentially important element of life safety consequences is risk to PAR while evacuating after receiving an evacuation order. A levee breach would necessitate that people at risk take protective action in many cases. In an effort to account for life safety risk to PAR while evacuating, HEC-LifeSim 1.0.1 simulates evacuation in vehicles on a road network. By simulating evacuation it is possible to estimate how much life safety risk on roads contributes to life safety risk as a whole. Table 1-17 and Table 1-18 present the estimated total median life loss estimates in comparison with the estimated median life loss on roads.

Table 1-18: Life Loss on Roads – Minimal Warning Breach

Location (Station)	Scenario Name	Median Total Life Loss		Median Life Loss on Roads	
		Day	Night	Day	Night
LCL	Maximum Flood Overtopping	7,437	8,459	2,588	2,849
	2 ft Overtopping	4,141	4,713	1,489	1,626
	1 ft Overtopping	719	829	287	319
	<2ft Overtopping Breach	90	121	19	22
	Top of Levee	219	274	87	83
	75% Levee Height	34	29	13	2
	50% Levee Height	6	2	6	0
MHL	Top of Levee	1,434	1,830	412	535
	75% Levee Height	660	925	135	168
	50% Levee Height	342	444	87	102
PHC	Top of Levee	417	503	313	316
	75% Levee Height	49	74	24	24
	50% Levee Height	5	17	2	1
Beargrass Creek	100-year Interior Rain Event	82	15	1	1
	25-year Interior Rain Event	16	5	0	0

Table 1-19: Life Loss on Roads – Non-Breach

Location (Station)	Scenario Name	Median Total Life Loss		Median Life Loss on Roads	
		Day	Night	Day	Night
LCL	Maximum Flood Overtopping	7,512	8,533	2,589	2,852
	2 ft Overtopping	4,141	4,715	1,489	1,624
	1 ft Overtopping	49	62	49	62
	<2ft Overtopping Breach	0	0	0	0
Beargrass Creek	100-year Interior Rain Event	2	0	0	0
	25-year Interior Rain Event	0	0	0	0

1.3.11 Economic Losses

Economic considerations help inform risk management decisions. Direct economic losses considered in this risk assessment include direct property damages and levee repair and replacement costs.

1.3.12 Property Damage

An inventory of downstream property directly damaged by the inundation was developed using the structure inventory described previously in the modeling parameter section which contains information for residential, commercial, industrial, agricultural, public and private structures as well as data for essential facilities such as hospitals, clinics, fire stations, police stations, emergency operation centers, schools and universities. Property damage in this assessment accounts for damage to structures and their associated contents and vehicles. The median estimates for direct property damage due to a levee breach are displayed in Table 1-19.

Table 1-20: Estimated Median Direct Property Damage

Location (Station)	Scenario Name	Median Direct Economic Damage Estimates		
		Breach	Non-Breach	Incremental
LCL	Maximum Flood Overtopping	$23,770,627,433	$23,770,622,000	$5,433
	2 foot Overtopping	$15,175,410,000	$15,175,359,000	$51,000
	1 foot Overtopping	$5,271,772,000	$1,392,696,900	$3,879,075,100
	<2ft Overtopping Breach	$1,974,283,500	$40,951,585	$1,933,331,915
	Top of Levee	$2,050,153,440	$0	2,050,153,440
	75% Levee Height	$379,301,390	$0	379,301,390
	50% Levee Height	$114,005,160	$0	114,005,160
MHL	Top of Levee	$5,109,151,850	$0	5,109,151,850
	75% Levee Height	$3,130,406,800	$0	3,130,406,800
	50% Levee Height	$2,002,849,200	$0	2,002,849,200
PHC	Top of Levee	$4,684,880,800	$0	4,684,880,800
	75% Levee Height	$2,250,283,700	$0	2,250,283,700
	50% Levee Height	$606,470,700	$0	606,470,700
Beargrass Creek	100-year Interior Rain Event	$1,990,462,200	$243,785,460	$1,746,676,740
	25-year Interior Rain Event	$1,094,257,700	$60,139,410	$1,034,118,290

Levee Repair Costs

Levee repair or replacement costs depend on the extent of damage to the levee. For catastrophic failure, these rebuilding costs are estimated using 2015 prices. If the levee can be repaired (e.g., partial breach), the repair costs can be included in the direct economic losses using this method. For those scenarios, detailed cost estimates were not prepared, and the repair or replacement costs for risk-driver potential failure modes resulting in partial breach were estimated separately by the SQRA team in Chapter 7. Environmental restoration, emergency response expenses, and other indirect costs were not included in the estimates. The levee repair costs were estimated using "Guidance for Estimating Earthen Levee and Floodwall Costs" and are presented in Table 1-20. A more detailed analysis of potential repair cost may yield different results than this simple methodology.

Table 1-21: Levee Repair Estimates by Breach Location

Location (Station)	Breach Scenario	Breach Length (feet)	Repair Cost Range		
			Low	Average	High
PHC	TOL	269	$9,528	$39,004	$68,479
MHL	TOL	820	$29,003	$118,722	$208,441
LCL	TOL	428	$15,138	$61,968	$108,798

Other Impacts and Considerations

Lower-income residents in the leveed area may be particularly vulnerable, as they are less likely to have reliable means of transportation and communication during an emergency flood scenario. However, there are several major egress routes out of the leveed area, and many interstates and expressways would be elevated above expected inundation depths, which could facilitate efficient evacuations of the hazard area if a breach or overtopping were to occur. Flood recovery could be impeded if these residents lack flood insurance or other necessary financial and political resources.

There are industrial and chemical facilities immediately behind the levee in west Louisville that may experience severe impacts upon inundation. A resulting combustion has the potential to increase life loss, economic damages and environmental impacts. It was determined that trying to quantify these risk is outside the scope of this assessment, but should be considered for future studies. The local sponsor along with other various agencies is currently working develop additional information related to these issues and potential quantify the consequences.

1.4 Project Benefits

As mentioned previously, the economic evaluation efforts associated with the LMFPS Feasibility Study were conducted primarily around the limited reconstruction objective which produces no change in the original project's scope or function. As such, traditional economic evaluation procedures were not utilized and the PDT and vertical team decided to evaluate the benefits of the LMFPS on a system wide basis, based on annualized flood damages reduced by the project since its construction.

1.4.1 Louisville Metro Flood Protection System Benefits

Each year, the Louisville District produces Annual Project Accomplishments for every urban local protection project, agricultural local protection project, and multipurpose reservoir within its Civil Works boundary. This memorandum provides information on storm events and associated flood damages in the Louisville District in support of the U.S. Army Corps of Engineers Annual Flood Damage Reduction Report to Congress. The report is prepared in response to House Committee Report 98-217, Energy and Water Development Appropriation Act of 1984. This report includes data on flood damages reduced by projects controlled by the U.S. Army Corps of Engineers. The report represents preliminary estimates available at the end of the fiscal year from a variety of sources. These estimates are generated by applying real rainfall, stream, and gauge data to established depth-damage curves for each project within the Louisville District Civil Works boundary. The data is intended to provide an overall assessment of storm events and the extent of beneficial flood damages prevented by the Louisville District. The Louisville District Project Accomplishments are utilized in the annual Report of the Secretary of the Army on Civil Works Activities. Upward reporting of flood damage reduction outcomes is also required by the Office of Management and Budget (OMB) to assess the Corps via the Performance Assessment Rating Tool (PART).

The process for developing the annual flood damages reports is fairly straightforward. Each year, typically around December or January, the district water control or Hydraulics and Hydrology branch will review available data (gages, etc.) around completed flood risk management projects (FRM). Those data are then distilled to a set of flows, stages, or frequencies representing reductions in the area of, or as a result of an existing project. For example, storage projects typically provide information for (1) what

level the river would have reached, had the project not been operated and (2) what level the river did reach. Levee projects typically only require the actual river levels. This information is then passed to a district economist, who compares the H&H information with a set of project-specific stage-damage functions. These functions, combined with the H&H information, produce the economic value of the damages prevented. These values are then passed back to water control or H&H, then progress through the MSC, and Headquarters before ultimately being combined in an annual report to Congress.

The stage-damage curves used for the LMFPS date back to 1962. While the price levels are typically updated by the economist each year, the population centers and surrounding areas have seen significant change over the past 60+ years, particularly in growth of residential, commercial, and industrial structures. This means it is nearly certain that the District is systematically underestimating the value of existing FRM projects, including LMFPS, by failing to capture the intensification of benefits that has occurred. Table 21, on the following page, displays the actual Louisville Metro Flood Protection System Annual Flood Damage Reductions in the year in which they transpired, with each occurrence also indexed to current FY19 price levels using the Engineering News-Record's Construction Cost Index.

Table 1.1-22: Louisville Metro FPS Annual Flood Damage Reduction

Flood Damages Prevented Calculator

Year	Base Year Index	Current Year: 2019	Index Factor (ENR CCI)	Flood Damage Prevented (observed year)	Damages Prevented 2019 Price Level
1955	660	11183.53	16.9447	$ 1,430,000	$ 24,230,982
1956	692	11183.53	16.1612	$ -	$ -
1957	724	11183.53	15.4469	$ -	$ -
1958	759	11183.53	14.7346	$ 410,200	$ 6,044,116
1959	797	11183.53	14.0320	$ -	$ -
1960	824	11183.53	13.5722	$ -	$ -
1961	847	11183.53	13.2037	$ 919,100	$ 12,135,516
1962	872	11183.53	12.8251	$ 1,887,300	$ 24,204,904
1963	901	11183.53	12.4124	$ 1,350,000	$ 16,756,676
1964	936	11183.53	11.9482	$ 6,136,000	$ 73,314,252
1965	971	11183.53	11.5175	$ -	$ -
1966	1019	11183.53	10.9750	$ -	$ -
1967	1074	11183.53	10.4130	$ 1,617,300	$ 16,840,897
1968	1155	11183.53	9.6827	$ 484,000	$ 4,686,432
1969	1269	11183.53	8.8129	$ -	$ -
1970	1381	11183.53	8.0981	$ -	$ -
1971	1581	11183.53	7.0737	$ 100	$ 707
1972	1753	11183.53	6.3797	$ 230,000	$ 1,467,320
1973	1895	11183.53	5.9016	$ -	$ -
1974	2020	11183.53	5.5364	$ -	$ -
1975	2212	11183.53	5.0558	$ -	$ -
1976	2401	11183.53	4.6579	$ -	$ -
1977	2576	11183.53	4.3414	$ -	$ -
1978	2776	11183.53	4.0286	$ -	$ -
1979	3003	11183.53	3.7241	$ 14,146,000	$ 52,681,390
1980	3237	11183.53	3.4549	$ -	$ -
1981	3535	11183.53	3.1637	$ -	$ -
1982	3825	11183.53	2.9238	$ -	$ -
1983	4066	11183.53	2.7505	$ 89,000	$ 244,794
1984	4146	11183.53	2.6974	$ -	$ -
1985	4195	11183.53	2.6659	$ -	$ -
1986	4295	11183.53	2.6038	$ -	$ -
1987	4406	11183.53	2.5383	$ -	$ -
1988	4519	11183.53	2.4748	$ -	$ -
1989	4615	11183.53	2.4233	$ 1,499,000	$ 3,632,527
1990	4732	11183.53	2.3634	$ -	$ -
1991	4835	11183.53	2.3130	$ -	$ -
1992	4985	11183.53	2.2434	$ -	$ -
1993	5210	11183.53	2.1466	$ -	$ -
1994	5408	11183.53	2.0680	$ -	$ -
1995	5471	11183.53	2.0441	$ -	$ -
1996	5620	11183.53	1.9900	$ -	$ -
1997	5826	11183.53	1.9196	$ 61,353,000	$ 117,772,591
1998	5920	11183.53	1.8891	$ -	$ -
1999	6059	11183.53	1.8458	$ -	$ -
2000	6221	11183.53	1.7977	$ -	$ -
2001	6334	11183.53	1.7656	$ -	$ -
2002	6538	11183.53	1.7105	$ -	$ -
2003	6694.64	11183.53	1.6705	$ -	$ -
2004	7114.89	11183.53	1.5718	$ 1,786,000	$ 2,807,322
2005	7445.98	11183.53	1.5020	$ 13,280,000	$ 19,945,968
2006	7749.36583	11183.53	1.4432	$ -	$ -
2007	7970.52083	11183.53	1.4031	$ -	$ -
2008	8311.14083	11183.53	1.3456	$ 2,146,000	$ 2,887,673
2009	8570	11183.53	1.3050	$ 2,101,000	$ 2,741,727
2010	8799	11183.53	1.2710	$ -	$ -
2011	9070	11183.53	1.2330	$ 18,836,000	$ 23,225,245
2012	9308	11183.53	1.2015	$ -	$ -
2013	9547	11183.53	1.1714	$ -	$ -
2014	9806	11183.53	1.1405	$ -	$ -
2015	10035	11183.53	1.1145	$ 9,525,000	$ 10,615,159
2016	10338	11183.53	1.0818	$ -	$ -
2017	10737	11183.53	1.0416	$ 218,000	$ 227,066
2018	10870.06	11183.53	1.0288	$ 30,630,000	$ 31,513,306
2019	11183.53	11183.53	1.0000	$ -	$ -

Number of Years	$ 64	
Unindexed Cumulative	$ 170,073,000	
Unindexed Annual Average	$ 2,657,391	
Indexed Cumulative		$ 447,976,570
Indexed Annual Average		$ 6,999,634
Present Value		$184,452,884.17

1.4.2 Project Accomplishments Comparison to LifeSim model runs

It is understood that the Louisville District has certainly underestimated annual project accomplishments associated with the Louisville Metro Flood Protection System by using the 1962 stage-damage curves. To account for this underestimation, a comparison between expected flood damages using the 1962 stage-damage curves and expected flood damages observed using a HEC-LifeSim model with an up-to-date structure inventory was conducted.

The Louisville District's Engineering Division provided hydraulic models from HEC-RAS that demonstrated the inundation of the Metro Louisville area during 1-, 2-, 5-, 10-, 25-, 50-, 100-, and 500-year flood events in a simulation wherein the city is unprotected by the levee system. In the HEC-RAS model cross sections, the levee was removed to represent the without project condition. These flood events are derived from the updated flow frequency curve produced by the 2019 SQRA. The flood scenarios were imported into HEC-LifeSim 1.0.1 along with a structure inventory based on the National Structure Inventory 2.0. Structure placement in the NSI 2.0 is based on 2017 parcel data, and structure, content, and vehicle values are in 2018 prices. The resulting property damage expected from those flood events is shown in Table 1-22 below.

Table 1-23: Estimated property damage using LifeSim

Flood event	Estimated property damage per event
1-year	$279,202
2-year	$7,771,261
5-year	$12,508,673
10-year	$27,691,290
25-year	$66,677,426
50-year	$202,267,170
100-year	$483,377,680
500-year	$1,634,487,200

To estimate damage from the same events using the 1962 state-damage curves, Engineering Division provided corresponding river elevations and stages at the Upper Gage and Lower Gage at Louisville's McAlpine Locks and Dam, which are used to calculate benefits for the system. The estimated property damage from the 1962 stage-damage curves are shown in Table 1-23 below.

Table 1-24: Estimated property damage using 1962 stage-damage curves

Flood event	McAlpine Upper Gage		McAlpine Lower Gage		Total expected damage per event
	Stage	Damage	Stage	Damage	
1-year	17.47 feet	$0	46.33 feet	$0	$0
2-year	23.64 feet	$0	55.04 feet	$0	$0
5-year	27.43 feet	$1,572,000	59.97 feet	$0	$1,572,000
10-year	31.12 feet	$11,845,000	63.99 feet	$116,000	$11,961,000
25-year	34.80 feet	$22,974,000	67.58 feet	$1,218,000	$24,192,000
50-year	37.79 feet	$35,128,000	70.65 feet	$8,755,000	$43,883,000
100-year	40.17 feet	$48,433,000	73.03 feet	$26,929,000	$75,362,000
500-year	44.95 feet	$203,908,000	77.62 feet	$139,766,000	$343,674,000

The difference in these two methods of estimation demonstrates vividly the failure of the 1962 stage-damage curves to capture the intensification of benefits that has occurred from increased development in the leveed area since the origin of the curves.

Expected annual damages were estimated based upon the flood events simulated in LifeSim, shown in Table 1-24 below.

Table 1-25: Expected Annual Damages Computation

Louisville Metro Flood Protection System
Emergency Supplemental Feasibility Study
Annual Damage Computation
LifeSim Model Results

Recurrence Interval	Probability	Probability Interval	Damages	Interval Average Damages	Interval Damage Calculation	Summary of Expected Annual Damages
1	0.999		$249,202			
		0.499		$4,010,232	$2,001,106	$2,001,106
2	0.5		$7,771,261			
		0.3		$10,139,967	$3,041,990	$5,043,096
5	0.2		$12,508,673			
		0.1		$20,099,982	$2,009,998	$7,053,094
10	0.1		$27,691,290			
		0.06		$47,184,358	$2,831,061	$9,884,155
25	0.04		$66,677,426			
		0.02		$134,472,298	$2,689,446	$12,573,601
50	0.02		$202,267,170			
		0.01		$342,822,425	$3,428,224	$16,001,825
100	0.01		$483,377,680			
		0.008		$1,058,932,440	$8,471,460	$24,473,285
500	0.002		$1,634,487,200			

Applying the LifeSim-based expected annual damages ($24,473,285) to the project's total average annual costs of $6,729,000 results in a benefit-cost ratio of 3.6:1.

1.5 Screening

The PDT engaged in a screening-level analysis of select pumping stations to determine if there was a need for further study. If upon inspection it was determined a pump station required further review, the intent of the PDT was to then study each pump station on an individual and incremental basis, as directed by the expanded scope. Ultimately, no such analysis was necessary.

1.5.1 Paddy's Run Pumping Station

Paddy's Run pumping station was screened by visually comparing the 1% annual chance exceedance ponding frequency under a few conditions: current rainfall, projected rainfall in 2065, and projected 2065 rainfall with doubled pump station capacity. As shown in the figure below, projected 2065 rainfall at current capacity does not cause any flooding of note to structures around the ponding area.

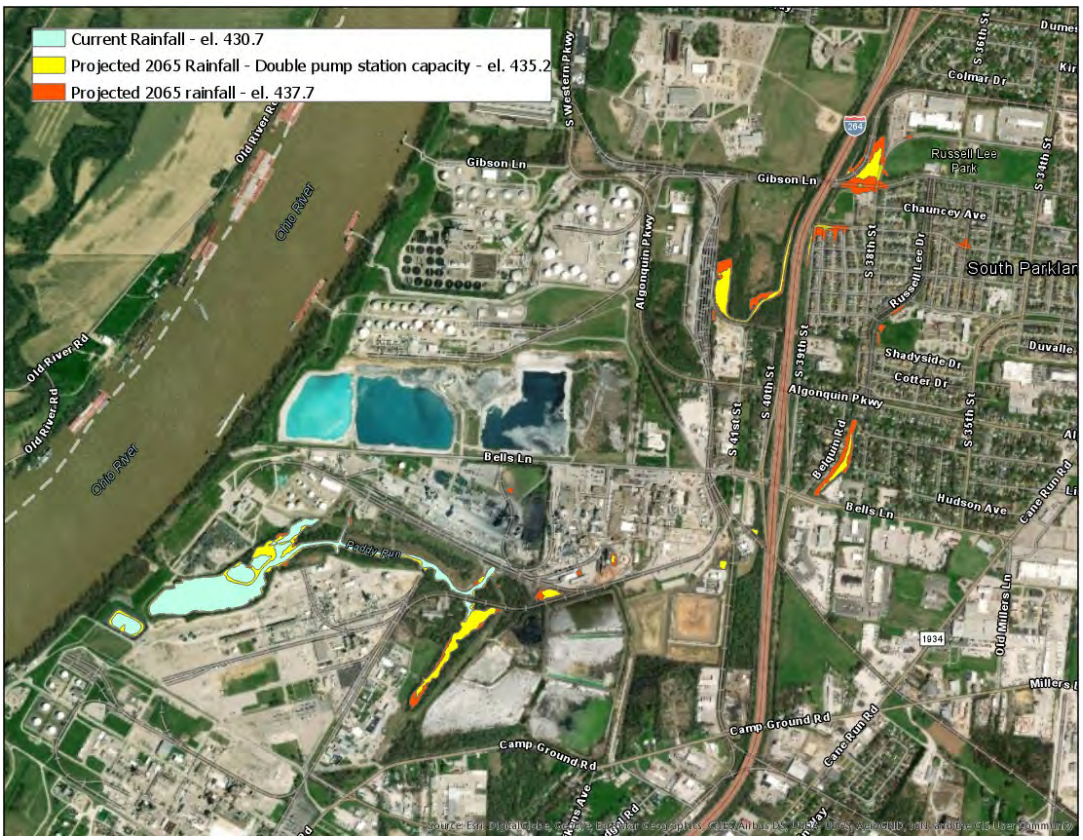

Figure 1-10: 1% Annual Chance Exceedance Ponding Frequency at Paddy's Run Pump Station

1.5.2 Riverport Pumping Station

The Riverport pumping station was screened by analyzing the inundation boundaries of the 10% annual chance exceedance and 1% annual chance exceedance ponding frequencies (10-year and 100-year events, respectively) with and without pumps operating. As shown in the figures below, no significant inundation of structures occurs even with no pumps operating.

Figure 1-11: Riverport pumping station 10% ACE event with and without pumps operating

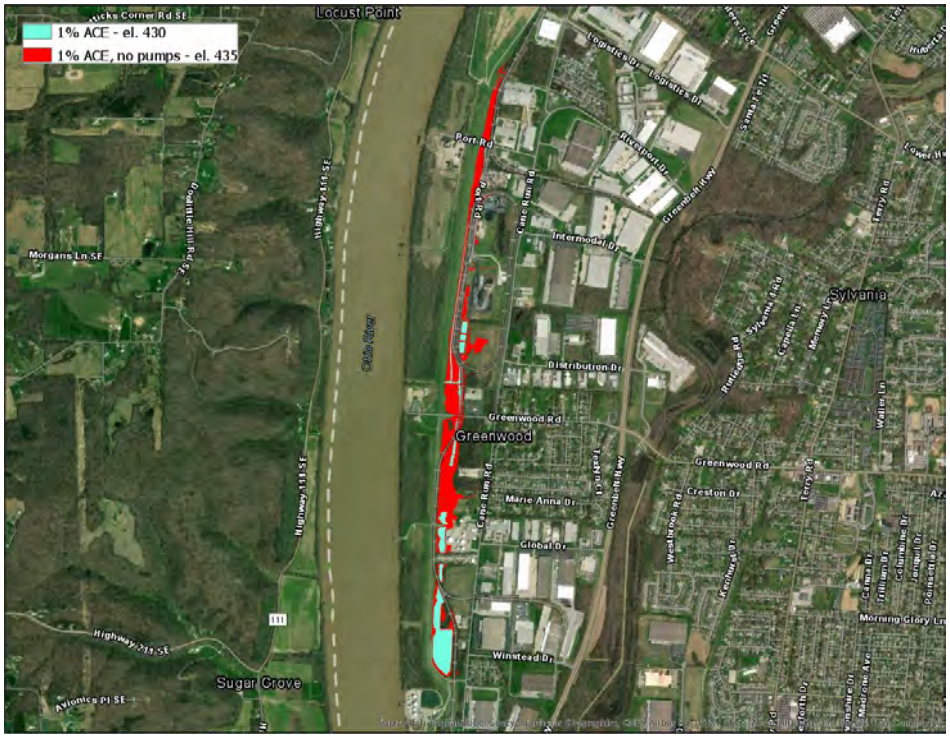

Figure 1-12: Riverport pumping station 1% ACE event with and without pumps operating

1.6 Summary of Annual Benefits and Costs

A summary of annual costs and benefits based on project accomplishments is presented below in Table 1-26.

Table 1-26: Annual Benefits and Costs – Project accomplishments-based benefits

Louisville Metro FPS Feasibility Study
(August 2019 Price Level, 50-Year Period of Analysis, 2.875 Percent Discount Rate)

Investment Costs	
Total Project Construction Costs	$ 167,742,000
Interest During Construction	12,468,000
Total Investment Cost	$ 180,210,000
Average Annual Costs	
Interest and Amortization of Initial Investment	$ 6,839,000
OMRR&R	0
Total Average Annual Costs	$ 6,839,000
Average Annual Benefits	$ 6,999,000
Net Annual Benefits	$ 161,000
Benefit-Cost Ratio	1.02 to 1
Benefit-Cost Ratio (computed at 7%)[1]	0.48 to 1

[1] Per Executive Order 12893 and OMB Circular A-94

A summary of annual costs and benefits based on LifeSim simulations is presented below in Table 1-27.

Table 1-27: Annual Benefits and Costs - LifeSim-calculated benefits

Louisville Metro FPS Feasibility Study
(August 2019 Price Level, 50-Year Period of Analysis, 2.875 Percent Discount Rate)

Investment Costs	
Total Project Construction Costs	$ 167,742,000
Interest During Construction	12,468,000
Total Investment Cost	$ 180,210,000
Average Annual Costs	

Interest and Amortization of Initial Investment	$ 6,839,000
OMRR&R	0
Total Average Annual Costs	$ 6,839,000
Average Annual Benefits	$ 24,473,285
Net Annual Benefits	$ 17,681,285
Benefit-Cost Ratio	3.6 to 1
Benefit-Cost Ratio (computed at 7%)[1]	1.7 to 1

[1] Per Executive Order 12893 and OMB Circular A-94

US Army Corps of Engineers
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Great Lakes and Ohio River Division
Louisville District

Louisville Metro Flood Protection System
Emergency Supplemental
Reconstruction Feasibility Study

VOLUME 1

APPENDIX F

CULUTRAL RESOURCE REPORTS

US Army Corps of Engineers
Louisville District

PHASE I ARCHAEOLOGICAL SURVEY OF THE RECONSTRUCTION AND REHABILITATION OF THE LOUISVILLE METRO FLOOD PROTECTION SYSTEM, JEFFERSON AND BULLITT COUNTIES, KENTUCKY

November 5, 2019

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Abstract

The following report describes the results of the Phase I archaeological survey of the proposed reconstruction and rehabilitation of an existing Flood Risk Management Project for the Louisville Metro Flood Protection System (LMFPS) located along the Ohio River in Jefferson and Bullitt Counties, Kentucky. The proposed reconstruction and rehabilitation of the LMFPS is located along sections of the Louisville Reach and Southwestern Jefferson County Reach in Jefferson County, Kentucky. This project is authorized by the Flood Control Act of 1938 and amended by the Flood Control Act of 1968. This project is a cooperative effort between the United States Army Corps of Engineers (USACE)-Louisville District and the Non-Federal sponsors interested in modernizing, upgrading, and making repairs to the LMFPS.

The archaeological area of potential effects (APE) of the archaeological survey includes the areas of proposed ground disturbing activities for the project which totals 48.95 acres (19.8 hectares). These areas of proposed ground disturbance associated with the reconstruction and rehabilitation of the LMFPS include:

- I-Wall reinforcement of three sections of the floodwall along North Clay and North Shelby Streets
- The proposed permanent closure of the 10th Street Closure and install swing gate closure
- New Canal Station T-Wall alignment located northeast of the Northwestern Parkway and southwest of the Louisville Riverwalk
- Demolition and filling of the 27th Street Closure
- A new asphalt road extending from North 31st Street to the McAlpine Lock and Dam Visitor Center
- Replacing discharge lines at Paddy's Run Pump Station
- Replacing discharge lines at Riverport Pump Station
- The demolition and replacement of the Johnson Road Closure Vault.
- Repair of the I-walls on either side of the Pond Creek Pump Station

The remaining elements of the reconstruction and rehabilitation of the LMFPS consist of replacing older elements within the pump stations or other elements of the flood protection system (replacing gates, upgrading mechanical/electrical equipment, etc.) that will not require ground disturbance.

The above ground historic structure survey of the project will be covered by a separate evaluation of the Louisville Reach and Louisville Gas and Electric Building in a separate report (Poole 2019).

Results of this archaeological survey revealed no evidence of prehistoric or historic archaeological sites within the APE. The survey did attempt to relocate sites 15Jf2, 15Jf766, and 15Bu160 that were previously recorded either within or adjacent to the proposed APE. All three areas have been previously disturbed from prior construction activities. No sign of intact soils were observed within the locations of 15Jf2, 15Jf766, or 15Bu160. Given these results, the proposed undertaking is considered to have no effect to archaeological sites eligible for listing to the National Register of Historic Places (NRHP) (36CFR part 800.4 (d)(1). Therefore no additional archaeological survey is recommended for the proposed reconstruction and rehabilitation of the LMFPS.

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Introduction

The following report describes the results of the Phase I archaeological survey of the proposed reconstruction and rehabilitation of an existing Flood Risk Management Project for the Louisville Metro Flood Protection System (LMFPS) located along the Ohio River in Jefferson and Bullitt Counties, Kentucky (Figures 1–10). The proposed reconstruction and rehabilitation of the LMFPS is located along sections of the Louisville Reach and Southwestern Jefferson County Reach in Jefferson County, Kentucky. The Louisville Reach finished construction in 1956 and the Southwestern Jefferson County Reach finished construction in 1989. This project is authorized by the Flood Control Act of 1938 and amended by the Flood Control Act of 1968. This project is a cooperative effort between the United States Army Corps of Engineers (USACE)-Louisville District and the Non-Federal sponsors interested in modernizing, upgrading, and making repairs to the LMFPS.

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- New Canal Station T-Wall alignment located northeast of the Northwestern Parkway and southwest of the Louisville Riverwalk
- Demolition and filling of the 27th Street Closure
- A new asphalt road extending from North 31st Street to the McAlpine Lock and Dam Visitor Center
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The remaining elements of the reconstruction and rehabilitation of the LMFPS consist of replacing older elements within the pump stations or other elements (replacing gates, upgrading mechanical/electrical equipment, etc.) that will not require ground disturbance.

The above ground historic structure survey of the project will be covered by a separate evaluation of the Louisville Reach and Louisville Gas and Electric Building in a separate report (Poole 2019).

The survey was performed by personnel from USACE. This undertaking is in compliance with Section 106 and 110 of the National Historic Preservation Act of 1966 (as amended). The work conducted follows the professional standards and guidelines outlined in the Secretary of the Interior Standards and Guidelines for Archaeology and Historic Preservation (Secretary of the Interior 1983) and the *Specifications for Conducting Fieldwork and Preparing Cultural Resources Assessment Reports* from the Kentucky State Historic Preservation Office (KY-SHPO) and the Kentucky Heritage Council (KHC) (Sanders 2017).

The goal of this survey was to identify any prehistoric and historic archaeological sites that could be eligible for the National Register of Historic Places (NRHP). This was met through a literature review and records search to identify any known archaeological sites and an archaeological survey

to locate any previously unknown archaeological sites in the APE. USACE archaeologist Jared Barrett prepared this report and conducted the fieldwork on August 7, 2019 with the assistance of USACE archaeologist Jennifer Guffey. The field work took approximately 8 hours to complete.

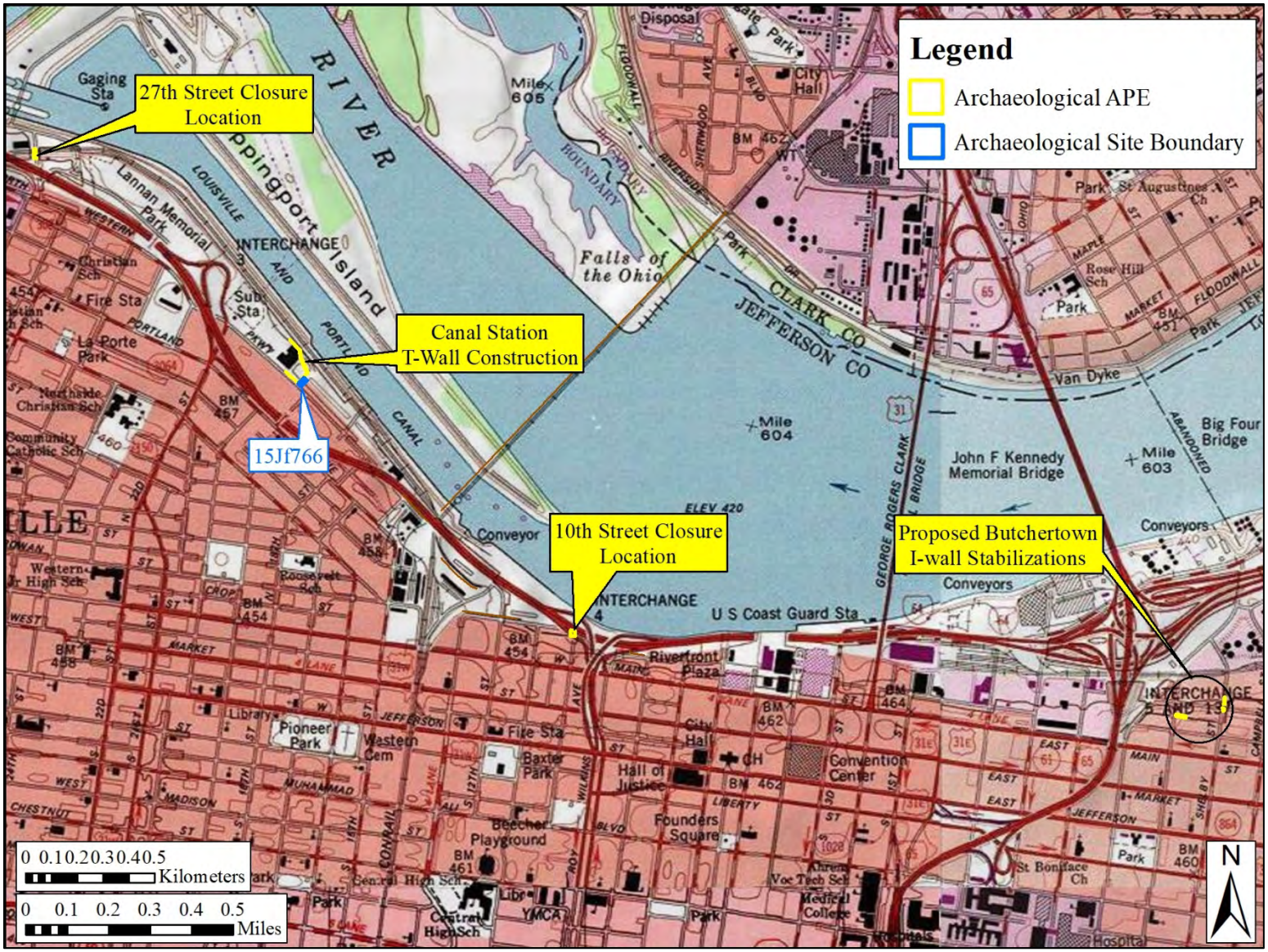

Figure 1. Excerpts of the New Albany and Jeffersonville, IN/KY and Louisville East and West, KY USGS 7.5-minute quadrangle maps showing the locations of the APE and previously recorded sites adjacent to the APE.

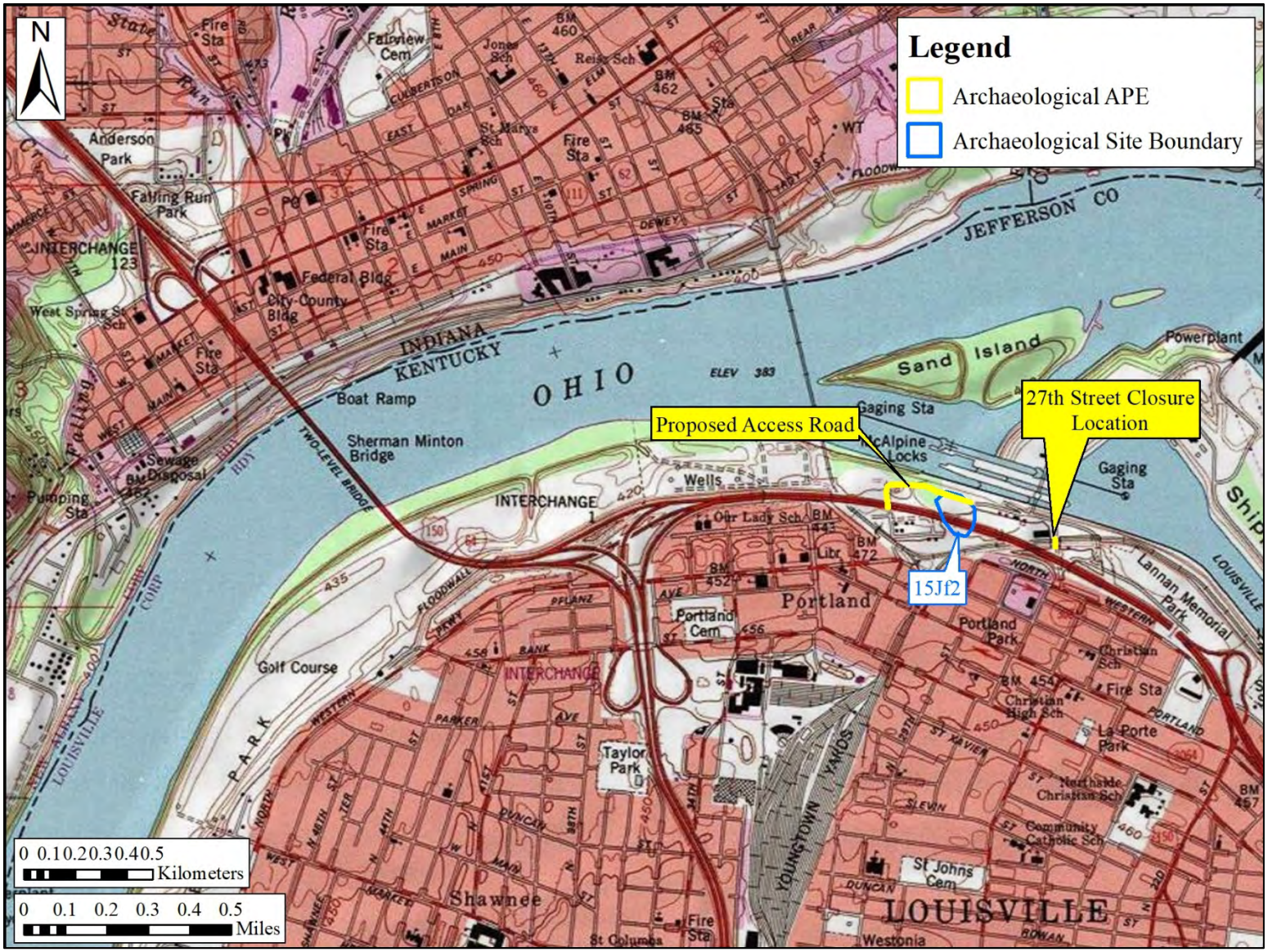

Figure 2. Excerpt of the New Albany, IN/KY USGS 7.5-minute quadrangle map showing the locations of the APE and previously recorded archaeological sites within the APE.

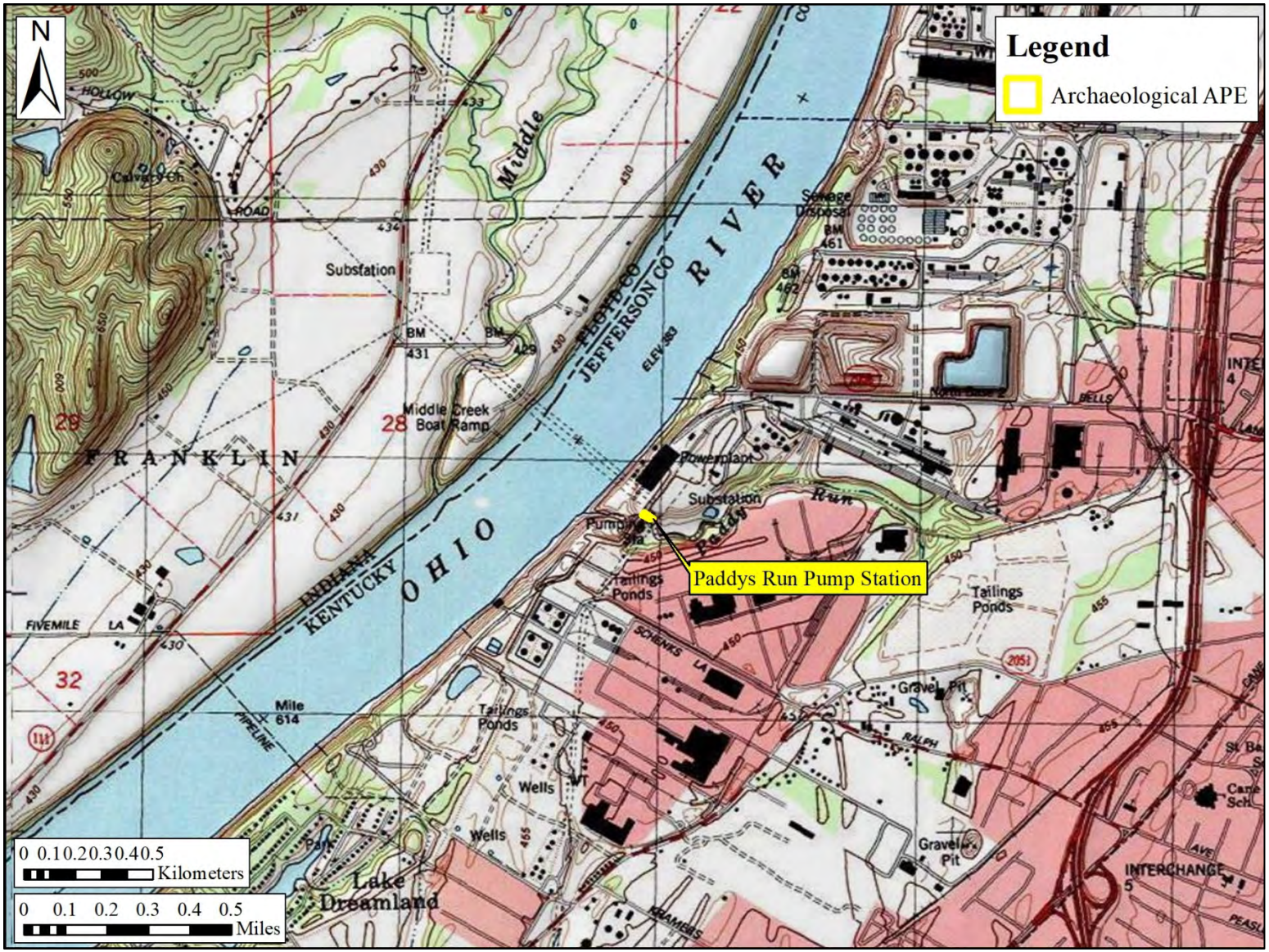

Figure 3. Excerpt of the Louisville West, KY/IN USGS 7.5-minute quadrangle map showing the location of the APE.

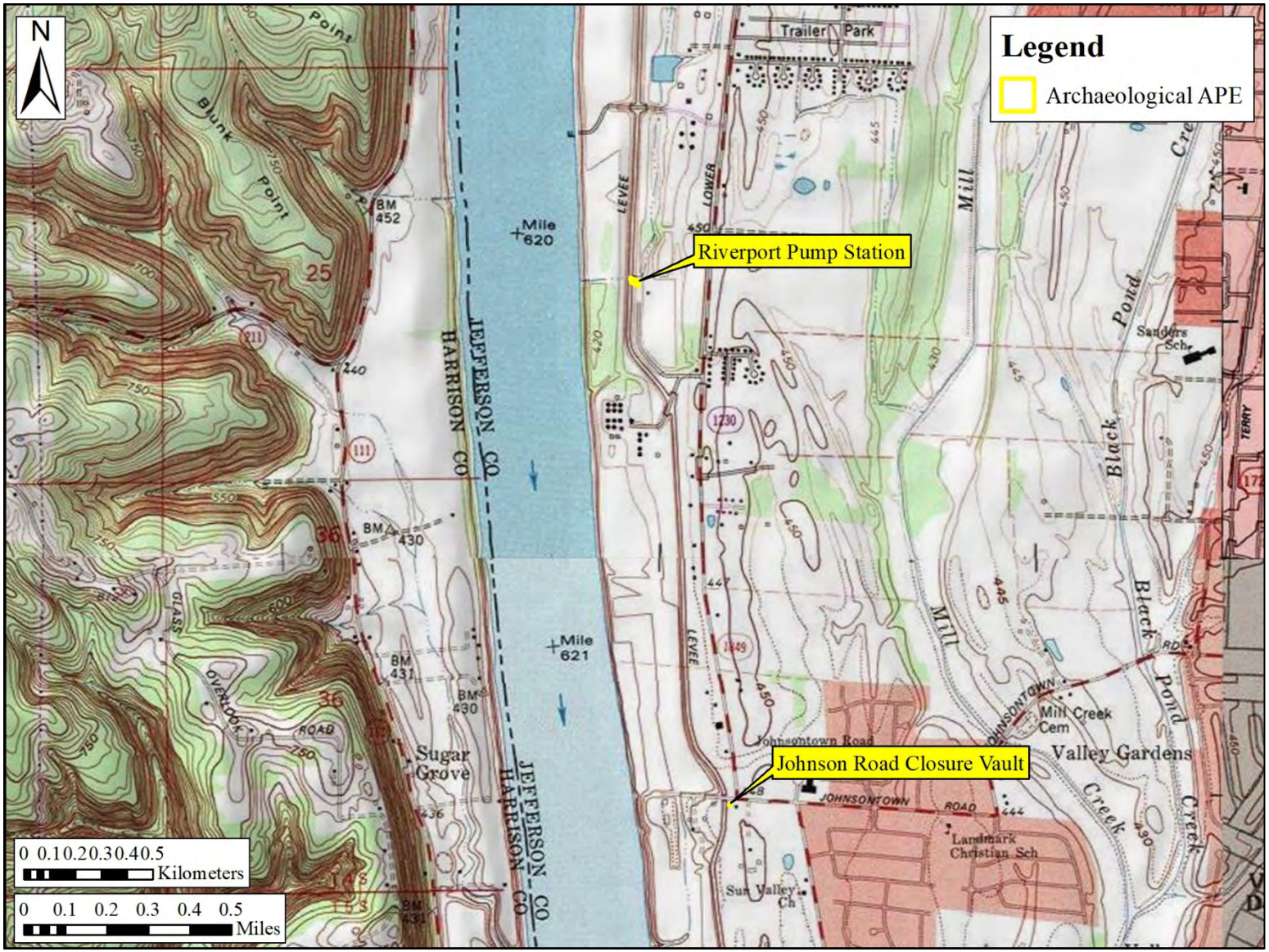

Figure 4. Excerpts of the Lanesville and Kosmosdale, IN/KY USGS 7.5-minute quadrangle maps showing the locations of the APE.

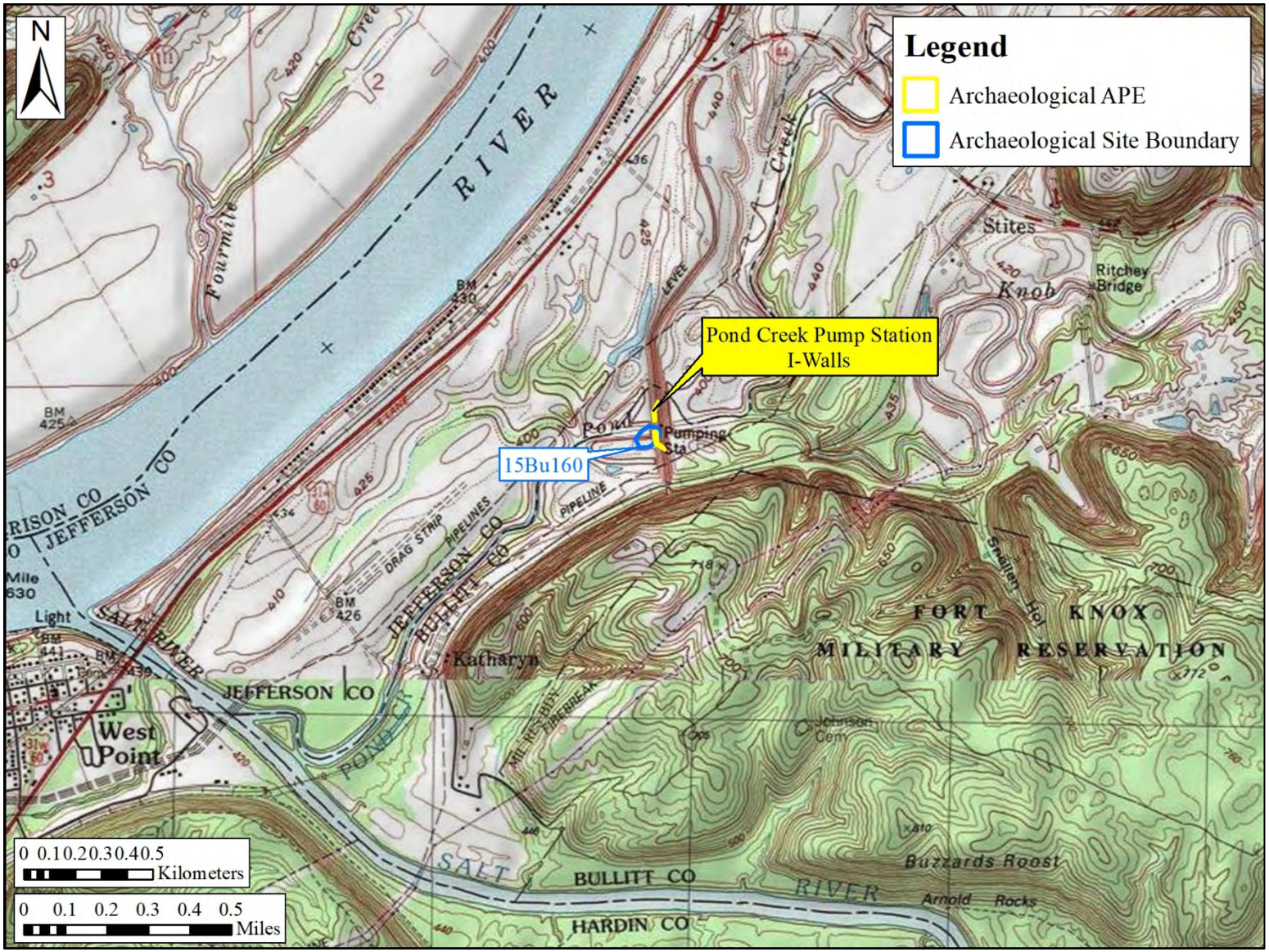

Figure 5. Excerpts of the Kosmosdale, IN/KY and Fort Knox, KY USGS 7.5-minute quadrangle maps showing the location of the APE and previously recorded archaeological sites within the APE.

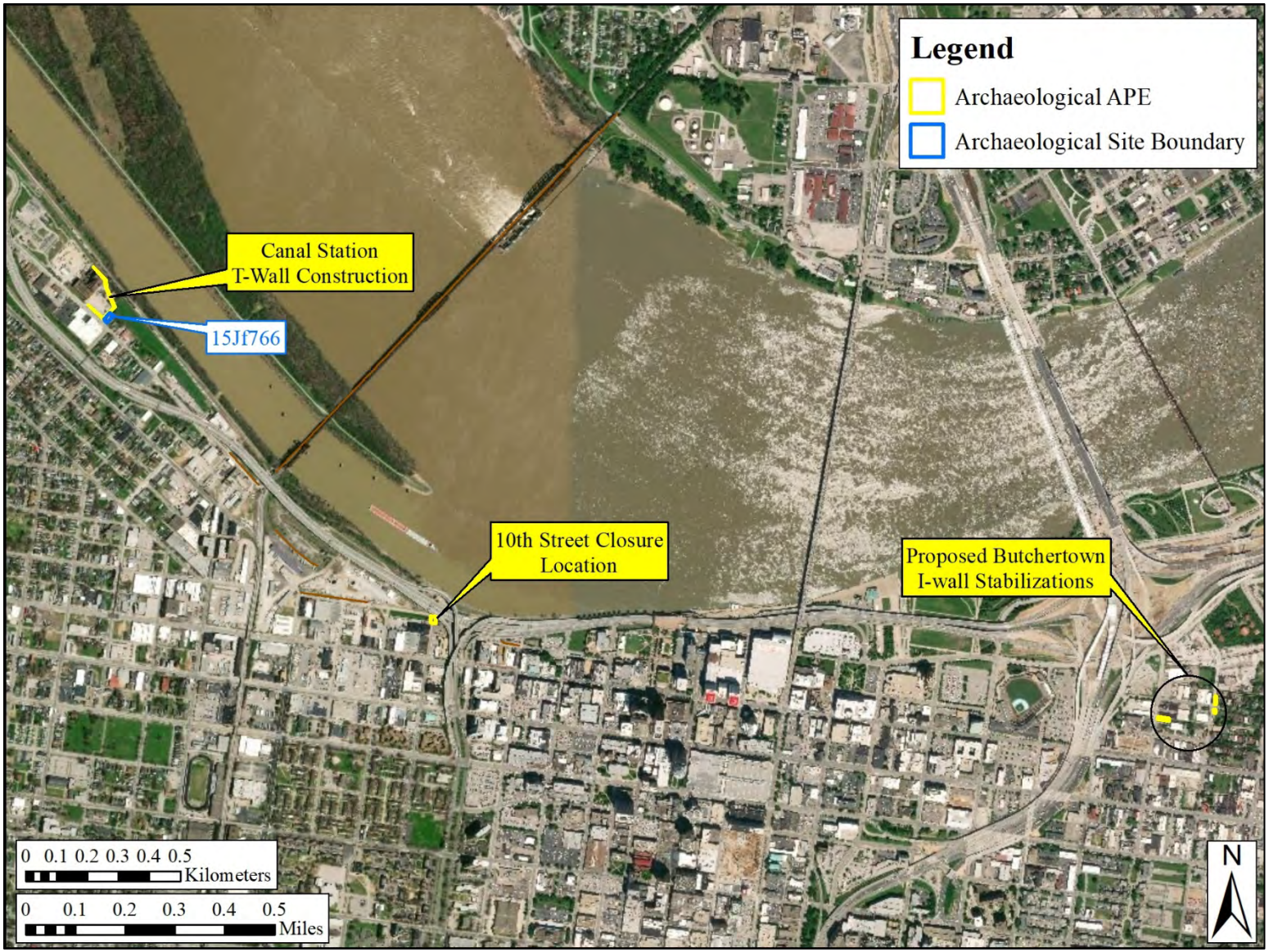

Figure 6. Aerial view of downtown Louisville showing sections of the APE and previously recorded archaeological sites adjacent to the APE.

Figure 7. Aerial view of near McAlpine Lock and Dam showing sections of the APE and previously recorded archaeological sites within the APE.

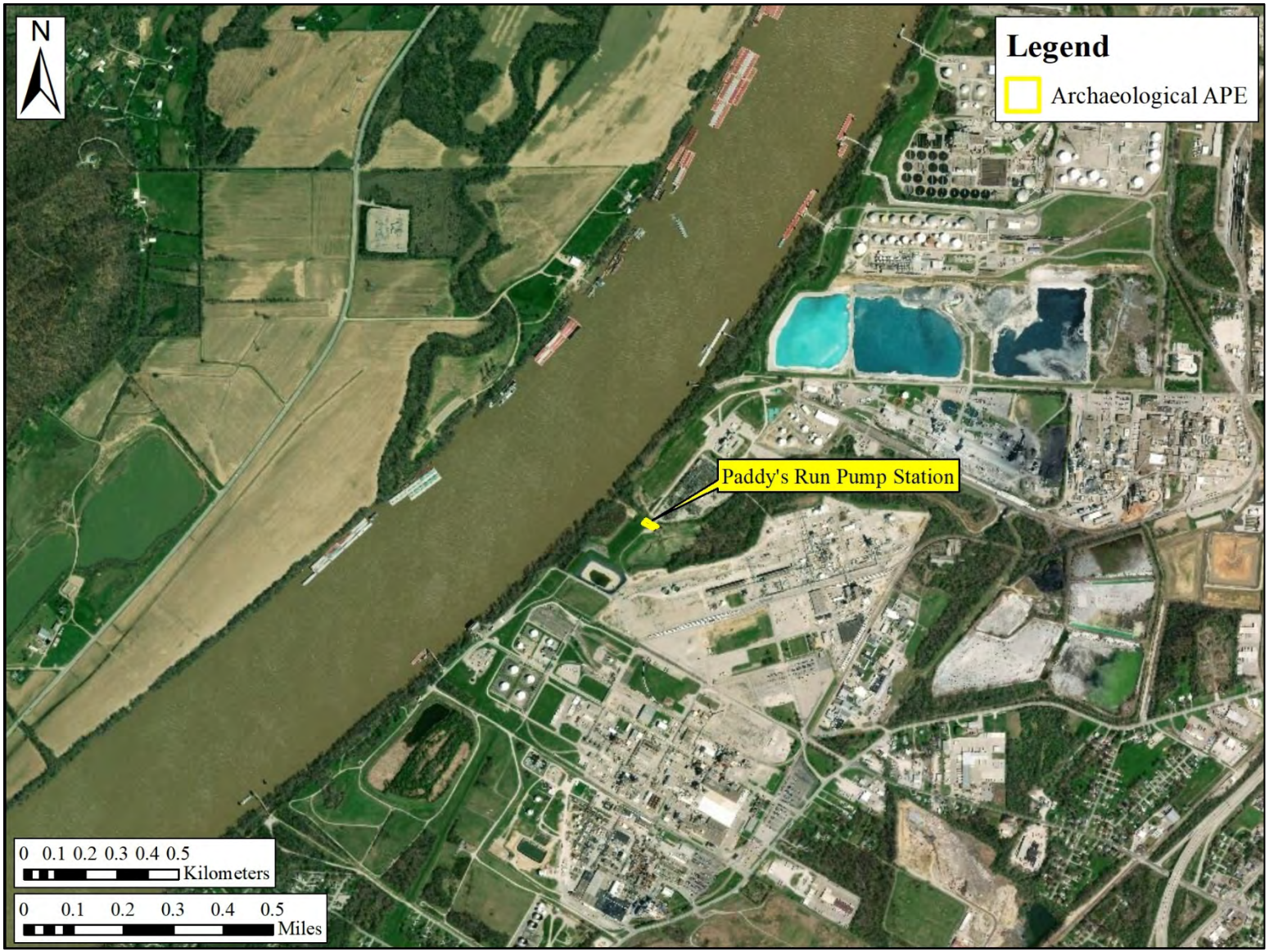

Figure 8. Aerial view along Ohio River showing APE at Paddy's Run Pump Station.

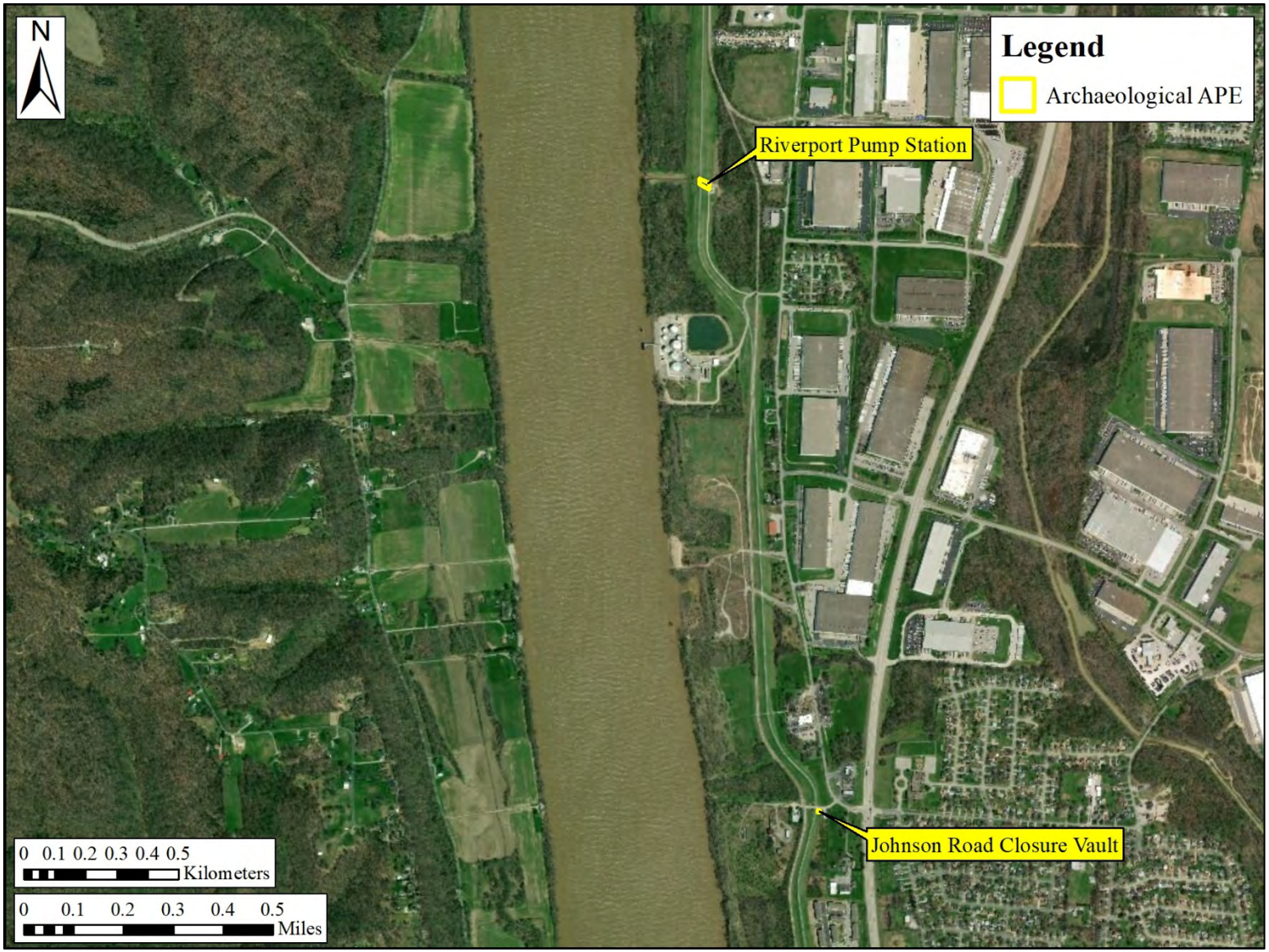

Figure 9. Aerial view along Ohio River showing APE at Riverport Pump Station and Johnson Road Closure Vault.

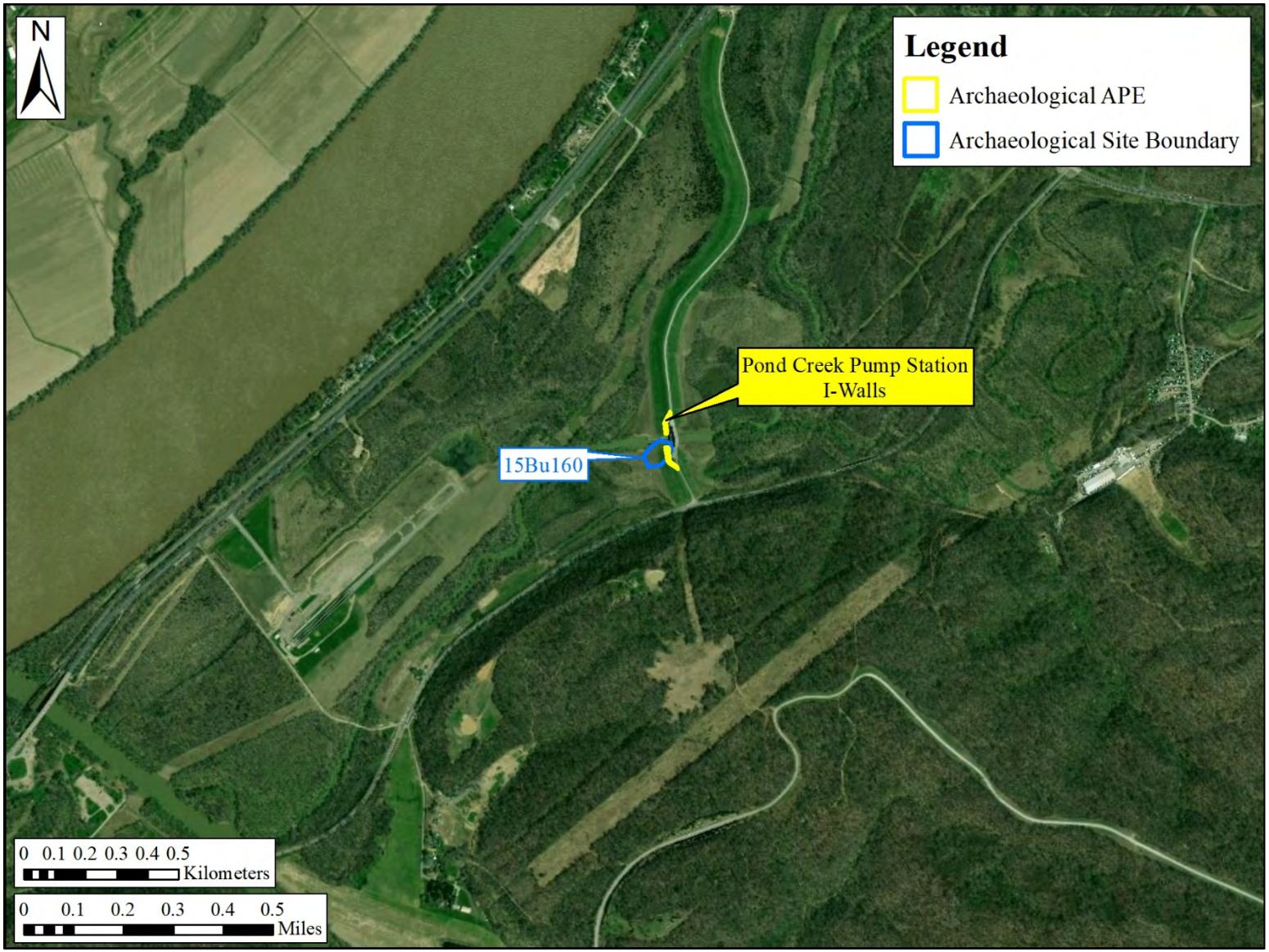

Figure 10. Aerial view along Ohio River showing APE at Pond Creek Pump Station and previously recorded site within the APE.

Literature Review and Records Check

A number of steps were taken in an effort to identify any archaeological sites within a 1.2 mile (2 km) radius of the APE. These include a background check of the NRHP online database, Louisville District Geographic Information System (GIS), the Kentucky Office of State Archaeology (OSA) GIS database, and previous cultural resources reports that have occurred at or in the vicinity of the project areas.

The site file search of the OSA GIS database on February 19, 2019 and a records search of the OSA records in Lexington on August 30, 2019 allowed the use of topographic maps, previous investigations, and archaeological sites to collect information about the APE. Reviews of the previous survey reports conducted either within or near the APE were used to provide background information around the project area. The NRHP online database was used to collect information on NRHP eligible or listed archaeological sites within a 1.2 mile (2 km) radius of the APE. A review of the OSA GIS database showed there were three previously recorded archaeological sites recorded within or adjacent to the APE: Site 15Jf2 is the Sand Island Channel site, has not been evaluated for the NRHP, and was previously recorded at the proposed access road near the 27th Street Closure; Site 15Jf766 is an urban house lot dating from the mid nineteenth to mid twentieth century and an indeterminate prehistoric lithic scatter site, was previously recommended as not eligible for listing in the NRHP and was previously recorded adjacent to the existing floodwall that will be removed located northeast of the Northwestern Parkway; and Site 15Bu160 has an unknown site type with an unknown cultural affiliation, has not been evaluated for the NRHP, and was previously recorded prior to the construction of the Pond Creek Pump Station (see Figures 1, 2, and 5) In addition to these three sites, there are 138 previously recorded archaeological sites located within 1.2 miles (2 km) of the APE (Table 1). None of the sites presented in Table 1 will be impacted by the reconstruction and rehabilitation of the LMFPS.

Table 1. List of previous archaeological sites located within a 1.2 mile (2 km) radius of the APE.

Site Number	Cultural Affiliation and Site Type	NRHP Eligibility
15BU313	Historic Euro American/Open habitation without mounds	NRHP status not assessed
15BU315	Indeterminate Prehistoric/Open habitation without mounds	NRHP status not assessed
15BU384	Historic farm/residence	NRHP status not assessed
15BU412	Indeterminate Prehistoric	Inventory site (doesn't meet NR criteria)
15BU678	Indeterminate Prehistoric/Open habitation without mounds	NRHP status not assessed
15BU679	Indeterminate Prehistoric/Open habitation without mounds	NRHP status not assessed
15HD277	Woodland/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15HD278	Indeterminate Prehistoric/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15HD685	Indeterminate Prehistoric/Open habitation without mounds	NRHP status not assessed
15HD1028	Indeterminate Prehistoric/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15HD1074	Indeterminate Prehistoric/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF3	Indeterminate Prehistoric	NRHP status not assessed

Site Number	Cultural Affiliation and Site Type	NRHP Eligibility
15JF4	Early & Late Archaic	Unknown
15JF12	Early-Late Archaic, Early-Middle Woodland/Open habitation without mounds	NRHP status not assessed
15JF13	Early-Middle Woodland, Late Prehistoric/ Open habitation without mounds	NRHP status not assessed
15JF14	Middle-Late Archaic, Early-Middle Woodland, Late Prehistoric/ Open habitation without mounds	NRHP status not assessed
15JF15	Middle-Late Archaic, Early-Middle Woodland, Late Prehistoric /Open habitation without mounds	NRHP status not assessed
15JF18	Middle-Late Archaic/Open habitation without mounds	Eligible for NRHP
15JF20	Late Archaic/Open habitation without mounds	NRHP status not assessed
15JF35	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF52	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF53	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF54	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF55	Indeterminate prehistoric-historic farm/residence 1851-1950/Open habitation without mounds	NRHP status not assessed
15JF56	Early Woodland/Open habitation without mounds	NRHP status not assessed
15JF57	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF60	Middle-Late Archaic/Open habitation without mounds	NRHP status not assessed
15JF66	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF68	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF69	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF93	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF94	Historic American Indian	NRHP status not assessed
15JF95	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF107	Indeterminate Prehistoric/Open habitation without mounds	NRHP status not assessed
15JF159	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF210	Early Woodland/Open habitation without mounds	NRHP status not assessed
15JF211	Early – Late Archaic & Early Woodland /Open habitation without mounds	NRHP status not assessed
15JF212	Archaic /Open habitation without mounds	NRHP status not assessed
15JF216	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF217	Late Archaic, Early Woodland/Open habitation without mounds	NRHP status not assessed
15JF226	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF227	Middle Archaic/Open habitation without mounds	NRHP status not assessed
15JF228	Early-Middle Archaic/Open habitation without mounds	NRHP status not assessed
15JF234	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF244	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF245	Indeterminate Prehistoric/Open habitations without mounds	NRHP status not assessed
15JF247	Indeterminate Prehistoric/Open habitations without mounds	NRHP status not assessed
15JF248	Indeterminate Prehistoric/Open habitations without mounds	NRHP status not assessed
15JF249	Indeterminate Prehistoric/Open habitations without mounds	NRHP status not assessed
15JF260	Indeterminate Prehistoric/Open habitations without mounds	NRHP status not assessed
15JF269	Middle-Late Archaic/Open habitations without mounds	NRHP status not assessed
15JF300	Open habitations without mounds	NRHP status not assessed
15JF313	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed

Site Number	Cultural Affiliation and Site Type	NRHP Eligibility
15JF315	Middle Archaic, Late Prehistoric / Open habitation without mounds	NRHP status not assessed
15JF316	Early Archaic, Early Woodland / Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF317	Early Archaic, Early Woodland / Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF324	Late Archaic/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF325	Terminal Archaic, Early-Late Woodland/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF326	Indeterminate prehistoric/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF327	Late Prehistoric/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF328	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF329	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF330	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
1515JF331	Late Prehistoric/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF332	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF333	Archaic/Open habitation without mounds	NRHP status not assessed
15JF334	Indeterminate prehistoric & historic Euro-American 1851-1950 /Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF337	Indeterminate prehistoric /Open habitation without mounds	NRHP status not assessed
15JF338	Indeterminate prehistoric / Open habitation without mounds	NRHP status not assessed
15JF339	Late Archaic/ Open habitation without mounds	NRHP status not assessed
15JF340	Indeterminate prehistoric / Open habitation without mounds	NRHP status not assessed
15JF342	Indeterminate prehistoric / Open habitation without mounds	NRHP status not assessed
15JF344	Indeterminate prehistoric / Open habitation without mounds	NRHP status not assessed
15JF345	Open habitation without mounds	NRHP status not assessed
15JF350	Indeterminate prehistoric/Open habitation without mounds	NRHP status not assessed
15JF414	Indeterminate prehistoric/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF418	Historic farm/residence 1801-1950	Nominated to NRHP by SHPO
15JF531	Archaic, Woodland, Historic farm-residence 1801-1850/Open habitation without mounds	Listed on NRHP
15JF556	Industrial-historic farm/residence 1871-1900	NRHP status not assessed
15JF592	Historic farm/residence 1801-1850	Inventory site (doesn't meet NR criteria)
15JF593	Historic farm/residence 1801-1850	Inventory site (doesn't meet NR criteria)
15JF594	Historic farm/residence 1801-1950	Inventory site (doesn't meet NR criteria)
15JF595	Historic farm/residence 1801-1950	Inventory site (doesn't meet NR criteria)
15JF596	Historic farm/residence 1801-1850	Inventory site (doesn't meet NR criteria)
15JF597	Historic farm/residence 1801-1850	Inventory site (doesn't meet NR criteria)
15JF598	Historic farm/residence 1801-1850	Inventory site (doesn't meet NR criteria)

Site Number	Cultural Affiliation and Site Type	NRHP Eligibility
15JF599	Historic farm/residence 1801-1850	Inventory site (doesn't meet NR criteria)
15JF600	Historic farm/residence 1801-1950	NRHP status not assessed
15JF601	Historic farm/residence 1801-1950	NRHP status not assessed
15JF602	Historic farm/residence 1801-1950	NRHP status not assessed
15JF603	Historic farm/residence 1801-1950	NRHP status not assessed
15JF604	Historic farm/residence 1801-1950	NRHP status not assessed
15JF605	Historic farm/residence 1801-1950	NRHP status not assessed
15JF606	Historic farm/residence 1801-1950	NRHP status not assessed
15JF624	Historic farm/residence 1851-1950	NRHP status not assessed
15JF625	Historic farm/residence 1851-1950	NRHP status not assessed
15JF626	Historic farm/residence 1851-1950	NRHP status not assessed
15JF627	Other special activity area/historic farm/residence 1801- 1900	Listed on NRHP
15JF633	Indeterminate prehistoric & historic farm/residence 1900-2000/Open habitation without mounds	NRHP status not assessed
15JF634	Indeterminate prehistoric & Historic farm/residence 1950-1951/Open habitation without mounds	NRHP status not assessed
15JF637	Indeterminate prehistoric & historic farm/residence 1900-2000/Open habitation without mounds	NRHP status not assessed
15JF646	Historic farm/residence 1801-1950	Considered eligible for NRHP
15JF649	Early Woodland/Open habitation without mounds	NRHP status not assessed
15JF658	Industrial/historic euro-american 1801-1950	NRHP status not assessed
15JF665	Indeterminate prehistoric/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF666	Indeterminate prehistoric/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF667	Archaic, Woodland/Open habitation without mounds	NRHP status not assessed
15JF668	Late Woodland, Late Prehistoric, Mississippian, historic farm/residence 1801-1950/Open habitation without mounds	Considered eligible for NRHP
15JF697	Historic farm/residence 1871-1900	Inventory site (doesn't meet NR criteria)
15JF699	Historic farm/residence 1801-1850	NRHP status not assessed
15JF702	Mississippian, historic farm/residence 1801-1950/Open habitations without mounds	NRHP status not assessed
15JF716	Historic farm/residence 1850-1900	Inventory site (doesn't meet NR criteria)
15JF717	Historic farm/residence 1850-1900 / Indeterminate prehistoric / Open habitation without mounds	Eligible for the NRHP
15JF718	Historic farm/residence 1801-1950	Eligible for the NRHP
15JF721	Historic farm/residence 1851-1950	Inventory site (doesn't meet NR criteria)
15JF727	Historic farm/residence 1870-1900, Indeterminate prehistoric	Listed on NRHP
17JF729	Industrial 1870-1900	NRHP status not assessed
15JF730	Historic farm/residence 1901-1950	Inventory site (doesn't meet NR criteria)
15JF731	Indeterminate prehistoric/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF732	Indeterminate prehistoric, historic farm/residence 1851-1950/Open habitation without mounds	Considered eligible for NRHP

Site Number	Cultural Affiliation and Site Type	NRHP Eligibility
15JF770	Historic farm/residence 1850-1950	NRHP Property (Riverside)
15JF771	Indeterminate prehistoric/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF772	Indeterminate prehistoric/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF777	Commercial 1851-1900	Inventory site (doesn't meet NR criteria)
15JF778	Modern Dump 1801 - 1950	Inventory site (doesn't meet NR criteria)
15JF785	Indeterminate prehistoric/Open habitation without mounds	Inventory site (doesn't meet NR criteria)
15JF793	Urban 1801 - 1900	NRHP status not assessed
15JF808	Historic farm/residence 1801-1950	NRHP status not assessed
15JF813	Historic farm/residence 1801-1950	NRHP status not assessed
15JF814	Commercial 1801-1950	NRHP status not assessed
15JF815	Commercial 1801-1950	NRHP status not assessed
15JF816	Historic farm/residence 1801-1950	NRHP status not assessed
15JF817	Commercial 1801-1950	NRHP status not assessed
15JF818	Historic farm/residence 1801-1950	NRHP status not assessed
15JF819	Historic farm/residence 1801-1950	NRHP status not assessed
15JF820	Industrial 1801-1950	NRHP status not assessed
15JF902	Urban 1801-1950	NRHP status not assessed
15JF912	Historic farm/residence 1801-1950	NRHP status not assessed

Five archaeological surveys have been carried out within the APE. In 2015, Cardno, Inc conducted a Phase I cultural resources records review and reconnaissance of a proposed natural gas pipeline at Paddy's Run (Grob et al 2015). Two historic archaeological sites were identified during the survey. Site 15JF867 consists of a concrete slab historic foundation and demolition debris scatter, while site 15JF900 consists of a historic foundation with associated refuse scatter (Grob et al 2015). Sites 15JF867 and 15JF900 are outside the current APE and not be impacted by the current project.

In 2016, Cultural Resources Analysts (CRA) conducted a Phase I archaeological survey of Paddy's Run Pump Station during a proposed rehabilitation project (DelCastello et al. 2016). The CRA 2016 survey of the Paddy's Run Pump Station did not uncover any archaeological sites or deposits within the APE.

In 2016 and 2017, Corn Island Archaeology LLC conducted a Phase I archaeological investigation to support the Louisville and Jefferson County Metropolitan Sewer District (MSD) Downtown Combined Sewer Overflow Interceptor Project. The project consisted of diversion structures, control gate structures, and new sewers north of Main Street between 12th and 10th Streets and between 8th and 5th Streets (Sullivan and Bader 2016, 2017). The survey did not uncover any archaeological sites within the APE.

In 2006, Environmental and Archaeology LLC, conducted a Phase I archaeological survey of a proposed cellular communications tower and access road (Breetzke 2006). The tower and access

road is located at 700 North 31st Street adjacent to Interstate 64 in Jefferson County, Kentucky. No prehistoric or historic cultural material was identified within the APE.

As part of the Jefferson County Flood Protection Project, the University of Louisville conducted an archaeological investigation in 1975 of the proposed Riverport Industrial Park (Granger and DiBlasi 1975). Thirty-one archaeological sites were identified during the survey. Following Granger and DiBlasi's (1975) efforts, the University of Louisville Archaeological Survey conducted sub-surface testing of the 31 sites within the Riverport Industrial Park between June 4, 1980 and July 18, 1980 (Hale 1981). Auger testing and backhoe testing was the method used to test the 31 sites. None of these 31 sites are located within the APE and will not be impacted by the project.

In addition to the five (5) surveys described above, 29 archaeological reconnaissance surveys have been conducted within a 1.2 mile (two kilometer) radius of the APE. In 1976, Environmental Consultants, Inc. conducted archaeological testing within Section Two of the Southwest Jefferson County Local Flood Protection Project (Dragoo 1976). Backhoe trenching was conducted every 100 meters along terraces and within the borrow areas. This method revealed four areas of potential National Register significance and suggested mitigation for the adverse effects. These four areas were labeled as sites: 15JF14, 18, 110, and 243. These four sites were most likely damaged by the development of the floodwall. Sites 15Jf14, 18, 110, and 243 are located outside the APE and will not be impacted by the project.

In 1992, The University of Kentucky Program for Cultural Resource Assessment (PCRA) conducted a Phase I cultural resources survey for the proposed 50-acre Municipal Harbor/Thurston Park waterfront redevelopment project in Louisville, Jefferson County, Kentucky (Esarey 1992). The survey was conducted to determine if any historic properties were present within the project area. The survey methodologies included a pedestrian survey, extensive shovel probing, archival research, and photography of the project area (Esarey 1992). A total of eight historic archaeological sites (15JF592-599) were identified, including two houses; the Paget House and Heigold House façade; which is listed on the NRHP. The author recommended additional Phase II testing for the eight sites mentioned above. None of these eight sites identified during the 1992 survey are located within the APE and will not be impacted by the project.

The University of Kentucky PCRA conducted a Phase I cultural resources survey at a proposed Downtown Master Plan Section of the Waterfront Redevelopment Project in Louisville, Jefferson County, Kentucky (Esarey 1993). The survey was conducted to determine if any historic properties were present within the proposed project area. The survey methodologies included shovel probes, backhoe trenching, and archival research of the project area (Esarey 1993). No archaeological sites or historic properties were identified during the survey.

In 1995, Kentucky Archaeological Survey conducted archaeological testing at the proposed Louisville Convention Center site. The convention center site is located on one full city block bound by Market Street, Second Street, Jefferson Street, and Third Street. Twelve historic features including privies and cisterns were identified and labeled as site 15Jf646 (Stottman and Watts-Roy 1995). From 1998 to 2000, the Kentucky Archaeological Survey conducted an excavation of the washhouse at the Farnsley-Moremen Landing near Greenbelt Highway. The purpose of the survey

was to possibly reconstruct the washhouse, learn about its role in the outbuilding complex, and the people who worked there (Stottman and Prybylski 2004). Site 15Jf646 lies outside the proposed APE and will not impacted by the proposed undertaking.

CRA conducted an archaeological survey for the proposed visitor center facilities associated with Riverside, the Farnsley-Moreman Landing in 1997 (McKelway 1997). Field methods consisted of both shovel testing and backhoe trenching. One archaeological site was identified (15JF654) however, the site will not be impacted by the proposed LMFPS.

In 1998, USACE conducted a cultural resources reconnaissance of the proposed Beargrass Creek local flood protection project in Jefferson County (Ball 1998). The survey found no evidence of prehistoric or historic era remains within the proposed project area.

In 2007, CRA monitored geotechnical borings for the Kennedy Bridge Interchange Area of the Southern Indiana Ohio River Bridges project (Herndon and Faberson 2007). Field methods consisted of monitoring soil augers excavated by engineers collecting soil data within the projects right-of-ways. The cultural material observed in the soil augers dated from the late 1800s and early 1900s. The area of the cultural material observed in the soil augers lies outside the proposed APE and will not impacted by the proposed undertaking.

TRILEAF Corporation conducted an archaeological survey of a proposed cell tower northeast of Montgomery Street in Jefferson County, Kentucky in 2008 (Miller 2008). The survey did not identify any cultural resources within the proposed cell tower location.

In the summer of 2010 AMEC Earth & Environmental, Inc. (AMEC) conducted archaeological monitoring of construction excavations associated with the 2nd Street Streetscape project (Stallings 2010). During monitoring of the removal of the existing sidewalks, storm drainage, and utility lines, and water lines, historic remnants including a coal chute and window well attached to the Trademark Building, and a small batch of in-situ paving stones and a brick foundation were identified. These historic materials are thought to be associated with archaeological site 15JF777; however, this site is located outside the current APE.

In 2010, CRA conducted a Phase I survey and Phase II testing of site 15Jf766 prior to the construction of the proposed Ninth Street Portland 2 cell tower (Donahue and McMahan 2010). The Phase I and additional Phase II testing determined that site 15Jf766 consisted of late nineteenth to early twentieth century house lot and a lithic scatter with an undetermined prehistoric cultural affiliation. Site 15JF766 was recommended by CRA as not eligible for listing in the NRHP. The site is adjacent to the APE and is discussed in detail in New T-Wall at Canal Station section of the report.

Survey Predictions

The APE is situated in the Salt River Section of Management Area 3 (Salt River) and is one of the smallest in Kentucky (Stackelbeck and Mink 2008). The entire Salt River Management Area is drained by the Salt River. The Salt River is also drained by the Rough River, Kentucky River, and smaller tributaries of the Ohio River (Stackelbeck and Mink 2008). The Salt River Management

Area includes the Mississippian Plateaus, Knobs, and Bluegrass physiographic regions. The most predominant site type in the Salt River Section is the open habitation site without mounds with 72.7 percent of the sites consisting of this type (Stackelbeck and Mink 2008). The second most predominant site type within this management area is historic farms with only 15.5 percent of this site recorded. There are several mound-related sites within the management area; such as earthen mounds and mound complex (n=48) (Stackelbeck and Mink 2008). Only 10 sites have been nominated to the NRHP in the Salt River Section. The Salt River Section has the lowest survey coverage out of the sections, with less than three percent having been surveyed. Surveys undertaken in the Salt River Section have been conducted as part of cultural resource management projects related to bridge and highway construction and general development (Stackelbeck and Mink 2008).

Expectations for the recovery of cultural material during field investigations were low, considering the APE is located within areas of previous development with the flood wall and pump stations and other utilities and development associated with urban environments. The Louisville Reach was constructed between 1946 and 1956. The Southwestern Jefferson County Reach was constructed between 1973 and 1989. The areas in and around downtown Louisville and the Portland neighborhood have been urban since the early to mid-nineteenth century as shown on maps of the area from 1858 (Figures 11–12). Areas of the APE in the western and southwestern portions of Jefferson County and northern Bullitt County have been relatively rural until the early to mid-twentieth century (Figures 13–14). Excerpts of the topographic maps from the 1950s show how much the APE has changed from the mid twentieth into the early twenty-first century (Figures 15–19). Much of the APE has seen urban growth with commercial, industrial, and residential developments throughout the area. The expected site type, given the topographic setting of the APE, is a prehistoric open habitation without mounds or a historic urban house lot or historic artifact scatter.

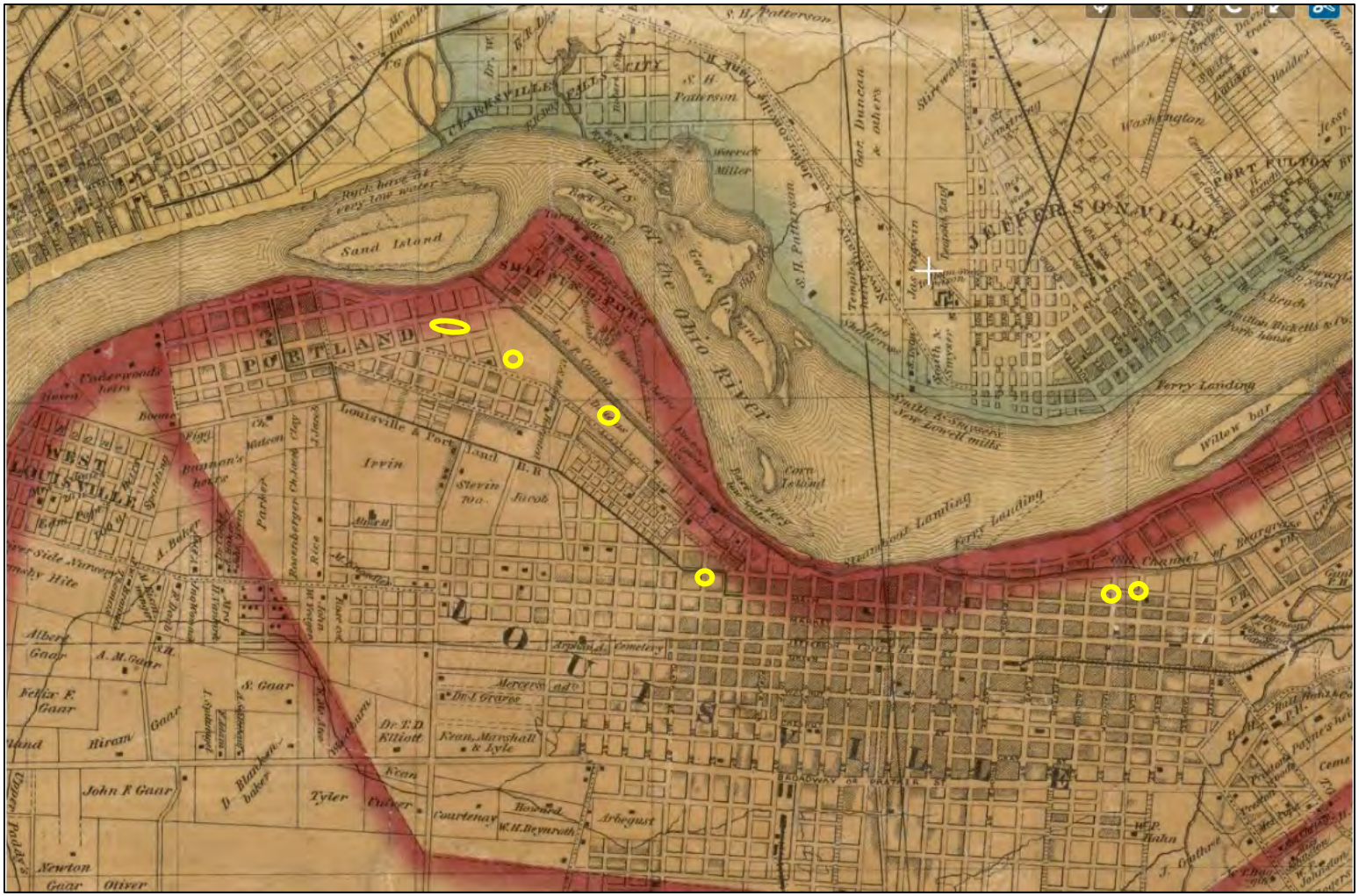

Figure 11. Excerpt of an 1858 map of Jefferson County, Kentucky showing APE in downtown Louisville and Portland neighborhood (general locations of APE highlighted in yellow) (Bergmann 1858).

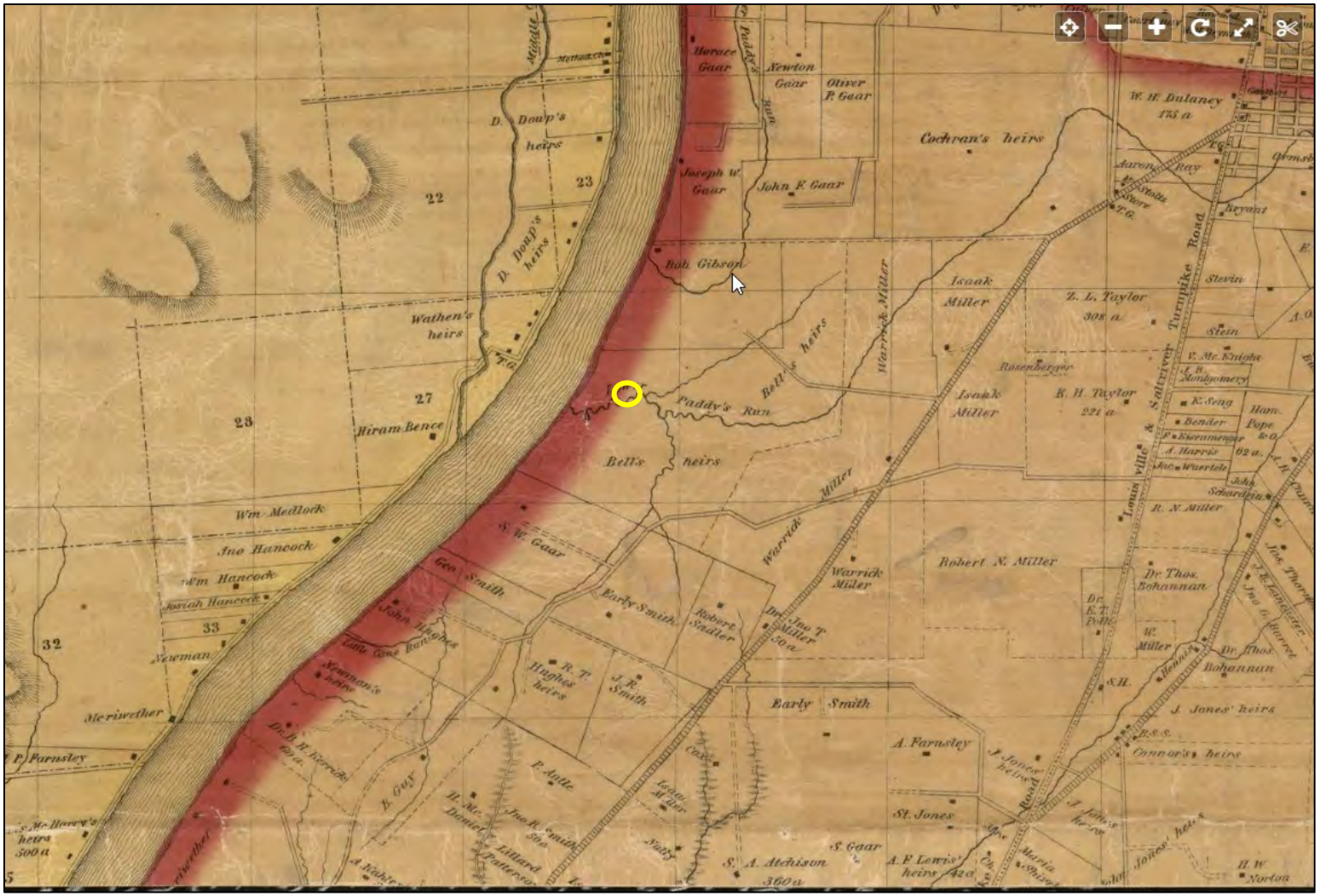

Figure 12. Excerpt of an 1858 map of Jefferson County, Kentucky showing property owner names and the APE along Lower Paddy's Run (general location of APE highlighted in yellow) (Bergmann 1858).

Figure 13. Excerpt of an 1858 map of Jefferson County, Kentucky showing property owner names along Mill Creek (general locations of APE highlighted in yellow) (Bergmann 1858).

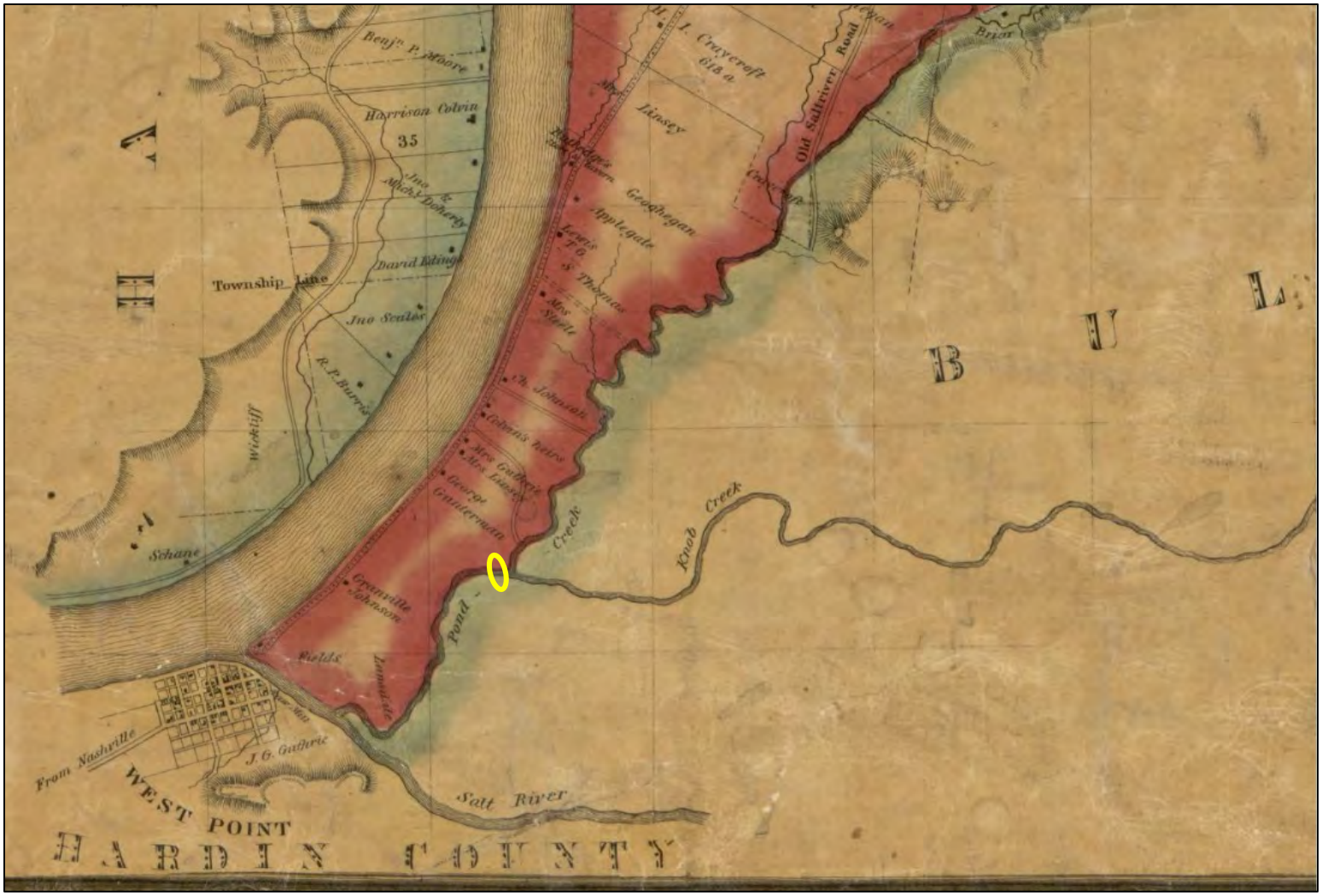

Figure 14. Excerpt of an 1858 map of Jefferson County, Kentucky showing property owner names at the southwest end of the county (general location of APE highlighted in yellow) (Bergmann 1858).

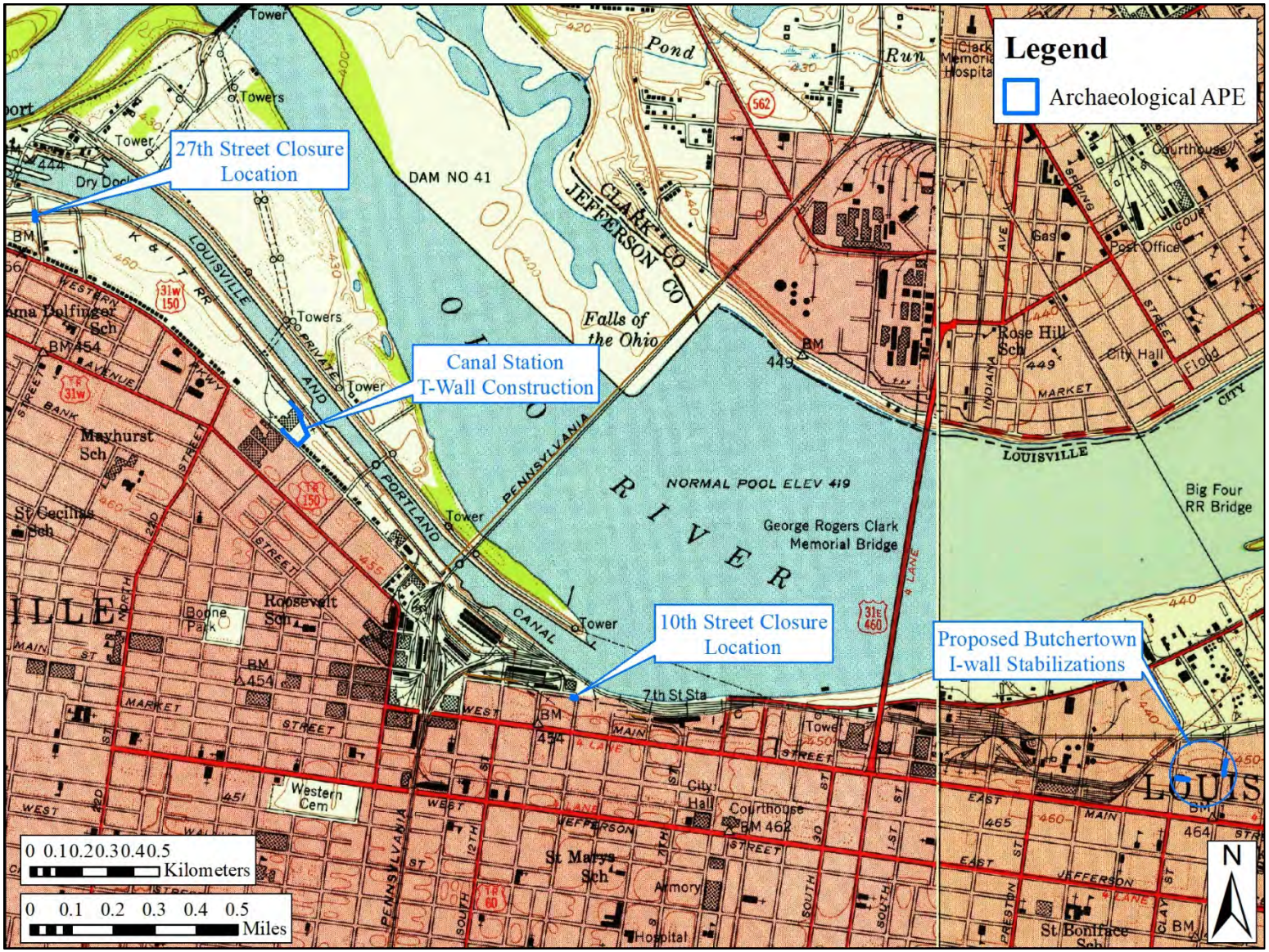

Figure 15. Excerpts of 1950 New Albany IN/KY and 1951 Jeffersonville IN/KY 7.5 Minute Series USGS topographic map showing the locations of the APE.

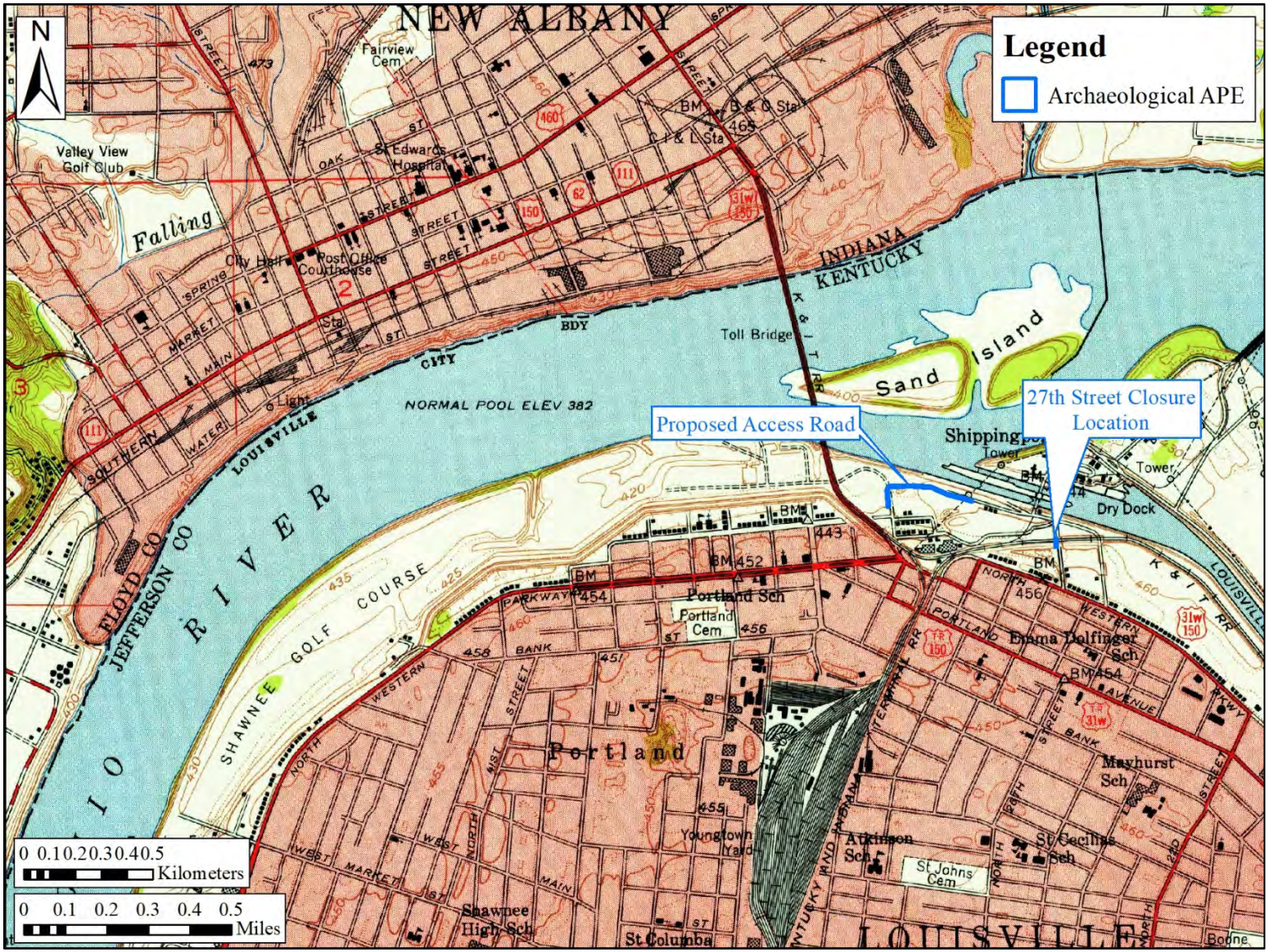

Figure 16. Excerpt of 1950 New Albany IN/KY 7.5 Minute Series USGS topographic map showing the locations of the APE.

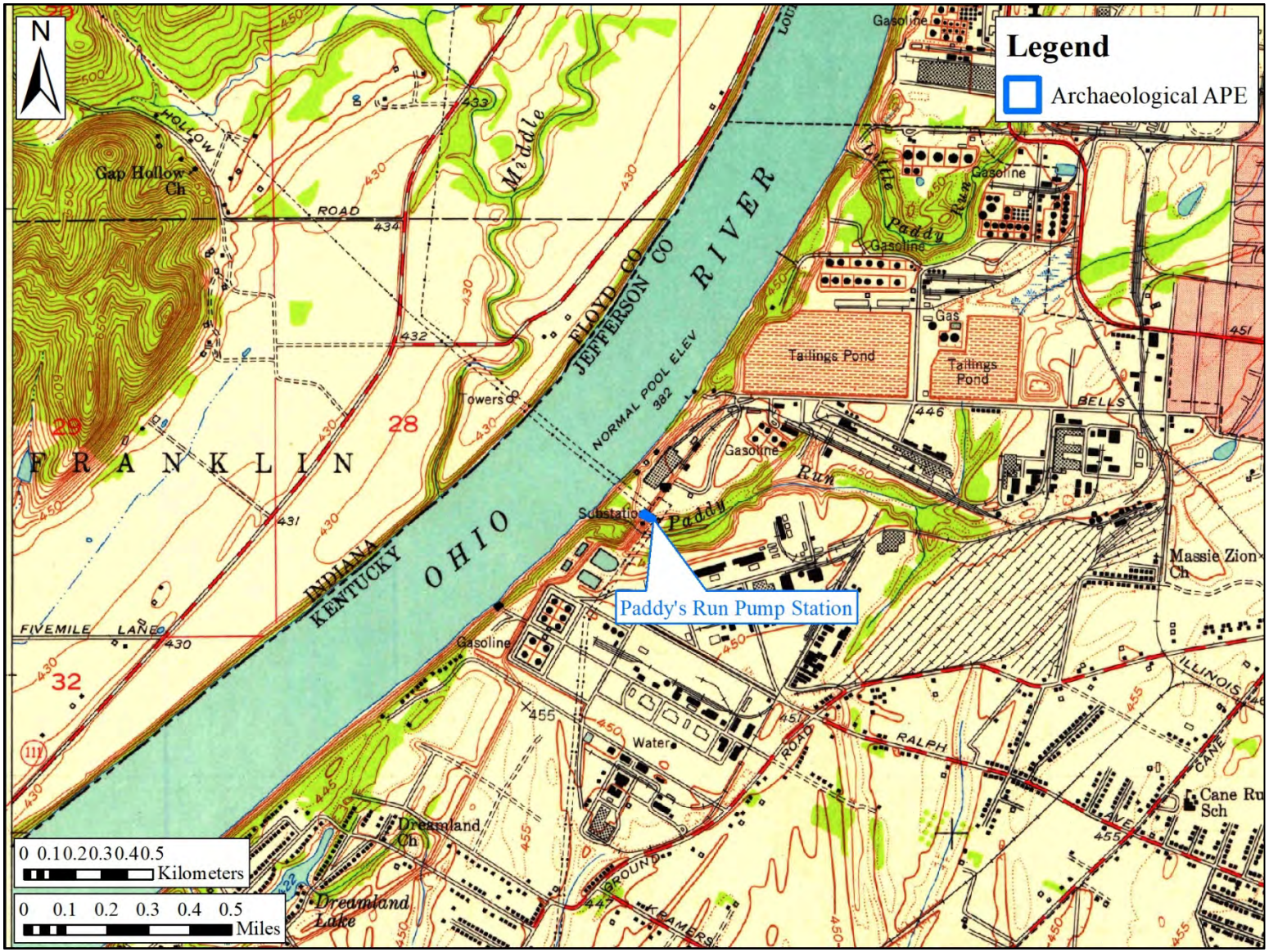

Figure 17. Excerpt of 1955 Louisville West, IN/KY 7.5 Minute Series USGS topographic map showing the location of the APE.

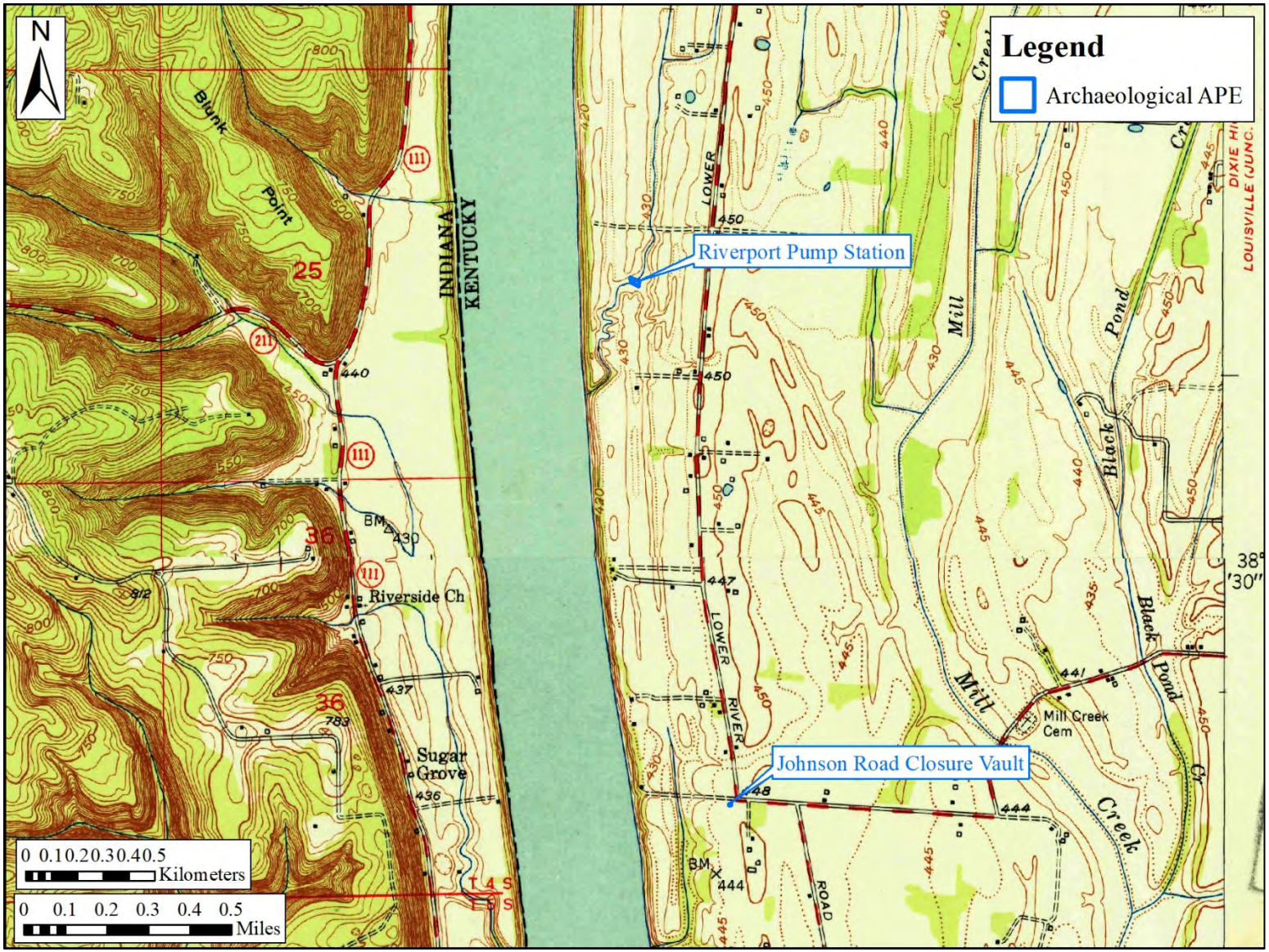

Figure 18. Excerpts of 1951 Kosmosdale, IN/KY and 1951 Lanesville IN/KY 7.5 Minute Series USGS topographic map showing the locations of the APE.

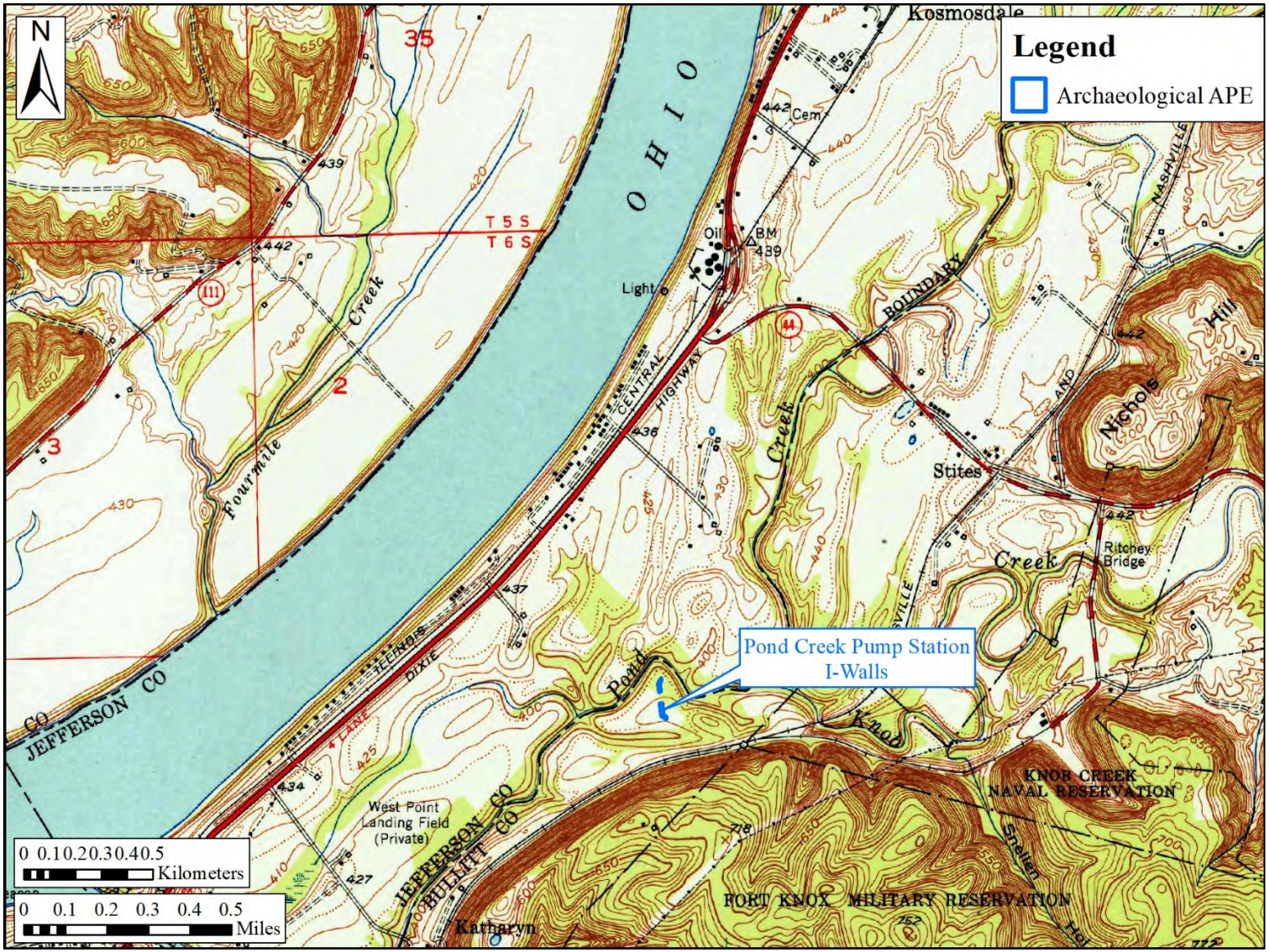

Figure 19. Excerpt of 1951 Kosmosdale IN/KY 7.5 Minute Series USGS topographic map showing the location of the APE.

Field Methods and Survey Results

Approximately 48.95 acres (19.8 hectares) were surveyed during field investigations (see Figures 6–10). The survey closely followed all guidelines for Phase I archaeological investigations as defined in the "Specifications for Conducting Fieldwork and Preparing Cultural Resource Assessment Reports," issued by the KY-SHPO (Sanders 2017). USACE personnel surveyed the proposed APE on foot. The survey included a combination of systematic pedestrian examination of all sloped terrain greater than 15 percent or areas of prior ground disturbance and shovel testing of areas located on terrain with a slope less than 15 percent and having poor surface visibility. Shovel tests (n= 5 total) consisted of 11.8 x 11.8 inch (30 x 30 centimeter [cm]) excavations into subsoil, with five (5) excavated at the proposed T Wall location located northeast of the Northwestern Parkway. Fill dirt was screened through ¼-inch (0.64 cm) mesh hardware cloth to insure uniform artifact recovery. All shovel tests were immediately backfilled following recordation. The Principal Investigator maintained field notes during the project, recording work accomplished, and general observations. Photographs of the APE were taken using a digital camera and a detailed photographic log was kept. All records associated with the survey area on file at USACE.

Land use within the APE consists of pump stations, flood walls and earthen levees, gravel parking and gravel access roads, existing roadways, and manicured lawns (Figures 20–33). The APE of the archaeological survey includes the areas with proposed ground disturbing activities as outlined in the Introduction.

Ground surface visibility was zero percent within the APE. Most of the APE that makes up the proposed reconstruction and rehabilitation of the LMFPS have seen previous disturbances associated with the construction and development of the flood protection system. These areas of previously disturbed soils or previously developed areas were visually scanned for cultural material and features.

Figure 20. View of section of I-Wall to be reinforced at corner of North Shelby Street and Franklin Street, facing north.

Figure 21. View of section of I-Wall to be reinforced at corner of North Shelby Street and Franklin Street, facing southeast.

Figure 22. View of section of I-Wall to be reinforced west of North Clay Street, facing west.

Figure 23. Overview of the 10th Street Closure, facing northwest.

Figure 24. Overview of proposed new T-Wall alignment located northeast of Northwestern Parkway, facing northwest.

Figure 25. View of section of T-Wall to be replaced and removed, facing south.

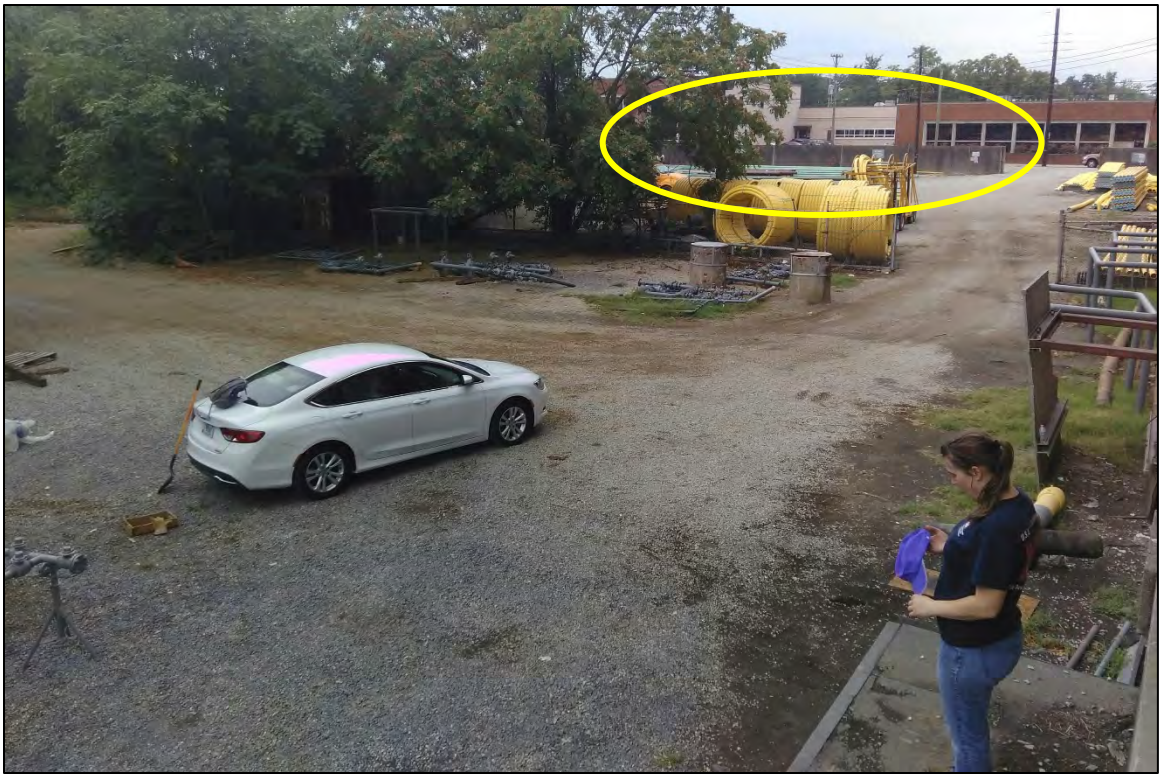

Figure 26. Section of the T-Wall to be replaced and removed in background, facing southeast (highlighted in yellow).

Figure 27. Overview of 27th Street Closure, facing north.

Figure 28. Overview of existing gravel drive way to be used as proposed access road starting at McAlpine Lock and Dam parking area, facing northwest.

Figure 29. Overview of proposed access road starting at 31st Street North, facing south.

Figure 30. Overview of location of the replacement of the discharge lines at Paddy's Run Pump Station, facing north.

Figure 31. Overview of location of the replacement of the discharge lines at Riverport Pump Station, facing southwest.

Figure 32. Overview of the Johnson Road Closure Vault to be demolished and replaced, facing southwest.

Figure 33. Overview of proposed repair of I-Walls on either side of the Pond Creek Pump Station, facing south.

I-Wall Reinforcement of Three Sections of Floodwall along North Clay and North Shelby Streets

The I-Wall reinforcement of the three locations of the floodwall along North Clay and North Shelby Streets in the Butchertown neighborhoods were visually scanned due to previous disturbances associated with the construction of the Louisville Reach in the 1950s (see Figures 1, 6, 20, 21, 22 and 34). The above ground structures associated with the Louisville Reach were evaluated for their NRHP eligibility in a separate report (Poole 2019). Soils in the area are characterized as Urban land (USDA NRCS 2019). Photos taken during the construction of the I-Wall in 1950 shows the level of disturbance during its construction (Figures 35 and 36). The visual examination of all three areas did not identify any intact soils or archaeological sites in the APE.

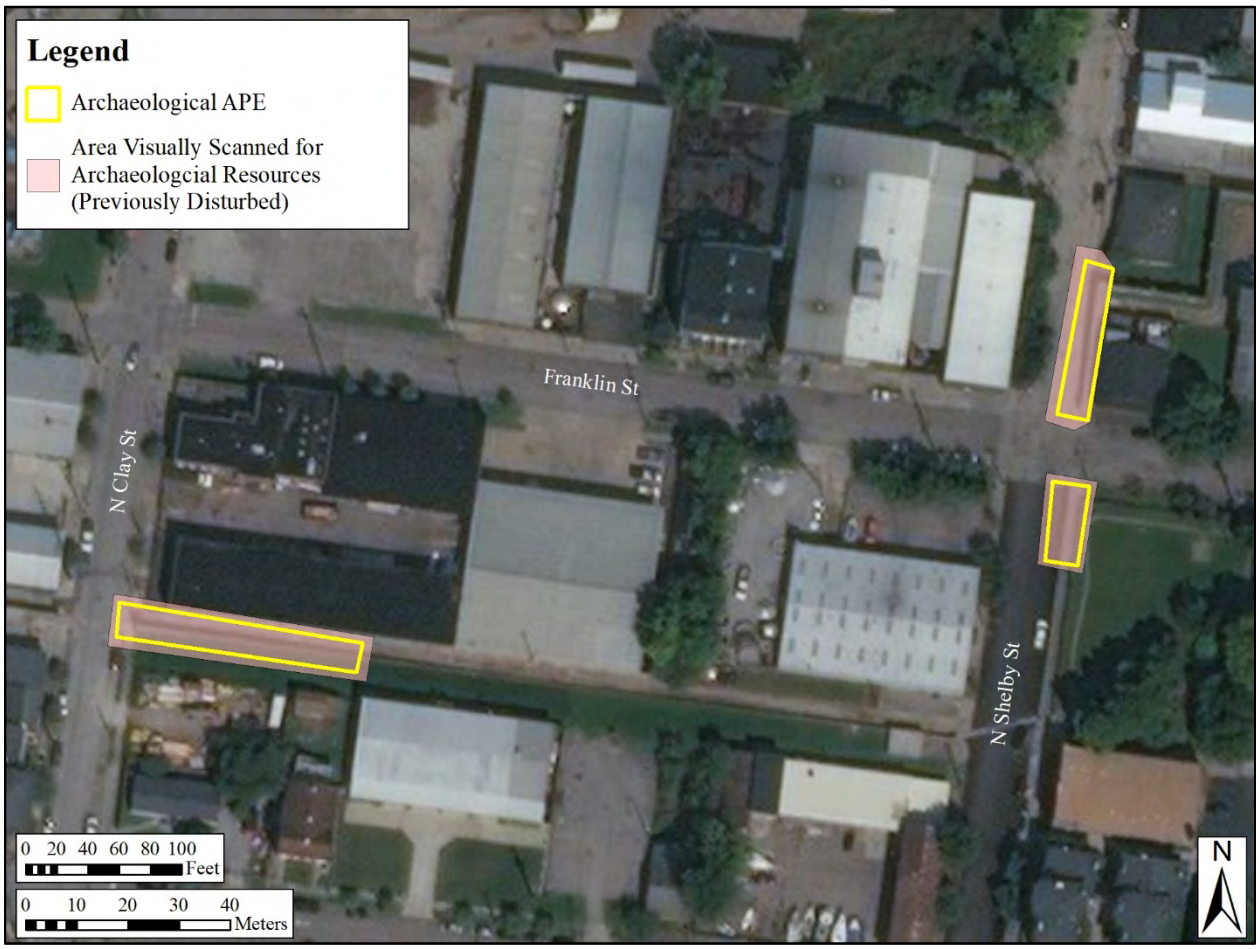

Figure 34. Aerial view showing locations of the proposed I-Wall reinforcements and areas visually scanned for archaeological resources.

LOUISVILLE DISTRICT, CORPS OF ENGINEERS, U. S. ARMY. Date: 24 May 1951. File No. 25449
Flood Control--Louisville, Kentucky, Section A, Part II, Ohio River, Contract DA-15-029eng-639, Traylor Brothers, Incorporated, Evansville, Indiana, dated 20 June 1950. Construction of Flood Protection Works. Looking upstream from landside of Station 79+66.30 showing partially completed wall.

Figure 35. Section of I-Wall under construction along North Shelby Street in 1950, note level disturbance, facing northeast.

Figure 36. Section of I-Wall under construction along North Shelby Street looking towards North Clay Street in 1950, note level disturbance on either side, facing west.

10th Street Closure and Installation of Swing Gate Closure

The 10th Street Closure and installation of a swing gate closure location was visually scanned due to previous disturbances associated with the construction of the Louisville Reach in the 1950s (see Figures 1, 6, 23, and 37). The above ground structures associated with the Louisville Reach were evaluated for their NRHP eligibility in a separate report (Poole 2019). Soils in the area are characterized as Urban land (USDA NRCS 2019). The 10th Street Closure had been previously surveyed in 2016 by Corn Island Archaeology during a survey of the downtown CSO Interceptor project (Sullivan and Bader 2016). Corn Island Archaeology's survey did not identify any archaeological resources or sites within the APE. A photo taken during the construction of the I-Wall in 1950 shows the level of disturbance during its construction (Figure 38). The visual examination of the 10th Street Closure did not identify any intact soils or archaeological sites in the APE.

Figure 37. Aerial view showing locations of the locations of the proposed I-Wall reinforcements and areas visually scanned for archaeological resources.

Figure 38. Overview of construction of 10th Street Pump Station in 1951, note level of disturbance during its construction, 10th Closure would be in background, facing east/northeast.

New T-Wall at Canal Station between Wall and Levee

The new T-Wall section at Canal Station is located between the Northwestern Parkway and the Louisville Riverwalk (see Figures 1, 6, 24, 25, and 26). This will also involve removal of the existing wall in portions of this location. The existing wall was built during the construction of the Louisville Reach in the 1950s. The above ground structures associated with the Louisville Reach were evaluated for their NRHP eligibility in a separate report (Poole 2019). The section of the wall that is currently amended to the building owned by LG&E will be left in place. Soils in the area are characterized as Urban land, Urban land – Alfic Udarents complex loamy substratum, and Urban land – Udorthents complex (USDA NRCS 2019). Five shovel tests were excavated at the location of the proposed T Wall location (Figure 39). These five shovel tests showed soils in the area consist of a top soil 10YR 4/2 dark grayish brown silt loam extending to a depth of 18 cm (7.1 inches) below ground surface (bgs). Underlying this topsoil was a layer of fill and disturbed soils consisting of a 10YR 4/2 dark grayish brown mixed with a 10YR 5/8 yellowish brown silty clay. This layer contained pieces of coal and brick mixed with modern trash including pieces of plastic. This disturbed soil layer extended from 18 to 29 cm (7.1 to 11.4 inches) bgs. Underlying the layer of disturbed soils was a compact silty clay 10YR 5/8 yellowish brown sterile subsoil (Figure 40). These disturbed soils in the area of the proposed T Wall location appear to be related to the past construction of the earthen levee and existing T Wall along with the area being used as a lay down yard by LG&E (see Figures 11, 24, and 39). The remainder of the APE in this location was visually scanned for intact soils or archaeological sites due to the past disturbances associated with the construction of the existing flood wall in this area. A photo taken during the construction of the I-Wall in 1951 shows the level of disturbance during its construction (Figure 41).

Adjacent to the existing floodwall in the APE in this location, archaeological site 15Jf766 was previously recorded just east of the APE. This site consists of an urban house lot dating from the mid nineteenth to mid twentieth century and an indeterminate prehistoric lithic scatter. The site was previously subjected to both Phase I survey and Phase II testing by CRA prior to construction of a cell tower (Donahue and McMahan 2010). After additional testing and archival research, CRA stated the site had no further research potential and recommended site 15Jf766 as not eligible for listing to the NRHP. The cell tower has since been built over site 15Jf766. The floodwall location adjacent to 15Jf766 saw heavy disturbance during its construction in 1951 (Figure 42). Due to the heavy prior disturbance of the construction of the floodwall in the early 1950s, the current survey did not find any evidence of intact soils or other archaeological features associated with 15Jf766 in the area of the floodwall location to be removed.

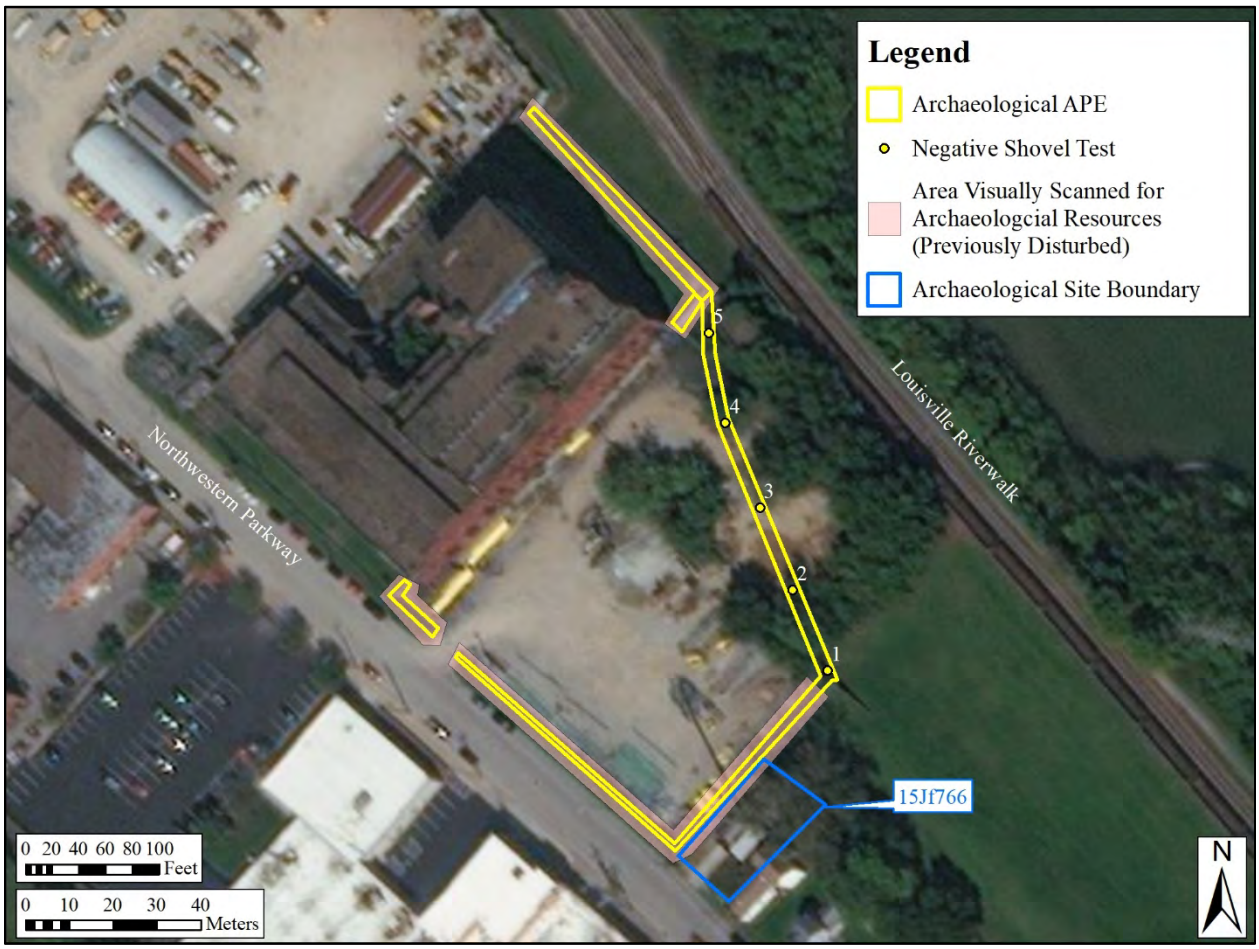

Figure 39. Aerial view showing location of new T-Wall alignment, shovel test locations, areas visually scanned for archaeological resources and location of archeological site 15Jf766.

Figure 40. Soil profile of shovel test 1 along new T-Wall alignment, facing east (scale in cm).

Figure 41. Overview of construction in 1951 of existing T-Wall to be removed and replaced along Northwestern Parkway, note level of disturbance during its construction, facing west.

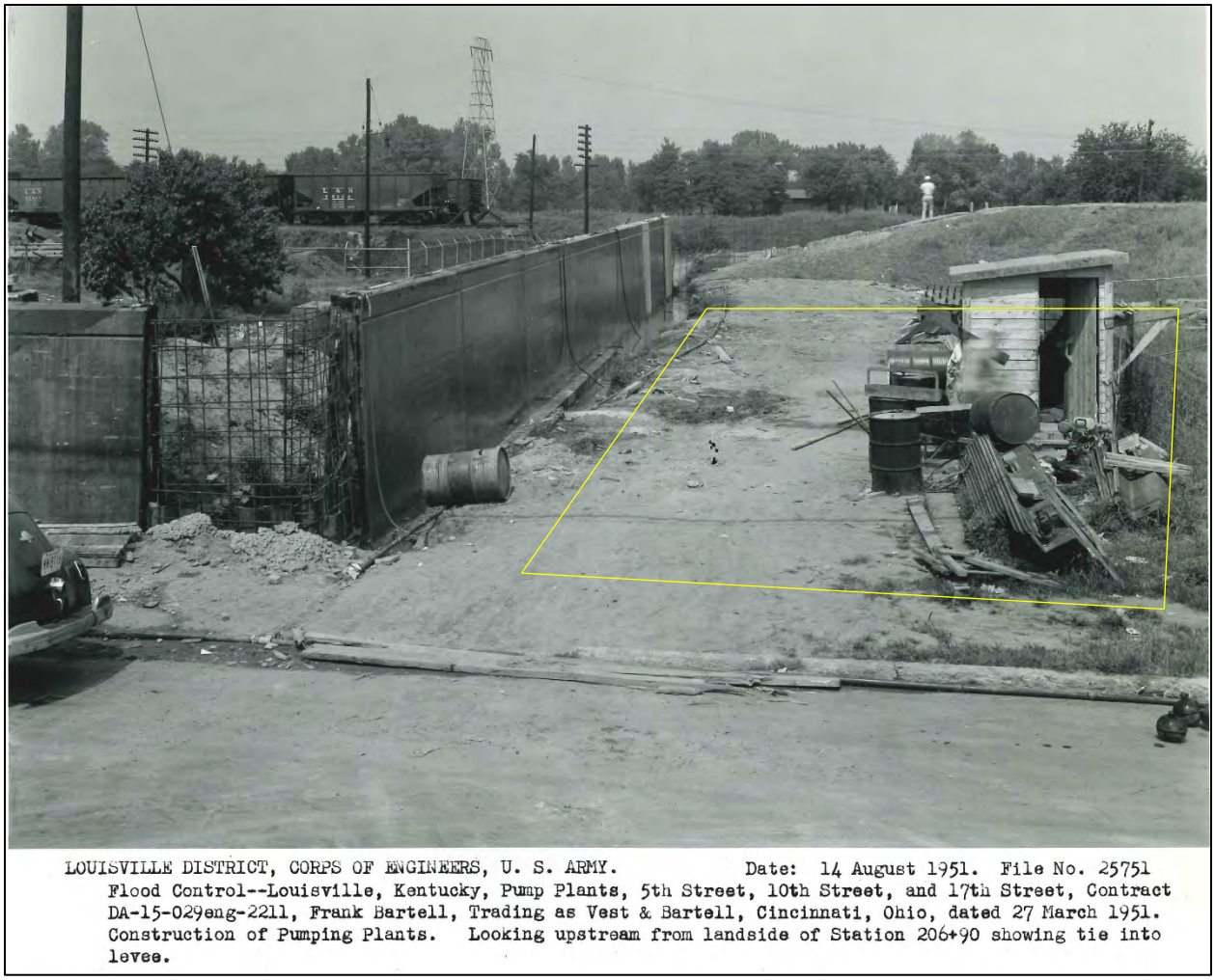

Figure 42. Overview of construction in 1951 of existing T-Wall to be removed and replaced along Northwestern Parkway, note level of disturbance during its construction, facing north (site boundary of 15Jf766 highlighted in yellow).

Demolition and Filling of 27th Street Closure

The demolition and filling of the 27th Street Closure location was visually scanned due to previous disturbances associated with the construction of the Louisville Reach in the 1950s (see Figures 2, 7, 27, and 43). The above ground structures associated with the Louisville Reach were evaluated for their NRHP eligibility in a separate report (Poole 2019). Soils in the area are characterized as Urban land – Udorthents complex, smoothed (USDA NRCS 2019). A photo taken during the construction of the 27th Street Closure in 1948 shows the level of disturbance during its construction (Figure 44). The visual examination of the 27th Street Closure did not identify any intact soils or archaeological sites in the APE.

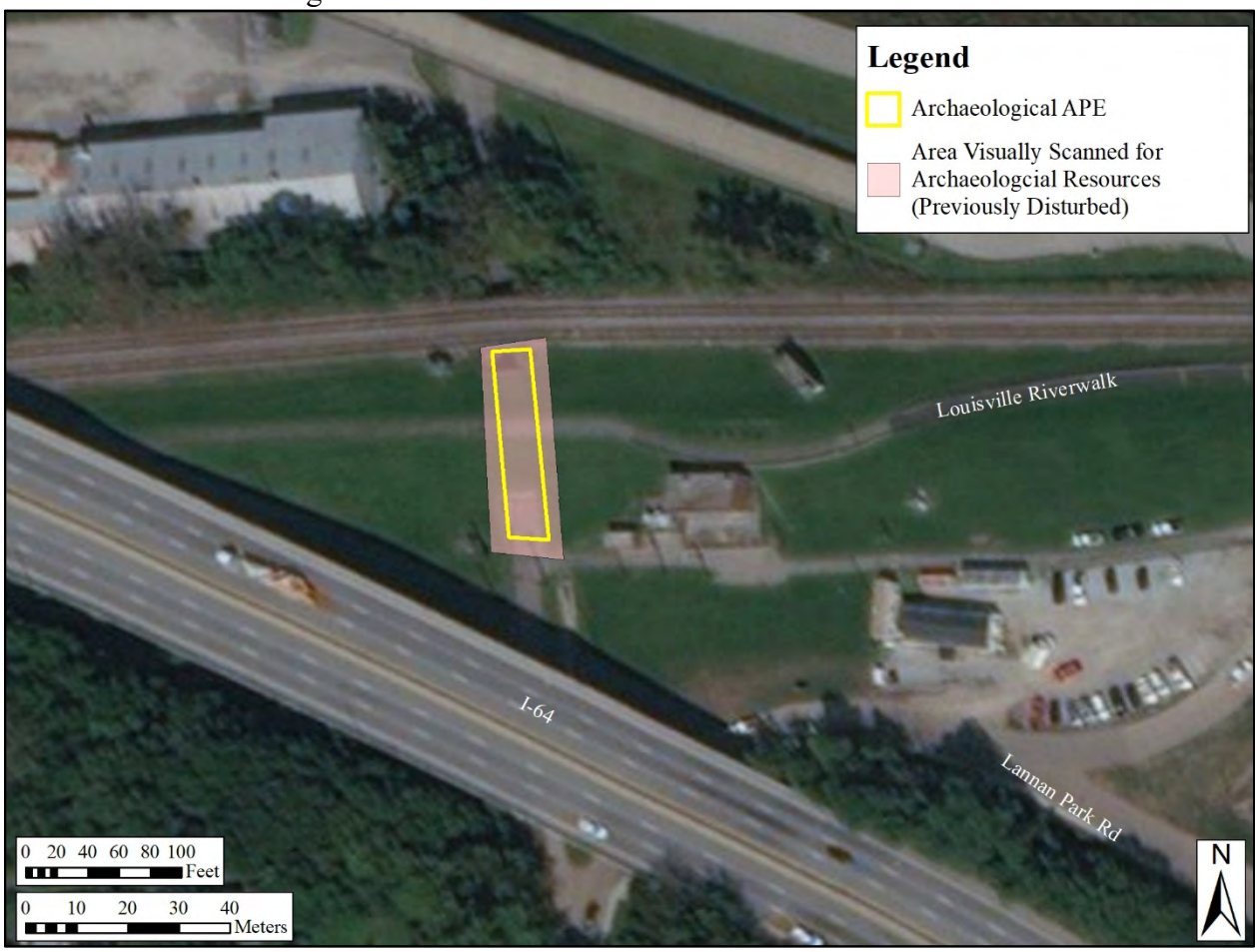

Figure 43. Aerial view showing location of the 27th Street Closure and areas visually scanned for archaeological resources.

Figure 44. Overview of construction of 27th Street Closure in 1948, note level of disturbance during its construction, facing north.

New Asphalt Access Road extending from North 31st Street to the McAlpine Lock and Dam Visitor Center

The new asphalt road extending from North 31st Street to the McAlpine Lock and Dam Visitor Center follows generally an existing gravel access road (see Figures 2, 7, 28 and 29). The proposed road starts at North 31st Street heading north. It then generally follows an existing gravel access road before then turning east before ending at an existing parking area located at the McAlpine Lock and Dam Visitor Center (Figure 45). Soils in the area are characterized as Urban land – Udorthents complex (USDA NRCS 2019). A portion of the proposed asphalt access road has been previously surveyed in 2006 during an archaeological survey for a proposed cell tower by Environment and Archaeology, LLC (Breetzke 2006). Breetzke's survey in 2006 did not identify any archaeological resources within the portion of the APE that was surveyed for the proposed cell tower. The existing gravel access driveway was visually scanned for intact soils or archaeological material. No sign of intact soils or archaeological sites were identified during the visual examination of the proposed asphalt road. The entire APE in the area of the road has been previously disturbed from past construction activities associated with the lock and dam and channel in the immediate vicinity (Figure 46). Most of the APE displays sloped terrain or evidence of previous grading activities. The visual examination of the proposed access road did not identify any intact soils or archaeological sites in the APE.

A search of the OSA records shows that site 15Jf2 is located within the APE at this location. A review of the OSA site record states that 15Jf2 is the Sand Island Channel and according to historical accounts, would have been located just at the head of the channel opposite Sand Island in the Ohio River (Sand Island Channel n.d.). The record states that this is the only information available for this site. It appears the location for site 15Jf2 is based on archival information and not based on any surveys, features, or recovered artifacts. The site record for 15Jf2 does state the site has been destroyed as a result of past construction of McAlpine Locks and the Louisville and Portland Canal. During the current survey, no evidence of a channel associated with 15Jf2 was encountered within the APE. It appears the site may be located either further north or northwest and outside the current APE.

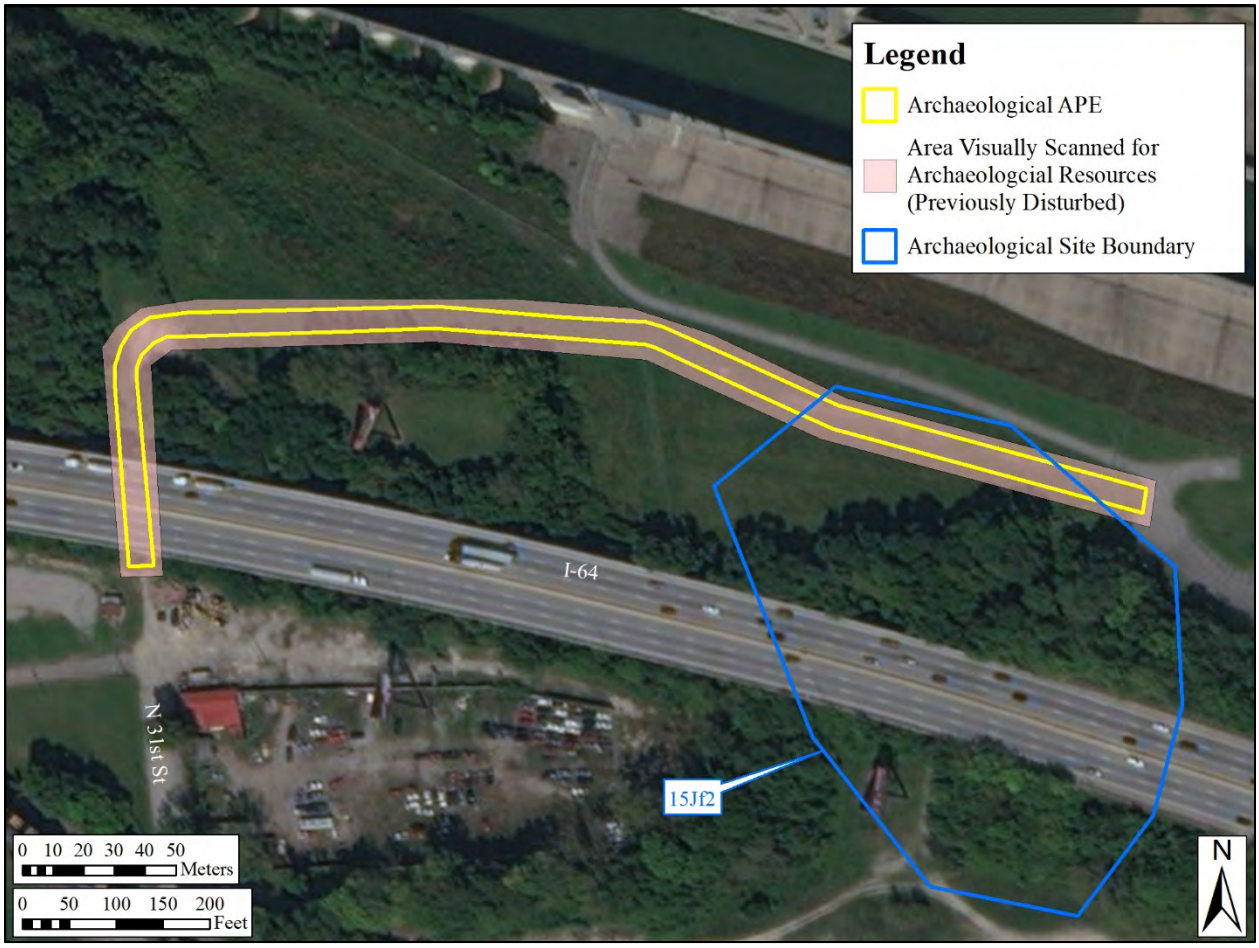

Figure 45. Aerial view showing location of the proposed asphalt access road, areas visually scanned for archaeological resources, and the location of archeological site 15Jf2.

Figure 46. Overview of proposed access road at McAlpine Lock and Dam showing existing gravel access road and sloped, borrowed area, facing southeast.

Replacing Discharge Lines at Paddy's Run Pump Station

The location of replacement of discharge lines at Paddy's Run Pump Station was visually scanned due to previous disturbances associated with the construction of the Louisville Reach in the 1950s (see Figures 3, 8, 30, and 47). The above ground structures associated with the Louisville Reach were evaluated for their NRHP eligibility in a separate report (Poole 2019). Soils in the area are characterized as Urban land – Udorthents complex, smoothed (USDA NRCS 2019). The area has also been previously surveyed for archaeological resources during a survey of the Paddy's Run Pump Station by CRA in 2016 (DelCastello et al. 2016). The CRA 2016 survey did not identify any archaeological sites within the APE. The visual examination of APE at Paddy's Run Pump Station did not identify any intact soils or archaeological sites in the APE.

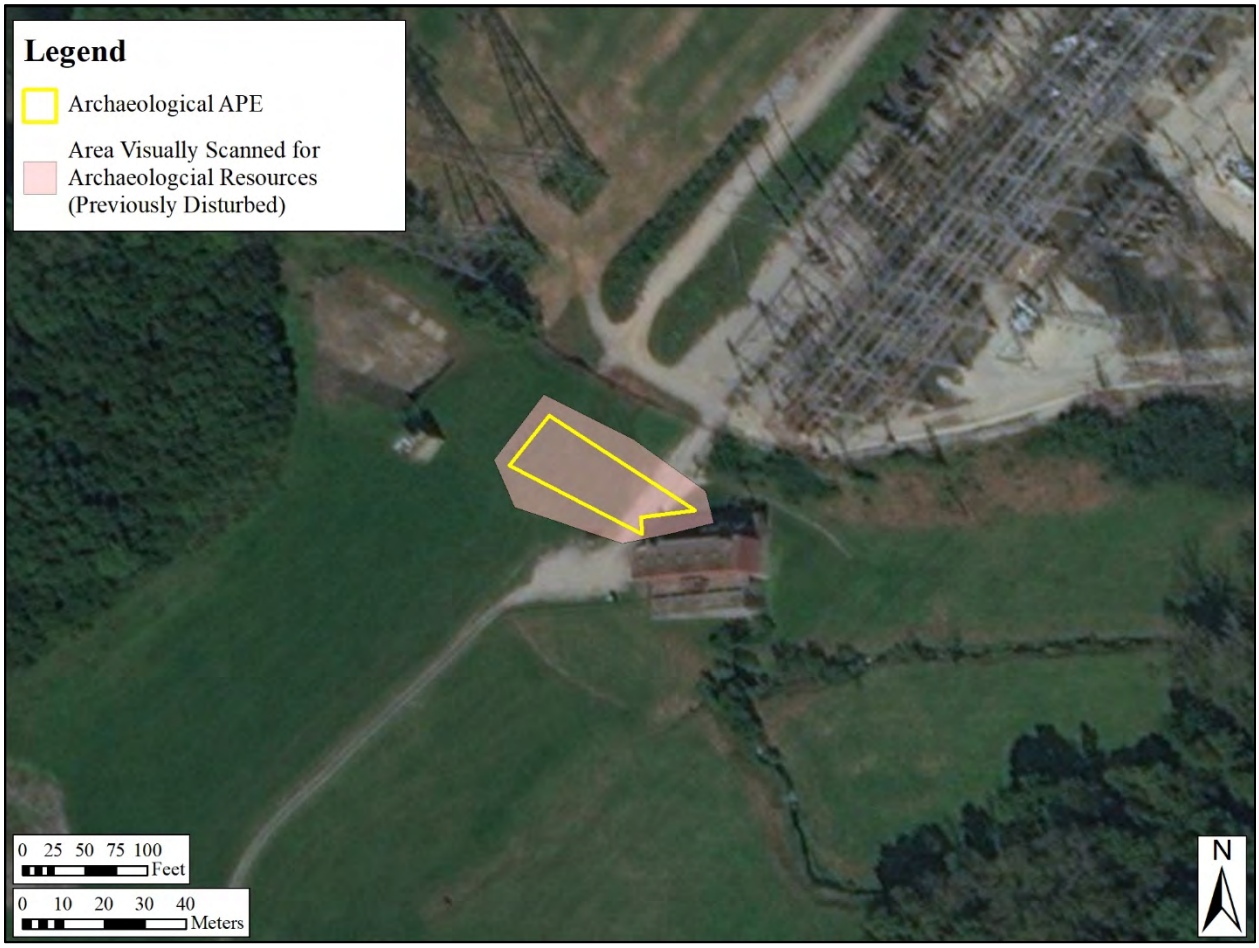

Figure 47. Aerial view showing the APE at Paddy's Run Pump Station.

Replacing Discharge Lines at Riverport Pump Station

The location of the replacement of discharge lines at Riverport Pump Station was visually scanned due to previous disturbances associated with the construction of the pump station in 1980 (see Figures 3, 8, 30, and 48). Soils in the area are characterized as Urban land – Udorthents complex, smoothed (USDA NRCS 2019). The Riverport Pump Station and floodwall were previously surveyed during an archaeological reconnaissance for the Riverport Industrial Park by the University of Louisville Archaeological Survey (Granger and DiBlasi 1975). The University of Louisville did not identify any archaeological sites during their reconnaissance of the Riverport Industrial Park. The visual examination of the APE at Riverport Pump Station did not identify any intact soils or archaeological sites in the APE.

Figure 48. Aerial view showing location of Riverport Pump Station and location of APE and areas visually scanned.

Demolition and Replacement of the Johnson Road Closure Vault

The location of the demolition and replacement of the Johnson Road Closure Vault was visually scanned due to previous disturbances associated with the construction of the closure vault in the 1980s (see Figures 4, 9, 32, and 49). Soils in the area are characterized as Urban land – Udorthents complex, smoothed (USDA NRCS 2019). The visual examination of the APE at the Johnson Road Closure Vault did not identify any intact soils or archaeological sites in the APE.

Figure 49. Aerial view showing location of the Johnson Road Closure Vault APE and areas visually scanned.

Repair of I-Walls on Either Side of the Pond Creek Pump Station

The repair of the I-Walls on either side of the Pond Creek Pump Station is located in Bullitt County (see Figures 5, 10, 33 and 50). Soils in the area are characterized as Urban land – Udorthents complex, smoothed and Lawrence silt loam (USDA NRCS 2019). The repair of the I-Walls at Pond Creek Pump Station were visually scanned due to previous disturbances associated with the construction of the pump station in the 1980s. The visual examination of the APE at Pond Creek Pump Station did not identify any intact soils or archaeological sites in the APE.

A search of the OSA GIS database did identify previously recorded archaeological site 15Bu160 within portions of the APE. A search of the OSA records on August 30, 2019 found no site record associated with 15Bu160. The only information available for the site is from the OSA GIS database. The OSA GIS database states the site is missing who recorded the site, the date the site was recorded, what type of site it is, the cultural affiliation of the site, and its NRHP eligibility. It is unclear how this site was recorded or who recorded it. During the current survey, no evidence of intact archaeological deposits or soils associated with 15Bu160 was encountered within the APE. It appears the site was destroyed during the construction of the Pond Creek Pump Station in the 1980s.

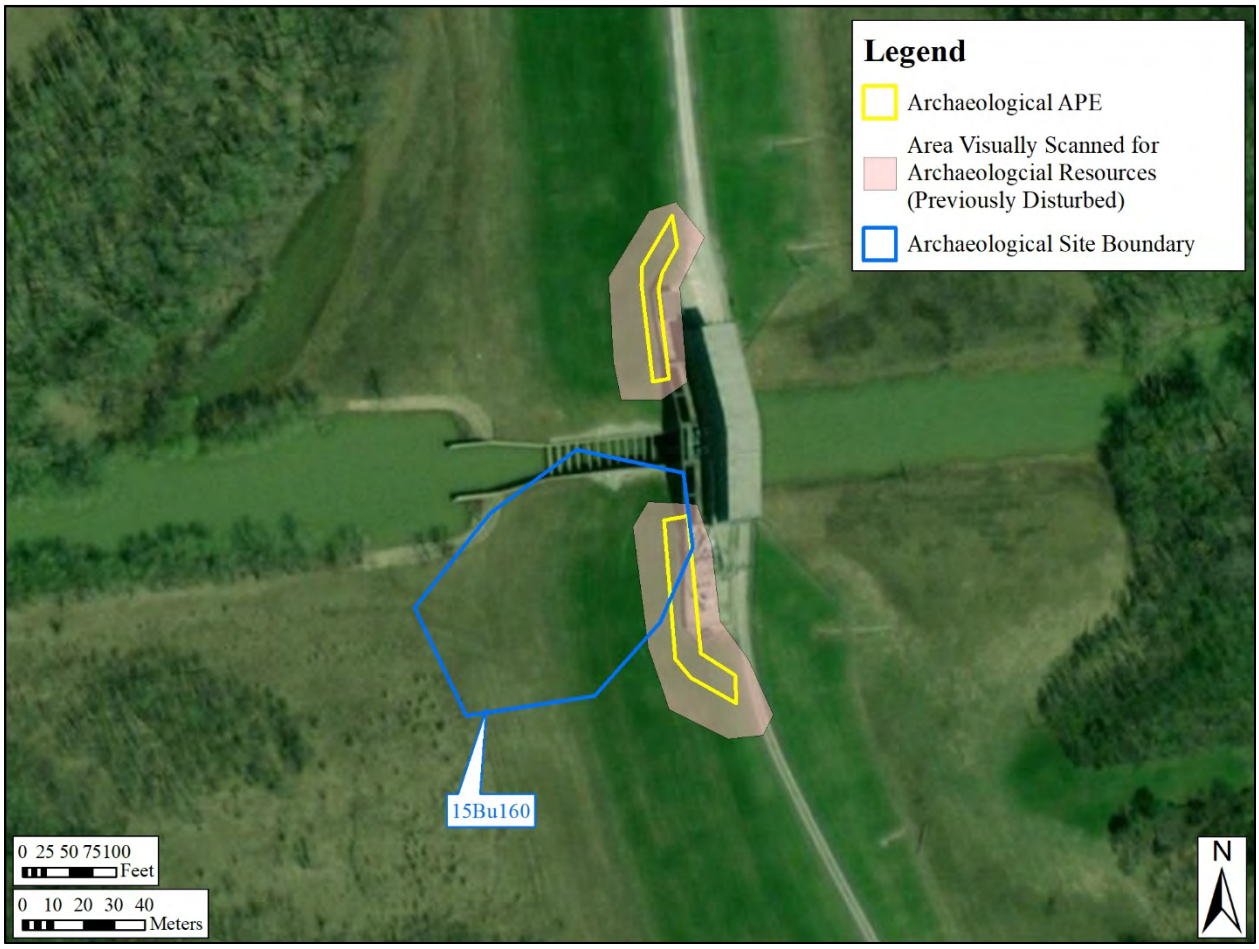

Figure 50. Aerial view showing location of I-Wall Repairs at Pond Creek Pump Station, areas visually scanned for archaeological resources, and location of archeological site 15Bu166.

Conclusion and Recommendations

An archaeological survey of the areas of ground disturbance associated with the reconstruction and rehabilitation of the LMFPS identified no archaeological sites within the APE. Furthermore, the areas where ground disturbing activities are proposed have been previously disturbed and suggests a low probability for archaeological sites or intact soils. Given these results, the proposed undertaking is considered to have no effect to archaeological sites eligible for listing to the NRHP [36CFR part 800.4 (d)(1)]. Therefore no additional archaeological survey is recommended and the project can proceed as planned.

References

Ball, Donald B.
1998 *A Phase I Cultural Resources Reconnaissance of the Proposed Beargrass Creek Local Flood Protection Project, Jefferson County, Kentucky*. Report prepared by the United States Army Corps of Engineers, Louisville District.

Bergmann, G.T.
1858 *Map of Jefferson County Kentucky*. G.T. Bergman. Louisville, Kentucky. Available online at: https://www.loc.gov/resource/g3953j.la000234/?r=0.659,0.645,0.28,0.191,0

Breetzke, David
2006 *Abbreviated Phase I Archaeology Report for the McAlpine 2 Cellular Tower, Jefferson County, Kentucky*. Report prepared by Environment & Archaeology, LLC. Report submitted to Terracon.

DelCastello, Brian G., Heather D. Barras, and James Heideman
2016 *An Archaeological Survey of the Proposed Paddys Run Flood Pump Station Rehabilitation Project in Jefferson County, Kentucky*. Report prepared by Cultural Resource Analysts, Inc. Report submitted to Third Rock Consultants, LLC.

Donahue, Robert C. and Matthew D. McMahan
2010 *An Archaeological Survey of the Proposed Ninth Street Portland 2 Cellular Communications Tower Location and National Register of Historic Places Evaluation of Archaeological Site 15Jf766 in Louisville, Jefferson County, Kentucky*. Report prepared by Cultural Resource Analysts, Inc. Report submitted to MACTEC Engineering and Consulting, Inc.

Dragoo, Don.
1976 *Prehistoric Cultural Resources of Section Two, Southwest Jefferson County Local Flood Protection Project: Test excavations.* Prepared by Environmental Consultants, Inc. Prepared for the Louisville District, U.S. Army Corps of Engineers.

Esarey, Mark
1992 *Phase I Cultural Resources Survey of Twelve City Blocks in the 50-Acre Municipal Harbor/Thurston Park Section of the Proposed Waterfront Redevelopment Project, Louisville, Jefferson County, Kentucky.* Prepared by Program for Cultural Resources Assessment University of Kentucky. Prepared for Falls Harbor, Inc.

1993 *Phase I Cultural Resource Survey of Twenty City Blocks in the 100-Acre Downtown Master Plan Section of the Proposed Waterfront Redevelopment Project, Louisville, Jefferson County, Kentucky.* Prepared by Program for Cultural Resources Assessment University of Kentucky. Prepared for Bravura, Inc.

Granger, Joseph E. and Philip J. DiBlasi
1975 *An Archaeological Reconnaissance of the Riverport Industrial Park, Jefferson County, Kentucky*. Report prepared by University of Louisville Archaeological Survey. Report submitted to Louisville and Jefferson County Riverport Authority.

Grob, Kaye., Katie Settle., and Veronica Parsell
2015 *Phase I Archaeological Records Review and Reconnaissance for the Paddy's Run Natural Gas Pipeline, Jefferson County, Kentucky*. Prepared by Cardno, Inc. Prepared for EN Engineering, LLC.

Hale, John
1981 *Archaeological Sites in Riverport: Report on sub-surface testing in the Riverport Industrial Park, Jefferson County, Kentucky, carried out by the University of Louisville Archaeological Survey in summer of 1980.* Report submitted to Stanley Consultants, Inc.

Herndon, Richard and Tanya Faberson
2007 *Archaeological Monitoring of Geotechnical Borings for the Proposed Kennedy Bridge Interchange Area of the Ohio River Bridges Project in Jefferson County, Kentucky: Phases 1 through 5 (Item No. 5-118.00).* Report Prepared by Cultural Resources Analysts, Inc. Report Submitted to Federal Highway Administration.

McKelway, Henry
1997 *An Archaeological Survey of Proposed Construction at Riverside, the Farnsley-Moremen Landing, Jefferson County, Kentucky.* Prepared by Cultural Resources Analysts, Inc. Report Submitted to Jefferson County Kentucky Division of Public Properties.

Miller, Paula
2008 *Phase I Archaeological Survey TRILEAF Corporation Cell Tower Site # 300614 (Louisville RR Yard) Louisville, Jefferson County, Kentucky, Kentucky Heritage Council Registration # FY08-5579.* Prepared by Cultural Heritage Research Services, Inc. Report Submitted to Dipti Motaganhalli TRILEAF Corporation.

Poole, Lauren
2019 *Cultural Historic Determination of Eligibility Survey for the Louisville Reach and Louisville Gas and Electric Building in Jefferson County, Kentucky*. Report prepared by Cultural Resources Analysts, Inc. Report submitted to United States Army Corps of Engineers, Louisville District.

Sand Island Channel
No Date (n.d.) *Site Form 15Jf2*. On file at the Kentucky Office of State Archaeology.

Sanders, Thomas N. (editor)
2017 *Specifications for Conducting Fieldwork and Preparing Cultural Resource Assessment Reports.* Issued by the Kentucky State Historic Preservation Office and the Kentucky Heritage Council, Edition 2.5, Frankfort, Kentucky.

Secretary of the Interior
1983 *Standards and Guidelines for Archaeological and Historic Preservation.* Federal Register, Vol. 48, No. 190.

Stackelbeck, Kary L. and Philip B. Mink
2008 Chapter 2: Overview of Archaeological Research in Kentucky. In *The Archaeology of Kentucky: An Update.* Edited by David Pollack, pp. 27–108. Kentucky Heritage Council, State Historic Preservation Comprehensive Plan Report No. 3, Frankfort.

Stallings, Richard
2010 *Archaeological Monitoring Along 2nd Street from Main Street to the Ohio River Floodwall, Louisville, Kentucky.* Prepared by AMEC Earth & Environmental Inc. Prepared for MAC Construction & Excavating, Inc.

Stottman, Jay and Matthew Prybylski
2004 *Archaeological Research of the River side Wash House.* Research Report No. 7 Prepared by the Kentucky Archaeological Survey.

Stottman, Jay and Jeffrey Watts-Roy
1995 *Phase I/II Archaeological Testing at the Louisville Convention Center Site.* Report prepared by the Kentucky Archaeological Survey. Report on file at the Kentucky Archaeology Office of Archaeology.

Sullivan, Tim D., and Ann Tobbe Bader
2016 *A Phase I Archaeological Survey of Approximately 28.12 Acres for the Proposed Downtown CSO Interceptor Project, Louisville, Jefferson County, Kentucky*. Report prepared by Corn Island Archaeology. Report submitted to Hazen and Sawyer.

2017 *Addendum Report of 1.2 Acre Addition to: A Phase I Archaeological Survey of Approximately 28.12 Acres for the Proposed Downtown CSO Interceptor Project, Louisville, Jefferson County, Kentucky*. Report prepared by Corn Island Archaeology. Report submitted to Hazen and Sawyer.

United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS)
2019 Online soil survey website. Available online at: www.in.nrcs.usda.gov. Site accessed on October 17, 2019.

2019

Louisville Metro Flood Protection System

Louisville, Kentucky Riverfront

Engineering

Engineering
Volume 2

VOLUME 2 – Engineering

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1. Appendix A - General

This appendix describes the general scope of the project and the options considered as part of the study.

1.1. Introduction

Volume 2 Covers the engineering team's assessment of the levee system's components and the analyses and decision criteria utilized in determining eligibility for reconstruction as well as upgrading to the latest design standards.

1.2. Scope of Study

The general scope of the study comes from the primary policy guidance being used which is CECW-PB Memorandum, Subject: *Reconstruction of U.S. Army Corps of Engineers Structural Flood Damage Reduction Projects for which Non-Federal Interests are Responsible for Operation, Maintenance, Repair, Rehabilitation, and Replacemen*t, dated 16 Aug 2005. This policy guidance outlines the process for evaluating the existing project for potential 'reconstruction', which consists of 'addressing performance deficiencies caused by a long-term degradation of the foundation, construction materials, and engineering systems that have exceeded their expected service lives and the resulting inability of the project to perform it authorized project functions'.

1.3. Periodic Inspection, Site Visits, Meetings

A Periodic Inspection of the Louisville Metro Levee System was performed in 2019 and is largely utilized to characterize the existing condition of the levee system. The Periodic Inspection is attached in Volume 3. The inspection ranked the system as 'minimally acceptable', the same ranking as approximately 90% of the USACE inventory, and noted recommendations in the report.

A multitude of site visits too frequent to list were performed for work on this project both with and some without the local sponsor (MSD), including the initial site visit in September, inspections for the PI, site visits for the SQRA, inspection of the Paddy's Run pump station, inspections of the Beargrass Creek pump station, inspections of the downtown floodwalls, etc. These visits helped to inform the study and the development of deficiencies and measures to correct those deficiencies.

A multitude of meetings were held with the local sponsor and other entities in developing the scope of the project. These included: Hydraulics Discussion with MSD and Heritage Engineering, Pump Station Discussion with MSD, Potential Failure Mode Analysis (PFMA) with MSD, Semi Quantitative Risk Assessment with MSD, SQRA Outbrief with MSD, Pump Station Electrical Reliability with LG&E (utility) and MSD, multiple Pump Station Capacity meetings, as well as the scheduled Planning Milestones. Each meeting gathered and exchanged information with experts and the local sponsor regarding the formulation of the measures and ultimately alternatives of the study.

A significant number of hydraulic/hydrologic discussions have been held on the project with HEC personnel as well as the Climate Change PCX. A substantial amount of effort on the project consisted of a determination regarding the pumping capacity of the stations, and the level of capacity the study would recommend.

1.4. Pump Station Design Capacity

Determining what capacity to recommend for this study involved a detailed joint probability, or coincident frequency analysis that examined the likelihood of interior flooding associated with varying the capacity of the stations from the existing. EM 1110-2-1413 provides the primary guidance on interior drainage capacity. This examined the risk reduction achieved for the surrounding homes/businesses at different stations. The analysis takes into account the current everyday risk of flooding, and determines how much this risk is increased by the likelihood of significant rain events occurring during a high river event when pumping is required. In general the study found that little additional risk reduction is achieved by adding capacity. Some stations capacity increases made more sense than others, yet was judged to not be significant enough to offset the cost. The rainfall frequency utilized also has a substantial impact on this analysis. The study did not utilize projected rainfall data based on climate change, but did utilize the upper confidence limit of the NOAA Atlas 14 rainfall frequency data. More detailed information on the hydraulic/hydrologic analysis is found in Appendices B and K.

1.5. Pump Station Equipment

One of the most significant performance deficiencies associated with the levee system currently is issues with the equipment at the pump stations. MSD is currently in a cycle of continuous major maintenance of multiple pumps at multiple stations. The 2019 PI found that there are currently five pumps inoperable at five different stations, all scheduled for maintenance currently during the off-season. This has been a recurring theme in recent years and after each flood event the sponsor is required to address multiple breakdowns. This equipment makes up the majority of the study scope.

1.6. Risk Assessment

Concurrent to the study, LRL performed a SQRA with the RMC on the Louisville Metro Levee System that was utilized to help formulate study measures. The risk assessment primarily examines the levee system for risk of incremental life loss from failure. It considers the likelihood of failure for all flood loadings of which the failure modes are plausible and estimates their likelihood as well as the life loss consequences of such a failure. Economic incremental impacts are also estimated. This produces an analysis of the probability of a feature not performing, and the physical and fiscal consequences of that failure to perform. Features identified which have a potential performance issue were considered for measures in the study associated with lessening the likelihood or consequences of the failure to a level in order to meet the tolerable risk quidelines (TRG's). Primary measures associated with addressing risk reduction from the SQRA are as follows, in order of achieving the greatest risk reduction:

1. Reinforcing the Pond Creek floodwalls
2. Adding capacity to the Beargrass Creek roller gates hoist mechanism and a secondary access to the Hoist
3. Repair/replacement of pump station equipment in the pump stations with potential life loss consequences.
4. Buttressing or replacement of Butchertown I-walls
5. Adding to the Operations Manual the indication to 'open' certain gravity gates when interior flooding exceeds the exterior elevation.

1.7. Proposed Reconstruction Items

The below figure shows the location of the pump stations. The below table provides a current list of the proposed reconstruction items.

Figure 1-1: Pump Station Locations

Table 1-1: Proposed Reconstruction Actions

Louisville Metro Proposed Reconstruction Actions	
Location	**Item**
Beargrass Creek	Rebuild Pump 1 - 52,750 GPM
	Rebuild Pump 2 - 300,000 GPM
	Rebuild Pump 3 through 8 - 350,000 GPM
	Upgrade River Gate hoist Machinery
	Inspect and upgrade/repair gate as needed to accommodate new hoist machinery.
	New Transducers for Upstream/Downstream Control
	Add Interior Walkway to Access River Gate Hoist
	Replacement of Service Transformers
	Inspect all motors and refurbish motor components as needed
	No Changes to MCC
Starkey	Rebuild Pump 1 - 24,500 GPM
	Rebuild Pump 2 - 24,500 GPM
	Rebuild Pump 3 - 24,500 GPM
	Rebuild Pump 4 - 24,500 GPM
	Replacement of Service Transformers
	Replacement of VFDs
	New MCC
	Inspect all motors and refurbish motor components as needed
4th Street	No Mechanical Work
	No changes to MCC
5th Street	Replace Pump 1 - 11,070 GPM with Submersible Column Pump
	Replace Pump 2 - 11,070 GPM with Submersible Column Pump
	Replace Pump 3 - 11,070 GPM with Submersible Column Pump
	Replace Pump 4 - 3,000 GPM with Submersible Pump
	New MCC
	Replacement of service transformers
	Replacement of controls
10th Street	Replace Pump 1 - 1,530 GPM with Submersible Pump
	Replace Pump 2 - 19,950 GPM with Submersible Column Pump
	Replace Pump 3 - 19,950 GPM with Submersible Column Pump
	Replace Pump 4 - 19,950 GPM with Submersible Column Pump
	New MCC
	Replacement of service transformers
	Replacement of controls

17th Street	Replace Pump 1 - 1,300 GPM with Submersible Pump
	Replace Pump 2 - 11,400 GPM with Submersible Column Pump
	Replace Pump 3 - 11,400 GPM with Submersible Column Pump
	Replace Pump 4 - 11,400 GPM with Submersible Column Pump
	New MCC
	Replacement of service transformers
	Replacement of controls
27th Street	Replace Pump 1 - 5,710 GPM with Submersible Pump
	Replace Pump 2 - 40,000 GPM with Submersible Column Pump
	Replace Pump 3 - 40,000 GPM with Submersible Column Pump
	Replace Pump 4 - 40,000 GPM with Submersible Column Pump
	Replace Pump 5 - 40,000 GPM with Submersible Column Pump
	New MCC
	Replacement of service transformers
	Replacement of controls
34th Street	Replace Pump 3 - 15,600 GPM with Submersible Column Pump
	Replace Pump 4 - 15,600 GPM with Submersible Column Pump
	Replace Pump 5 - 15,600 GPM with Submersible Column Pump
	Replace Pump 6 - 15,600 GPM with Submersible Column Pump
	New MCC
	Replacement of service transformers
	Replacement of controls
	Replace/Refurbish Two 75 HP Motors
Shawnee Park	Replace Pump 1 - 9,000 GPM with Submersible Column Pump
	Rebuild Pump 2 - 103,500 GPM
	Rebuild Pump 3 - 103,500 GPM
	Rebuild Pump 4 - 103,500 GPM
	Rebuild Pump 5 - 103,500 GPM
	Rebuild Pump 6 - 103,500 GPM
	Replace Pump 7 with Submersible Pump
	New MCC
	Replacement of service transformers
	Replacement of controls
	Replace/Refurbish five 800 HP Motors
Western Parkway	No Mechanical Work
	Replacement of controls
	Upgrade service transformers
	No Changes to MCC or Motors

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Paddy's Run	Replace Pump 1 - 60,750 GPM
	Replace Pump 2 - 60,750 GPM
	Replace Pump 3 - 121,500 GPM
	Replace Pump 4 - 121,500 GPM
	Replace Pump 5 - 121,500 GPM
	Replace Pump 6 - 121,500 GPM
	Replace trash rake
	Install Centralized Automatic Grease System
	New MCC
	Replacement of service transformers
	Replacement of controls
	Replace/Refurbish Two 700 HP Motors
	Replace/Refurbish Four 1250 HP Motors
	Structurally refurbish station
	Discharge lines replacement/rehab
	Upgrade overhead crane
Riverport	No Mechanical Work
	New MCC
	Replacement of service transformers
	Replacement of controls
	No Changes to Pump Motors
	Replace horizontal portion of discharge pipes
Lower Mill Creek	Rebuild Pump 1 - 73,500 GPM
	Rebuild Pump 2 - 73,500 GPM
	Rebuild Pump 3 - 73,500 GPM
	Install Centralized Automatic Grease System
	New MCC
	Replacement of service transformers
	Inspect all motors and refurbish motor components as needed
	Replacement of controls
	Rehab horizontal portion of discharge pipes
Upper Mill Creek	Rebuild Pump 1 - 173,000 GPM
	Rebuild Pump 2 - 173,000 GPM
	Rebuild Pump 3 - 173,000 GPM
	Rehab horizontal portion of discharge pipes
	Install Centralized Automatic Grease System
	New MCC
	Replacement of service transformers
	Replacement of controls

	Replace/Refurbish One 3000 HP Motors
Pond Creek	Rebuild Pump 1 - 460,082 GPM
	No Work on Pump 2 - 460,082 GPM
	Rebuild Pump 3 - 460,082 GPM
	Rebuild Pump 4 - 460,082 GPM
	Install vibration sensors and trend data
	Install FSI or Vortex Suppression Grid for all pumps
	New MCC
	Replacement of service transformers
	Replacement of controls
	Replace/Refurbish Four 4700 HP Motors
	Repair water service
	Repair I-walls on either side of station - structural modification
Canal Station	Construct T-wall between wall and levee in order to demolish abandoned building between Northwestern Parkway and Louisville Riverwalk and to abandon I-wall
Butcher town	Stabilize I-wall sections (3 locations)
10th Street	Permanently abandon closure (betterment: install swing gate closure)
27th St closure	Permanently abandon closure, construct new asphalt access road from 31st Street South of McAlpine Lock.
Johnston Rd. Closure	Replace closure vault with a new closure vault.
Gates (multiple	Replace actuators at multiple gates, replace multiple gates, refurbish multiple gates. Approximately 15 new actuators, 13 new gates, 10 gates to be refurbished.

Waterstop Repair	Installation of new external water stops at approximately 26 locations along the floodwall. New water stops will consist of a steel plate, adhesive anchors and new PVC water stops.

APPENDIX B – Hydraulics and Hydrology (H&H)
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2. Appendix B – Hydraulics and Hydrology (H&H)

This appendix lists and describes the hydrologic and hydraulic considerations that were part of the feasibility study and the formulation of the alternatives. Evaluation criteria for the features eligible for reconstruction is also discussed. Also listed are specific measures where H&H considerations were applied, the information available, analyses performed, the assumptions, future information needed, and the project risk involved with the information and assumptions utilized.

2.1. General Background and History of Project Area

The community of Louisville, Kentucky is located within Jefferson County along the banks of the Ohio River and contains numerous smaller streams within its boundaries. The Ohio River flows generally in a southwesterly direction and forms the northern boundary for the City of Louisville and State of Kentucky.

Additional information on the study area can be found in FEMA's 2006 Flood Insurance Study (FIS):

> *Drainage of Jefferson County directly into the Ohio River is by Harrods Creek, Goose Creek, Beargrass Creek, Mill Creek, and Upper Mill Creek watersheds. A large portion of the county lies within the broad floodplain of the Ohio River. However about 17,600 acres of this floodplain are protected by a flood protection project completed in 1956. An extension of this project downstream near the Bullitt County / Jefferson County limits increased the protected area by 24,100 acres to a total of 41,700 acres.* (Pond Creek also drains a substantial portion of Jefferson County, approximately 126 mi^2 at its confluence with the Salt River. Harrods Creek and Goose Creek mentioned in the FIS above are outside of the Louisville Metro Flood Protection System.)
>
> *The topography of Louisville-Jefferson County is mostly rolling, and the Ohio River floodplain areas have low relief characterized by a deep covering of Pleistocene outwash deposits of alluvium clay, silt, and gravel.*
>
> *Louisville-Jefferson County is located in the Deciduous Forest Formation of eastern North America. It is contained in the Western Mesophytic forest region. This region has a wide variety of upland forest types and extensive alluvial swamps. The floodplains of all streams in the county contain both residential and industrial developments, and a great deal of the residential development occurs in the areas in the vicinity of the expressway systems connecting the northeast and southwest portions of the county.*
>
> *In 1937, one of the worst storms of the century hit Louisville, devastating the city and causing major damage. Planning for Louisville and Jefferson County's Flood Protection System began not long afterward. The system was built over a period of 46 years. The first phase of the floodwall, called the Louisville Local Flood Protection Project (LLPP), is about 17 miles in length. The LLPP stretches along the Ohio River from Beargrass Creek to just south of Rubbertown, a major industrial area near the City of Shively. This phase was completed in 1957. A major extension to the first floodwall, called the Southwest Jefferson County Local Flood Protection Project (SJCLPP) began in the late 1960's and was completed in the late 1980's. This branch protected the remainder of southwest Jefferson County, from Rubbertown to near the Jefferson County I Bullitt County boundary. The latest addition is a new pumping station located between Second Street and Interstate 65 in Louisville's downtown Riverfront area. This station was completed in 1994.*

Major Ohio River floods of this century occurred in 1937, 1945, 1964, and 1997. The 1937 flood is believed to be the highest since settlement of the area, and it was used in setting heights of the Ohio River local protection projects in the area. That flood reached an elevation of 458.1 feet (NAVD88) at the USGS Ohio River Louisville gage (03294500) and has an expected frequency in excess of once in 500 years. The 1945 and 1964 floods have estimated average recurrence intervals of once in 70 years and 45 years, respectively. (Gage number 03294500 is referred to throughout the report as the Lower McAlpine Gage and is located at the downstream end of the McAlpine L&D guide wall. Additionally, the McAlpine Upper Gage is USGS number 03293551, it is located on the railroad bridge just upstream of the L&D, and observed a peak water surface elevation of approximately 458.89 ft-NAVD88 during the 1937 flood. Based upon flow frequency curves revised after the construction of upstream reservoirs, the 1937 event has an annual chance exceedance of less than 0.1%, and the 1945 and 1964 events have ACEs of approximately 1.25% and 1.61%, respectively.)

The Beargrass Creek watershed streams originate in eastern Jefferson County and flow into and through the eastern sector of the Louisville Metro to their confluences with the Ohio River. Flooding within the Louisville Metro is concentrated upstream of the Ohio River Flood Protection System, where inadequate bridge openings cause major flooding during headwater floods. Flooding from Beargrass Creek watershed streams is confined to the upper reaches of the watershed and is caused by local intense rainstorms. Major Beargrass Creek watershed floods have occurred in 1937, 1960, 1964, 1970, 1973 and 1997. To offset the increasing urbanization runoff effects from similar floods, a dry-bed reservoir was completed in the upper reach of South Fork Beargrass Creek in late 1980. This reservoir, which controls 2.57 square miles, reduces the impact of flooding down to Hikes Lane. Below Hikes Lane to the USGS stream gage located at Trevilian Way, the dry-bed reservoir compensates for increases of intense development in the watershed in the last few decades, so that the net result in flood levels is about the same as in the mid-1970's. (In addition to the aforementioned stormwater retention reservoirs, a large dry-bed in-line reservoir was constructed in the 1960's. A number of side-saddle reservoirs were also constructed throughout the watershed in the late 2000's after the FIS was published to further reduce flooding.)

Beargrass Creek is protected from Ohio River backwater flooding by a barrier dam, located at mile 0.76, equipped with a pumping plant, which is a part of the LLPP (Beargrass Creek Pump Station). *On South Fork Beargrass Creek, a concrete channel has been in place for decades from just below Main Street to about 400 feet upstream of Eastern Parkway. However, the lower half of this reach is still subject to flooding because the design frequency of the pumping plant is 30 years and bridge openings along the improved channel were not enlarged. The stretch of South Fork from upstream of Eastern Parkway to Trevilian Way was enlarged in the early 1950's. Also, channel improvements and bridge additions were made in the reach between Bashford Manor Lane and Bardstown Road in the late 1960's and late 1980's, respectively.* (The 30-year design frequency mentioned above in the FIS could not be independently verified by USACE.)

Before construction of the SJCLPP, the LLPP consisted of levees, floodwalls, pumping plants, and other necessary appurtenances which helped protect the Cities of Louisville and Shively, and some of the unincorporated areas of Jefferson County. The degree of protection was equal to the 1937 flood, with 3 feet of freeboard. Considering the present system of Ohio River watershed upstream flood control lakes, this level of protection is greater than a 0.2-percent annual chance frequency (i.e. the level of protection provided exceeds 0.2% ACE / 500-yr recurrence). *No floodwall was constructed in the vicinity of the George Rogers Clark Memorial Bridge because the line of protection is along Main Street, above the minimum protection grade.*

However, a two-block area upstream of the Clark Bridge and riverward of Main Street comprising the Presbyterian National Headquarters will be protected by walls, levees, and a pumping station to an elevation equal to the 1-percent-annual-chance flood profile plus approximately 3 feet. Therefore, this area is shown to be outside the 1-percent-annual-chance floodplain.

In the early 1970's, Jefferson County implemented a stormwater management program. This program is designed to preclude any increase in peak discharge from storm runoff because of development of a site for storms in the SO-percent to I-percent-annual-chance frequency range. The program, now under MSD, requires either onsite detention basins or financial contributions to construction and maintenance of regional detention basins. An alternative to this is equal replacement for lost floodplain storage.

Table 2-1 displays the population and number of structures which experience risk reduction from the various Louisville Metro Flood Pump Stations (FPS). The 4th column also displays the stormwater drainage area in acres which contribute to the pump stations. The table was adapted from the 2017 MSD Comprehensive Facility Plan.

Table 2-1. Population, Buildings, and Acreage Protected by the Flood Protection System

Flood Protection System Asset Name	Population Protected	Buildings Protected	Drainage Protected (Acres)
Beargrass Creek FPS	17,660	6,640	38,682*
Robert J. Starkey FPS	17,660	6,640	38,682*
4th Street FPS	1,640	440	350
5th Street FPS	1,710	180	171
10th Street FPS	3,280	290	258
17th Street FPS	1,010	510	142
27th Street FPS	10,510	5,610	910
34th Street FPS	12,580	6,660	1,205
Shawnee Park FPS	30,650	15,960	3,008
Western Parkway FPS	93,540	41,770	11,144
Paddy's Run FPS	36,540	23,500	5,699
Upper Mill Creek FPS	39,600	27,380	8,682
Riverport FPS	30	250	789
Lower Mill Creek FPS	70,480	51,320	17,432
Pond Creek FPS	33,950	22,600	15,473

* The Beargrass Creek and Robert J Starkey FPS have overlapping contributing areas. The Beargrass Creek FPS serves the area's watershed, and the Robert J Starkey FPS serves the area's sewershed.

2.2. Climate

Climate in Louisville, KY is humid subtropical with four distinct seasons. Spring-like conditions typically begin in mid-to-late March, summer from mid-to-late-May to late September, with fall in the October-November period. Seasonal extremes in both temperature and precipitation are not uncommon during early spring and late fall.

Records from the National Climatic Data Center for Louisville show an average annual rainfall of 44.91 inches and an average daily temperature of 58.2°F. These average values are based on a 29 year period from 1981 - 2010. Extremes from the entire period of record include a maximum observed temperature of 107°F in 1901, 1930, and 1936, as well as a minimum observed temperature of -22°F in 1994. Of the top ten wettest days in Louisville, KY seven have occurred during the months of March (4), April (1) and October (2). The highest precipitation amount occurred on 1 March 1997, with 10.48 inches of rain in a single day. Additional climate information can be found in the qualitative analysis of climate change, section 2.7 below. Figure 2-1 displays historic average monthly temperature and precipitation totals for the Bluegrass Region according to the Kentucky Climate Center for a period of 1895 – 2016.

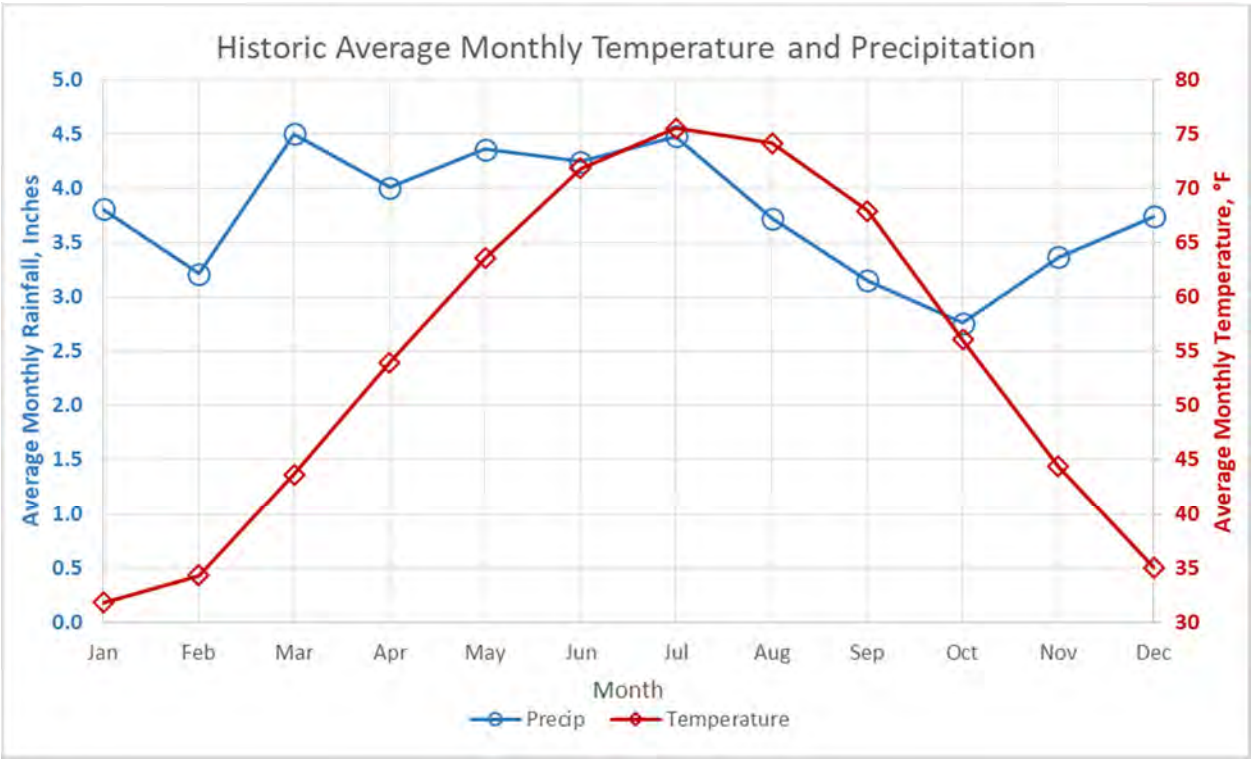

Figure 2-1. Historic Average Monthly Temperature and Precipitation

2.3. Hydrologic Modeling

2.3.1. Modeling Overview

Detailed hydrologic models were available for the Louisville Metro area and were used to analyze the interior drainage and performance of pumping stations throughout the area. For the Beargrass Creek watershed and associated subbasins contained within, hydrologic analysis was performed using the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS). For drainage areas within the Louisville Metro Area, but outside of Beargrass Creek watershed, hydrologic modeling was conducted using Innovyze InfoWorks Integrated Catchment Modeling Software (InfoWorks). The InfoWorks modeling was performed by Heritage Engineering, whereas the HMS modeling was performed by Louisville District Hydraulic Engineers.

2.3.2. Model Development and Calibration

Both hydrologic models were utilized to route the full range of rainfall frequency storms with a 10-day duration to the basins' outlet which was typically a pumping station with an outfall to the Ohio River. The 10-day duration was selected based on EM 1110-2-1413 "Hydraulic Analysis of Interior Areas," and takes into account the size of the receiving system's drainage area. The 10-day duration represents a typical period of time when the Ohio River experiences flood conditions and necessitates closed-gate pumping conditions at the pump stations. Precipitation frequency estimates were derived from NOAA's Atlas 14 90% upper confidence limits (UCL), more discussion regarding this section is found below as well as in the Climate Change Analysis – Appendix I.

Table 2-2 displays the depth of precipitation in inches associated with each frequency and duration of flow. These rainfall depth-duration-frequencies were converted to frequency storm hyetographs using HEC-HMS. A storm duration of 10-days, intensity duration of 5-minutes, and intensity position of 50% was applied, along with area reduction factors based upon drainage area and TP-40 methodology. One example 5-min hyetograph frequency storm for the 2% annual chance exceedance event is shown in Figure 2-2. While these frequency storms were generated within HEC-HMS, they also served as precipitation inputs to the InfoWorks hydrologic model.

Table 2-2. Precipitation Frequency Estimates (inches), Atlas 14 90% Upper Confidence Limit

	Annual Chance Exceedance *(Average Recurrence Interval)*								
	99.9%	**50%**	**20%**	**10%**	**4%**	**2%**	**1%**	**0.2%**	**0.1%**
Duration	*1-yr*	*2-yr*	*5-yr*	*10-yr*	*25-yr*	*50-yr*	*100-yr*	*500-yr*	*1,000-yr*
5-min	0.403	0.477	0.561	0.630	0.713	0.781	0.847	1.000	1.070
15-min	0.772	0.916	1.080	1.200	1.360	1.480	1.600	1.860	1.970
1-hr	1.26	1.51	1.870	2.14	2.51	2.81	3.12	3.86	4.20
2-hr	1.51	1.81	2.240	2.59	3.08	3.47	3.89	4.94	5.45
3-hr	1.64	1.96	2.430	2.82	3.36	3.81	4.28	5.51	6.12
6-hr	2.00	2.41	2.970	3.45	4.12	4.69	5.29	6.89	7.68
12-hr	2.39	2.86	3.530	4.08	4.87	5.54	6.24	8.08	9.00
1-day	2.81	3.38	4.190	4.86	5.83	6.64	7.51	9.83	11.00
2-day	3.33	3.99	4.930	5.70	6.80	7.71	8.68	11.20	12.50
4-day	3.77	4.51	5.530	6.35	7.51	8.46	9.45	12.00	13.20
7-day	4.48	5.35	6.520	7.48	8.87	10.00	11.20	14.40	16.00
10-day	5.03	6.00	7.300	8.36	9.88	11.10	12.40	15.80	17.50

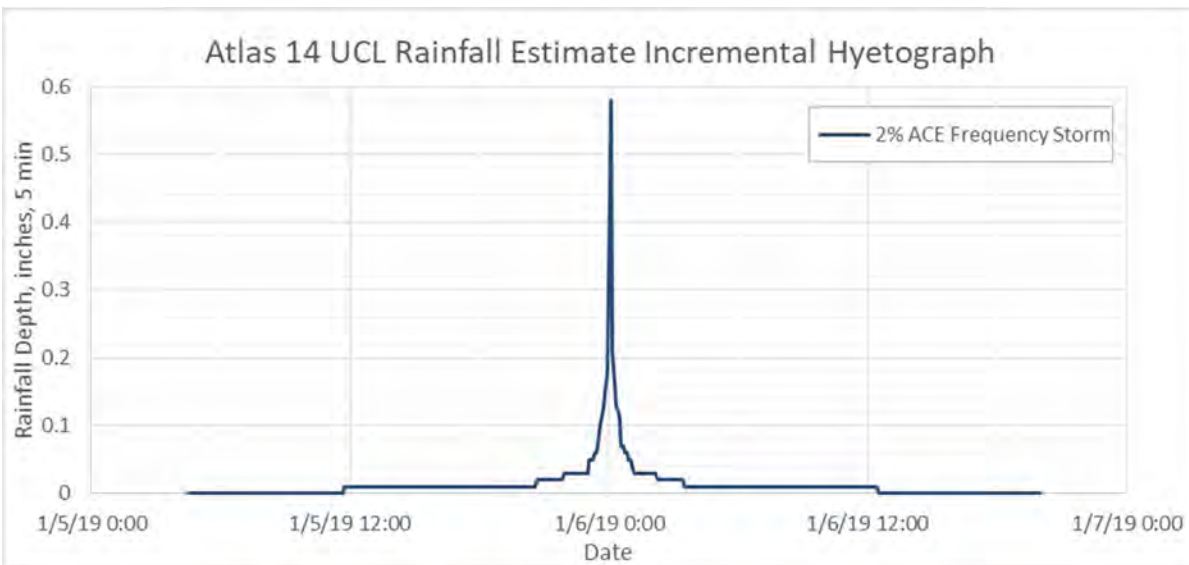

Figure 2-2. 2% ACE Frequency Storm Hyetograph

The interior areas were sub-divided based upon subbasin characteristics, stream networks, storm sewer networks, as well as a variety of other factors. Various hydrologic parameters are included in the hydrologic models, including: drainage area, hydrologic curve number, percent impervious area, lag time, and various routing parameters such as storage-discharge curves and Muskingum routing coefficients. The watershed contains numerous stormwater retention basins, which were represented within the models by elevation-area-discharge curves. All of these hydrologic parameters were estimated using GIS in conjunction with land usage and topographical data or directly measured in the field. Pertinent data regarding pumping stations was taken from the individual pumping station's operations and maintenance (O&M) manuals.

The Beargrass Creek HMS model was developed for the 2006 Flood Insurance Study (Version 2.2.2). This was conducted by a private A/E for Louisville MSD and FEMA in support of a Flood Insurance Study (FIS). TR-55 methodology was used to determine the appropriate Curve Number and lag time for each subbasin. Reach routing was modeled using either the Muskingum or Modified Puls methods. The Beargrass Creek basins were developed using GIS applications to estimate the parameters of the data at the time. The base model was calibrated to March 1997 and January 2000 events. USACE added further calibration events for observed flows and volumes from October 2013 and April 2015 events. Figure 2-3 and Figure 2-4 display calibration comparisons between modeled flows and observed flows for the April 2015 event for the Middle Fork and South Fork of Beargrass Creek, respectively. Observed streamflows were downloaded from the following USGS stream gages on Beargrass Creek: #03293000 (M Fk Beargrass Cr at Old Cannons Ln at Louisville) and #03292500 (South Fork Beargrass Creek at Louisville). While the calibration events are not perfectly represented by the hydrologic model, the calibration was deemed adequate and the model has been shown to sufficiently represent the watershed to serve its primary purpose as a tool for comparing alternatives such as differing pump capacities, gate operations, and pump schedules.

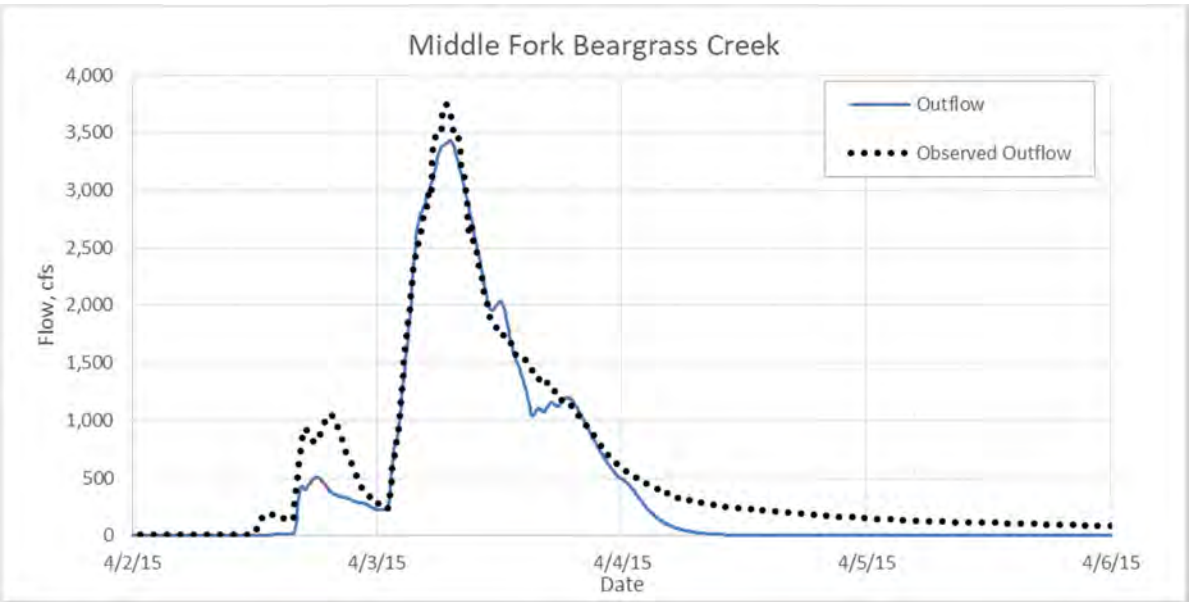

Figure 2-3. Modeled versus observed flows for 2015 on Middle Fork of Beargrass Creek

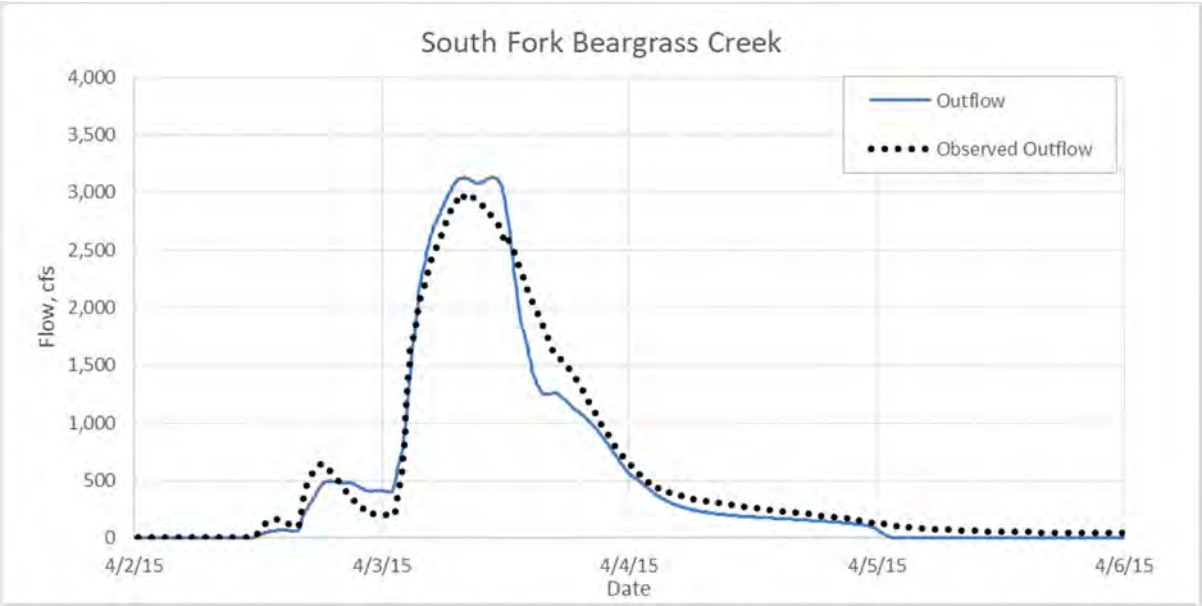

Figure 2-4. Modeled versus observed flows for 2015 on South Fork of Beargrass Creek

The InfoWorks Integrated Catchment Model (InfoWorks) is a software product provided by Innovyze. The model is used for hydraulic and hydrologic (H&H) modeling of the Louisville Metro combined sewer network. This software is and has been utilized by the local sponsor, Louisville MSD, in planning, optimizing, and sizing combined sewer projects for the Louisville Metro system. Because of the complex nature of the combined sewer network and the existence of a calibrated catchment model, InfoWorks is utilized by the Louisville Metro PDT to assess alternatives for this study.

The local sponsor in coordination with their consultants, Heritage Engineering, continually updates the InfoWorks H&H model to reflect existing conditions within the drainage area and to incorporate updates and modifications of the hydrologic network.

The InfoWorks combined sewer system model contains all sewers within Louisville's combined sewer system that are 12-inches in diameter or greater, as well as smaller pipes in many areas. All major pumping stations and their associated force mains are depicted in the model, with the flood pump stations in particular draining to outfall nodes representing the Ohio River that can be controlled with water level boundary conditions to represent specific conditions both above and below McAlpine Lock and Dam. Where necessary, real-time controls (RTC) are used to automate pump on/off conditions and gate openings or closures that may be required based upon flood conditions or other triggers.

Due to the scale of the combined sewer system model, quality control of the InfoWorks model for the project was primarily focused on the sewer network around and immediately upstream of the flood pump stations. The existing conditions geometry and model parameters were inspected to ensure that they reasonably represent the sewer network and surface water runoff conditions in the project area. Model results for existing and preferred conditions simulations have been examined to verify that conveyance of flow to, through, and out of the pump stations is reasonably depicted by the model.

The InfoWorks hydrologic model incorporates overland flows as well as underground pipe drainage networks, including Louisville's fairly complex storm sewer and combined sewer overflow (CSO) pipe network. This is contrasted with the HEC-HMS model, which only models overland flows into Beargrass

Creek. This assumption that overland flow dominates the hydrologic behavior of the system was deemed appropriate and necessary for a variety of reasons:

1. Beargrass Creek Watershed is not included in the existing InfoWorks model. Incorporating the watershed into this model was not feasible due to time, budget, and data availability constraints.
2. All storm sewers within the watershed ultimately drain into Beargrass Creek. The HMS model was calibrated to observed flows by changing hydrologic parameters such as lag time and various routing coefficients.
3. Beargrass Creek Watershed differs from the rest of the LMFS catchment in that it has a higher percent of forested area and less impervious area.

So while the drainage network included in the HMS model may be a simplification of the physical reality of the system, through calibration, the HMS model serves as a useful tool for evaluating the existing conditions of the stream and comparing alternatives. One inherent limitation of the HMS model is that it does not account for hydraulic obstructions to flow which can have a large influence on water surface elevation; bridge constrictions are one example of such an obstruction. For this reason, the 1% annual chance exceedance (ACE) inundation area for the Beargrass Creek ponding area calculated by HMS is smaller than the inundation area as reported by the FEMA Flood Insurance Study (FIS) for the same ACE. Again, this discrepancy is attributed to the Feasibility Study's inundation area being based upon a hydrologic model, which accounts for precipitation losses, transformation, and routing, whereas the FIS's inundation area is based upon a hydraulic model which calculates a sloped water surface and accounts for backwater induced by bridges and other constrictions. For this reason and other discussed later within the Appendix I – Climate Change Analysis, the upper confidence bound of Atlas 14 was used as a precipitation frequency estimate.

2.3.3. Flood Pump Stations

Flood pump stations of interest included within the Louisville Metro Feasibility Study (LMFS) were identified by the local sponsor and are included in their Comp Plan or 20-year Critical Repair and Reinvestment Plan. MSD uses a rating system referred to as Level-of-Protection, which ranges between 1 (inadequate) and 5 (adequate and preferred). Stations which did not meet MSD's Level-of-Protection 5 (LOP5) criteria became the primary focus of the LMFS H&H analysis and are shown, along with pertinent data, in Table 2-3. Out of the 15 federally built flood pumping stations, 7 flood pump stations were selected. They are provided in the table below with the number of structures protected as described in MSD Comp Plan, construction date, number of pumps, LOP information, and relevant exterior river data. Of the 7 flood pumping stations, 6 are modeled within the comprehensive Combined Sewer System InfoWorks Model.

Table 2-3. Pumping Station Pertinent Data

Pumping Station Name	Date Constructed	Number of Pumps	Structures Protected*	Current Pump Capacity (MGD)	LOP5 Capacity (MGD)	LOP5 Percent Increase	LOP Currently Provided	Flood Mode River Elevation (feet)	Minor Flood Mode River Elevation (feet)	Exterior Gage Controller	H&H Model
4th Street†	1952	3	440	137	195	42%	2	436.3	424.8	Upper	InfoWorks
17th Street†	1952	4	510	51	122	139%	2	437.5		Upper	InfoWorks
27th Street†	1952	5	5,610	239	320	34%	2	436.8	427.5	Upper	InfoWorks
Shawnee†	1951	7	15,960	770	1,250	62%	3	434.7	425.2	Lower	InfoWorks
Western†				1,150	1,600	39%	3	416.1		Lower	InfoWorks
Paddy's Run	1953	6	23,500	925	1,900	105%	3	432.0		Lower	InfoWorks
Beargrass Creek	1952	8	6,640‡	3,555	4,700	32%	4	432.1		Upper	HEC-HMS

* Source: MSD 20-Year Critical Repair and Reinvestment Plan.

† Pumping Stations without Ponding Areas.

‡ The Beargrass Creek and Robert J. Starkey FPSs have overlapping contributing areas.

2.4. Coincident Frequency Analysis

The strategy for assessing alternatives for the LMFS is to compare alternatives with respect to their combined probability coincident frequency water surface elevation curves. The coincident frequency curve describes the total probability of a variable (Variable C) given the probabilities of two other variables (Variables A and B). For this study, interior rainfall and exterior river stage were selected as variables A and B, respectively. Variable C was selected as the interior water surface elevation at locations where flood consequences would result. The pump stations operate when interior rainfall events and high exterior river stages occur coincidentally, and reduce flood risk to upstream project structures such as buildings and homes.

For this analysis, rainfall and river stage (variables A and B) were determined to be statistically independent, meaning that the probability of one variable occurring does not influence the probability of the other variable occurring. This assumption was selected primarily on the understanding that the drainage area of the interior ponding areas and that of the Ohio River are dramatically different. For example, Beargrass Creek has a drainage area of approximately 51 mi^2, whereas the Ohio River at Louisville has a much larger drainage area of 91,170 mi^2. Because of this substantial difference in watershed area, it can be assumed that a localized storm causing flooding on Beargrass Creek is not nearly large enough to influence the river stage on the Ohio River to any appreciable level. Similarly, a regional storm large enough to induce flooding on the Ohio River requires a fairly long duration of precipitation over a vast area.

Some extreme regional rainfall events, such as northerly tracking hurricanes and tropical storms, may have the potential to influence both the Ohio River and much smaller drainages within the LMFS area simultaneously. However, even under such circumstances where a storm may influence flooding on both watersheds, the vastly different hydrologic characteristics of the basins still cause them to behave as largely independent systems. Beargrass Creek for example is a much flashier and responsive system than the Ohio River. During an extremely large regional storm, it is likely that Beargrass Creek's stage may rise and fall in a matter of days, whereas it may take weeks for the Ohio River to respond to such a large storm. These differing hydrologic characteristics of the watersheds strongly support a statistically independent relationship between the Ohio River stage and interior precipitation.

Figure 2-5 and Figure 2-6 display paired data observations with precipitation (from Louisville at International Airport rain gage) on the x-axis versus Ohio River water surface elevation on the y-axis. Each data point represents a single point in time. In both of these figures, the upper pool of the Ohio River is shown in blue and the lower pool is shown in red. Figure 2-5 displays daily data, whereas Figure 2-6 displays monthly maximum precipitation data and the corresponding river stage on the day it occurred. The strength of a given correlation can be evaluated in a number of ways, including computation of the correlation coefficient (100% = perfect positive correlation, 0% = no correlation), r^2-value (higher r^2 indicates a stronger linear relationship between the data), or by simple visual evaluation of the data.

Regarding the daily observed data, no correlation was found between river stage and interior rainfall. Correlation coefficients were found to be 2.2% and 3.5% on the upper and lower gages, respectively. R^2-values were also very low for both datasets. Lastly no strong visual trends are apparent in the data points, which appear to be dominated by scatter. These same conclusions can be drawn to a lesser extent when the monthly maximum datasets are examined. This data shows slightly higher correlation coefficients (14.7% for the upper gage and 16.6% for the lower gage). Additionally the r^2-values are slightly higher, but still can be considered relatively low and do not indicate a linear relationship within the dataset. Visual trends are similarly lacking. These three lines of evidence show very little support of correlation between exterior river stage and interior rainfall. This supports the assumption that variables A and B can be considered statistically independent in regards to the coincident frequency analysis.

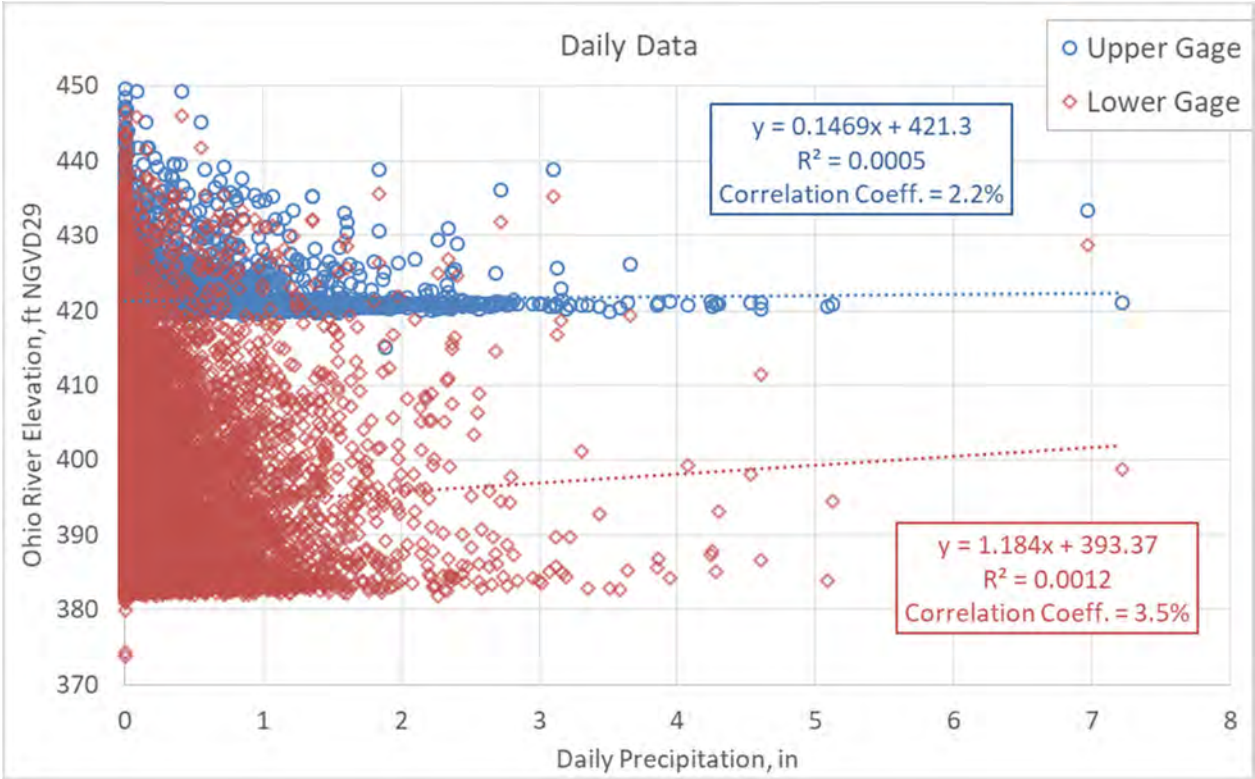

Figure 2-5. Correlation between Ohio River Elevation and Interior Rainfall, Daily Data

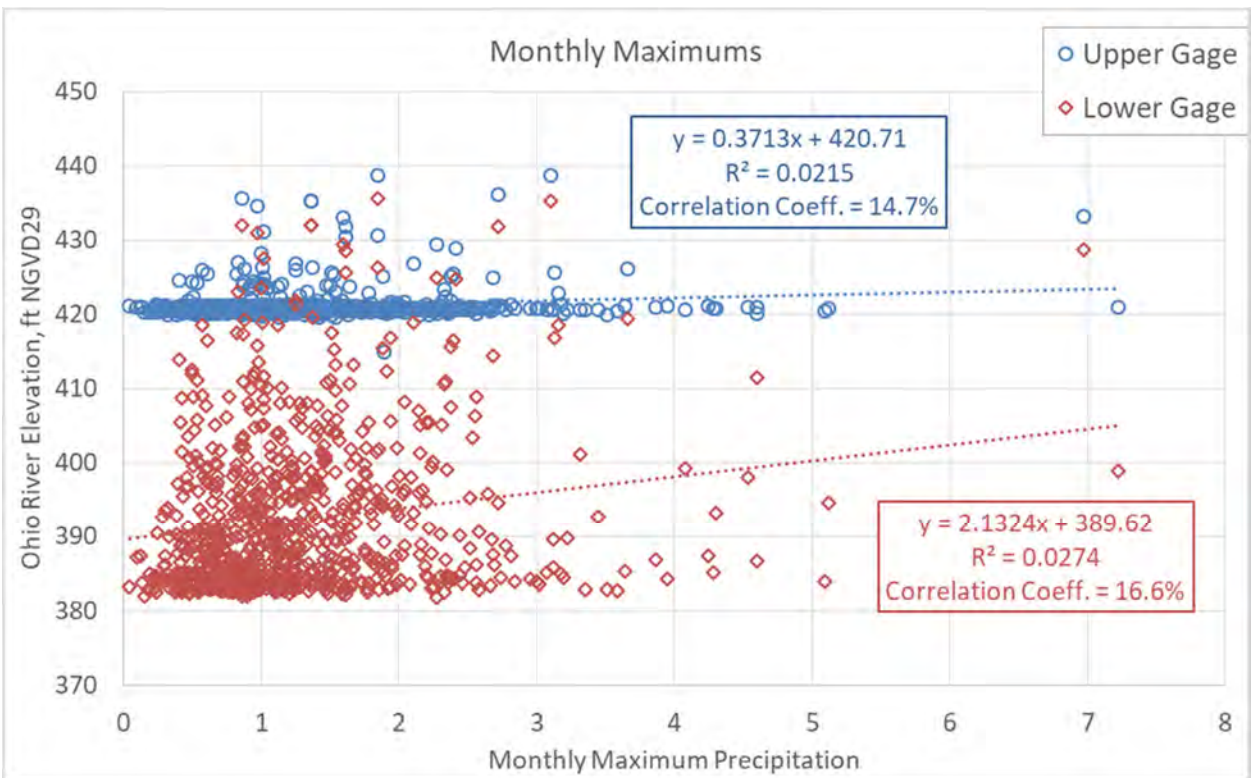

Figure 2-6. Correlation between Ohio River and Interior Rainfall, Monthly Maximum Data

As mentioned previously, the coincident frequency analysis requires 3 main parameters, the interior rainfall (Variable A), the exterior river stage duration curve (Variable B), and the response curve(s) (Variable C). An easy way to understand the response curve is that it is influenced by both the variables A and B; e.g. rainfall that falls on an interior drainage area causes peak flows and ponding in the interior watershed. The pump station and associated gravity structure receive these flows and let the runoff out through the gravity outlet or pumps the runoff out of the watershed during closed outlet condition. Meanwhile, the exterior stage condition affects how the pump station operates (i.e. how the pump station performs). The exterior stage at the McAlpine Upper or Lower Gage controls if the outlet in the pump station is open or closed. Pumping operation is controlled by the level of the water at the inlet. Therefore, the ponding elevation/critical elevation is both influenced by the exterior stage and the interior rainfall. However, many of the pump stations within the Flood Protection System pump floodwaters up and over the levee as opposed to through it. In this case the levee height determines the static head that the pumps must overcome and therefore pump station capacity is not directly dependent on the exterior river stage. In other words, for many of the stations which pump over the levee, once the exterior river stage induces a closed outlet pumping condition, the pump's performance is independent of river stage.

The coincident frequency analysis takes the set of probabilities of the given rainfall and the percent of time that the exterior stage equals or exceeds a given elevation and combines them using the total probability theorem and creates a coincident frequency curve. The probabilities of the exterior stages are derived from the stage duration curve, the analysis chooses "index elevations" to calculate the relative frequency of the stage from the set of possible stages (from the stage duration curve). The probabilities of interior rainfall are derived from the intensity duration frequency relationships of the given area, in this case from NOAA's Atlas 14 upper confidence limit, where the probability of rainfall depth of a particular duration is derived from its frequency.

2.4.1. Pump Station Operation and Modeling

In traditional USACE projects a pumping station is typically built with a ponding area. A ponding area acts as a basin during times of high flow to work in conjunction with the pumping station to reduce flood risk to structures within the watershed. Rainfall within the interior of the levee causes interior runoff. Interior runoff is diverted towards the ponding area by a series of drainage features. Generally ponding areas contain outlet structures to release interior runoff diverted into the ponding area. At times of high exterior stages this outlet structure is closed to prevent backflow into the ponding area from the exterior river flooding source. Damages within the ponding area can be directly related to the water surface elevation within that ponding area. Variable C is defined as the water surface elevation at the ponding area.

Five of the pump stations shown in Table 2-3 do not have ponding areas, rather they are directly fed by large sewer lines within the combined sewer system. Analysis of the upstream sewer network and drainage features was conducted to identify representative locations for Variable C. Typically these representative locations are located at manholes (MH).

Model runs are conducted and the water surface elevations at these locations monitored under various combinations of exterior river level and interior rainfall. Water surface elevations are assumed to be static and level, in other words, hydraulic gradient line calculations were not performed to determine how the water surface elevation varies as moving upstream away from the pumping station. The Variable C locations were selected in coordination with Louisville MSD and Heritage Engineering. These locations generally represent manhole locations which surcharge and result in flooded structures most frequently. Additional information on Heritage Engineering's analysis of Flood Pumping Stations for the Facilities

Plan is available in Appendix 4A of Louisville MSD's Comp Plan (2017). Table 2-4 shows the Variable C location for each pump station.

Table 2-4. Consequence Locations Selected for Variable C

Pump Station	Variable C Location (Consequence Location)	Latitude	Longitude
Beargrass Creek	Pool Elevation Upstream of the Flood Pumping Station	38.2608	-85.7178
4th Street	MH 75279	38.2545	-85.7569
17th Street	MH 08740	38.2590	-85.7780
27th Street	Main line near MH 07745	38.2706	-85.7944
Western	Sewer Node 63913-T	38.2401	-85.8280
Shawnee Park	MH 08597	38.2596	-85.8241
Paddy's Run	Southwest Sluice Gate Chamber, 50946-T	38.2209	-85.8243

These Variable C locations are generally just upstream of the pump station's location. Discussion amongst the team occurred that utilizing a static water level, and associated damages with that level, may be underrepresenting the damages due to the hydraulic grade line potentially causing additional damages upstream. The study however is primarily interested in the incremental damages reduced associated with adding measures, such as increased pumping capacity. Ponding that 'backs up' at the station was considered to be the primary incremental difference for the damages, largely due to the upstream drainage restrictions and flash flooding that would occur upstream for the more infrequent storms regardless of the pumping capacity.

Coincident frequency analysis was performed using HEC's Statistical Software Package (SSP) to weight the probability of interior precipitation with the probability of an elevated exterior river stage necessitating closed-gate pumping conditions. The behavior of the exterior river was described by elevation-duration curves for Ohio River. McAlpine Lock and Dam (L&D) is located on the Ohio River at Louisville and creates an upper and lower pool to which Louisville's pumping stations outfall. Some of these stations, such as Beargrass Creek, have outfalls located upstream of the L&D, these stations are therefore influenced by the upper pool. Other stations are located downstream of the L&D and their gates are therefore governed by the lower pool, such as Paddy's Run. Elevation-Duration Curves were developed for the upper and lower pools of McAlpine L&D on the Ohio River using data from 1930 to 2018 and are shown in Figure 2-7 and Table 2-5.

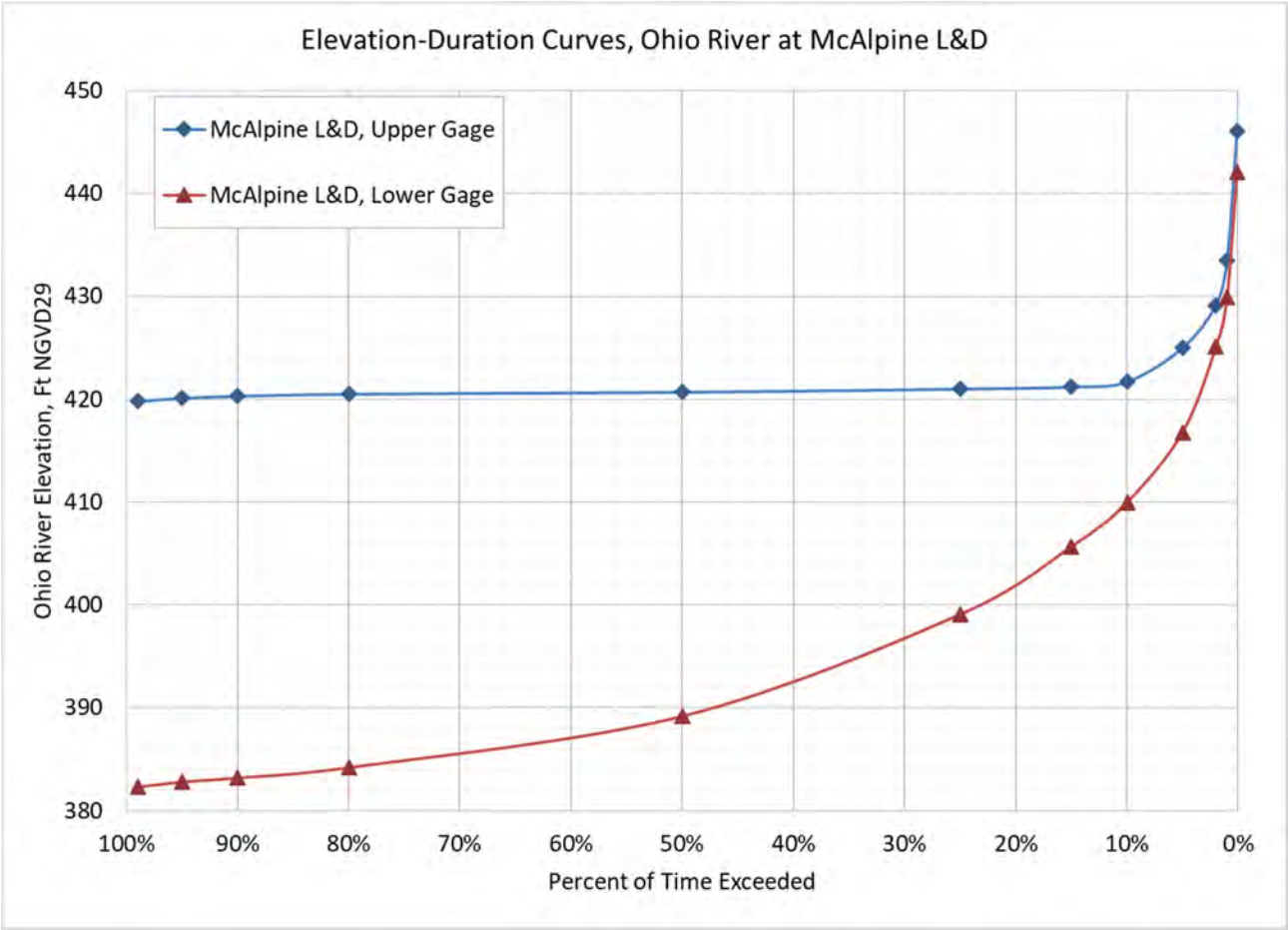

Figure 2-7. Elevation-Duration Curves for Ohio River at McAlpine L&D

Table 2-5. Elevation Duration Data for Ohio River at McAlpine L&D

Percent of Time Exceeded	Upper Gage Stage, NGVD29	Lower Gage Stage, NGVD29
99%	419.782	382.28
95%	420.082	382.78
90%	420.282	383.18
80%	420.482	384.18
50%	420.682	389.18
25%	420.982	399.08
15%	421.182	405.68
10%	421.682	409.98
5%	424.982	416.78
2%	429.144	425.08
1%	433.463	429.88
0.1%	446.022	442.07

The elevation of the exterior river stage determines whether the various flood pump stations (FPS) are in operation or not, with the FPSs going into service as the river stage rises. Table 2-6 displays the various combinations of exterior river stage on the Upper and Lower McAlpine gages. Elevations displayed are shown in NGVD29 and stations are either labeled as "ON" – indicating that the gates are closed and at least one of the station's pumps are operational – or "off" – indicating that the station's gates are open and the flow passes through the line-of-protection via gravity flow.

Table 2-6. Flood Pump Station (FPS) Operation Status by Exterior River Stage

Lower Gage Elevation (NGVD29)	Upper Gage Elevation NGVD29)	4th Street FPS	5th Street FPS	10th Street FPS	17th Street FPS	27th Street FPS	34th Street FPS	Shawnee FPS	Western FPS	Paddy's Run FPS
410	420	off	off	off	off	off	off	off	off	off
420	425	ON	off	off	off	off	off	off	ON	off
425	430	ON	off	off	off	ON	ON	off	ON	off
430	432.7	ON	off	off	off	ON	ON	ON	ON	off
432.6	435	ON	ON	ON	off	ON	ON	ON	ON	ON
435	437	ON	ON	ON	off	ON	ON	ON	ON	ON
440	440	ON	ON	ON	ON	ON	ON	ON	ON	ON

2.4.2. Model Results

Coincident frequency curves were computed at each pumping station initially for 3 scenarios: existing conditions, LOP5 conditions (i.e. increased pump capacity), and LOP5 conditions with increased conveyance lines leading to the pumps. Existing pump capacity and LOP5 pump capacity for each of the stations is shown in

Table 2-3. In order to account for the variability of the pump station operation under differing exterior river stages, each scenario was run with a variable exterior river stage elevation. Some of the pumping stations are located near the upper gage of the Ohio and others on the lower gage. To reduce the number of required model runs and minimize required computational time, 5 paired combinations of upper and lower gage stages were used such that a single model run could compute response curves for all pumping stations, both on the upper and lower gages.

Table 2-7 displays the combinations of upper and lower gate river stages. While these upper and lower gage stage combinations are not a precise match of the stage-duration curves or water surface profile relationship, they were deemed as an acceptable compromise required to minimize model runs and still include all required flood pumping scenarios. It should also be noted that there is very little interaction between pumping stations and they operate independently of one another for the most part. For this reason, there is no anticipated negative consequence of pairing upper and lower river stages that do not precisely match the stage-duration curves or water surface profile relationships developed with hydraulic modeling. Pump station status associated with the combinations of upper and lower river gages is shown previously in Table 2-6.

Table 2-7. Paired Combinations of Upper and Lower Gage River Stages (NGVD29)

Exterior River Stage Combination	Lower Gage Elevation	Upper Gage Elevation
1	410	420
2	420	425
3	425	430
4	430	432.7
5	432.6	435
6	435	437
7	440	440

The reduction in water surface elevation and corresponding inundation areas were used to screen pumping stations for the effectiveness of increased pump capacities. In general, stations with ponding areas showed larger reductions in water surface elevations in response to increased pump capacities. Other stations, including most in-line stations, showed very little change in water surface elevation in response to relatively large increases in pump capacity. A few examples of these coincident frequency curves are included below for Beargrass Creek, Paddy's Run, and 4th Street; Figure 2-8, Figure 2-9, and Figure 2-10 respectively. In these figures, the blue line represents existing conditions, red line represents increased pump capacity at LOP5, green line represents increased conveyance and pump capacity, and the orange line represents a modification in gate operating procedure. Beargrass Creek did not include a conveyance increase scenario. Note that the horizontal purple dashed line represents the approximate elevation corresponding to the start of economic consequences; in other words, this dashed-line delineates where the flooding of structures begins. Also, the horizontal x-axis of these figures is displayed as a probability scale beginning at 0.5 ACE (2-yr recurrence) and extending to 0.001 ACE (1,000-yr recurrence). Model results for all scenarios are included at the end of this appendix as Plate No. 1 through Plate No. 5, additionally the full coincident frequency results set is included as Plate No. 6 through Plate No. 8.

It should be noted from these results that all three scenarios are nearly identical up until the annual chance exceedance event that corresponds to a closed-gate pumping condition. At that point the curves begin to diverge as pump capacity comes into play. At all events more frequent than this, the pumping station acts as a gravity outlet and is independent of pump capacity.

Figure 2-11 displays the reduction in water surface elevations due to increasing pump capacity to LOP5 levels for each pumping station versus existing conditions (E.C.). As displayed in the figure, Beargrass Creek and 4th Street display the largest magnitude water surface reductions. However it is important to note that for nearly all scenarios where a substantial reduction in water surface was observed, the water was contained within the channel and surface flooding of structures was very limited. This is true even for fairly extreme events with annual chances of exceedance less than 1%. Using Beargrass Creek as an example, near the pumping station, the top of bank elevation is approximately 443 ft-NGVD29, whereas the 1% ACE water surface elevation is only approximately 438 ft and therefore flows are contained within the channel even at such infrequent events. For this reason and the lack of structures which would benefit from pump capacity increases, increasing capacity at the pumping stations was shown to statistically not significantly reduce the likelihood of flood damages, and subsequently not economically justified. These increases were screened out as potential alternatives within the study.

One important distinction is that only ponding and storage was evaluated, and not backwater flooding induced by hydraulic constrictions such as bridges. Consequences of flooding upstream of the ponding areas induced by flash flooding and other sources are not accounted for in this analysis since they are not expected to be incrementally different for the pump station capacities considered at equivalent storms.

2.4.2.1. Analysis of Gate Modifications

In addition to the increased pump capacity scenarios, modification of gate operating schedules was also analyzed. As the gates are currently operated, once the exterior river stage reaches a set elevation, the pump station gates are closed and pumping of floodwaters commences until a time when the exterior river elevation falls below a set elevation and the gates are reopened and pumps turned off. If an interior rain event occurs while the gates are closed, it is common that the interior ponding elevation may exceed the exterior river elevation. In this particular scenario where interior stage exceeds exterior stage, the gates could theoretically be opened to allow gravity flow to occur through the pump station outlet and thereby reduce the interior stage and associated flood consequences. For various pump stations within the flood protection system, the operation manual states that opening of the gates should be "considered" when the interior stage exceeds the exterior stage, however opening the gates under these conditions has historically not been performed.

Modification of gate operation procedures was done for the following stations: Beargrass Creek, 27th Street, 34th Street, Shawnee, Western, and Paddy's Run. For all stations other than Beargrass Creek, it was assumed that the gates would open at a speed of 1 ft/min whenever the interior elevation exceeded the exterior by 1ft or greater. For Beargrass Creek, due to modeling limitations within HEC-HMS, the gate was modeled similarly to a flap gate and therefore the model assumes an instantaneous gate opening whenever the interior stage exceeds the exterior by any amount. This leads to a slight overestimation of gravity flow through the open-gates, however this flow contribution is considered relatively minor considering the average duration of flow events
.
For Beargrass Creek and Paddy's Run, the coincident frequency curves associated with the gate modifications are shown as orange lines in Figure 2-8 and Figure 2-9. Figure 2-12 displays the water surface reduction associated with modifying the gates to open under certain conditions when the interior stage exceeds the exterior stage versus existing conditions. Note that gate operation modifications proved most effective for Beargrass Creek, followed by Paddy's Run and 27th Street to lesser degrees. Reductions in water surface elevation for this gate modification are limited to large flood events less frequent than the 1% ACE event.

There are various practical concerns regarding the implementation of these gate modifications:

1. The gate lifting machinery may not be adequate to reliably raise the gates under a differential head loading.
2. The gates may "rack" – or be unevenly lifted – as they are raised leading to malfunction and the inability to operate the gate. Similarly, the gates may be pushed out of their vertical guide rails by an uneven hydraulic loading and/or high flow velocities under the gate.
3. Debris, such as trash and tree limbs, may become trapped under the gate or on the gate's sill, making it difficult to close the gates once open until the debris has been cleared.

Concerns 2 and 3 pose risks when the Ohio River is rising and the gates are immediately needed to provide physical separation between the interior and exterior water surfaces. For this reason, it is reasonable to consider up-to-date Ohio River stage and interior precipitation forecasts before making the decision to open gates when the exterior river stage is elevated, even when the interior stage exceeds the exterior. Further investigation may be required before gate operation modifications are implemented. The current version of the Operations and Maintenance (O&M) manual does refer to opening the river roller gates at Beargrass Creek and at the Paddy's Run southwest outfall sluice gate. Due to the ponding frequency reduction shown in Figure 2-8, this is expected to remain part of the operating procedures for Beargrass. It is also recommended to remain the case for the Paddy's Run gate, with more caution perhaps to only be performed when the interior flooding situation is dire.

Figure 2-8. Coincident Frequency Curves for Beargrass Creek Pumping Station

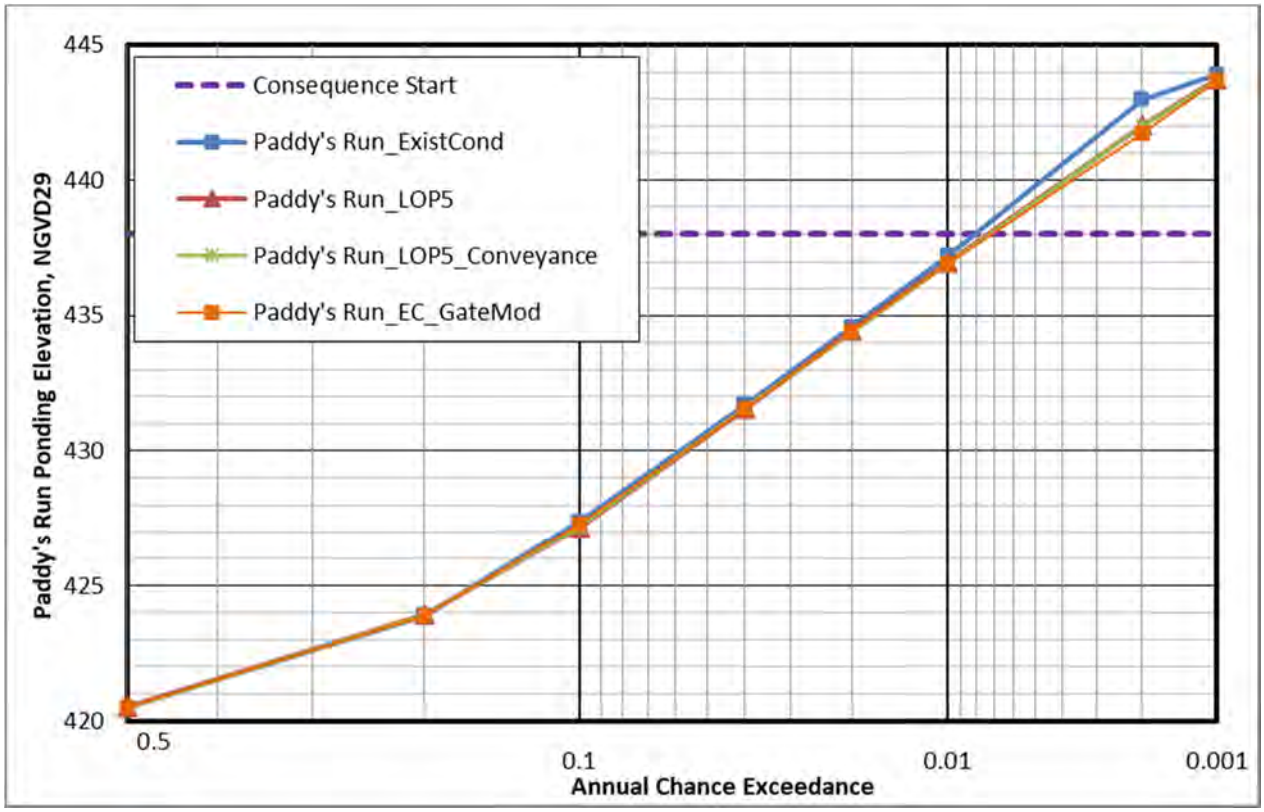

Figure 2-9. Coincident Frequency Curves for Paddy's Run Pumping Station

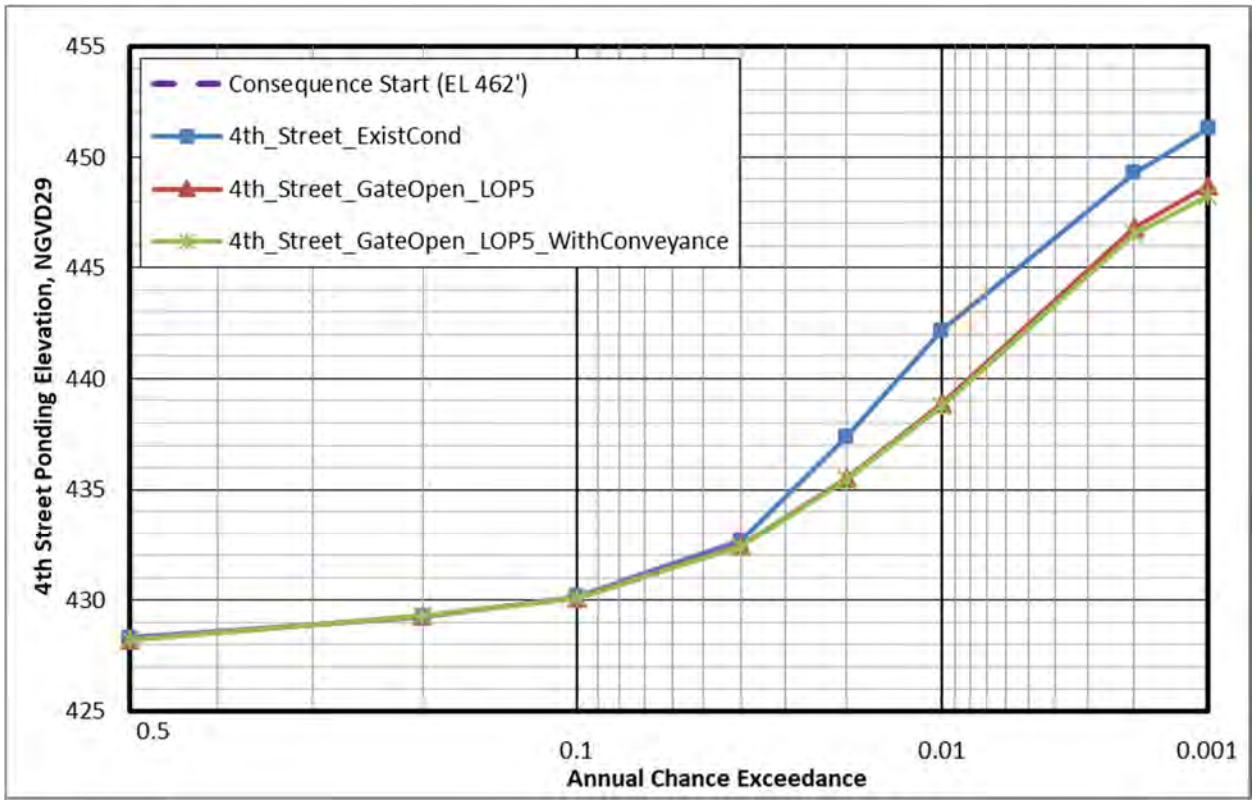

Figure 2-10. Coincident Frequency Curve for 4th Street Pumping Station

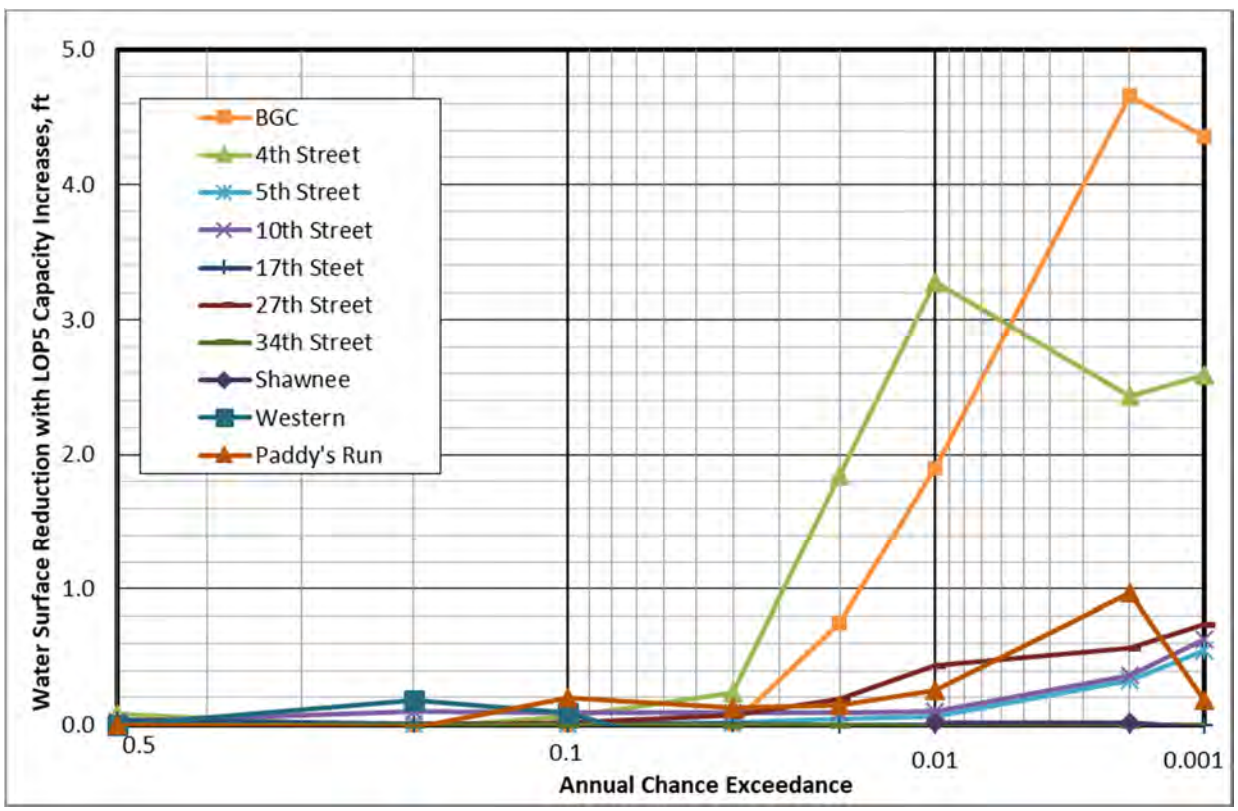

Figure 2-11. Water Surface Reduction with LOP5 Capacity Increases (versus E.C.)

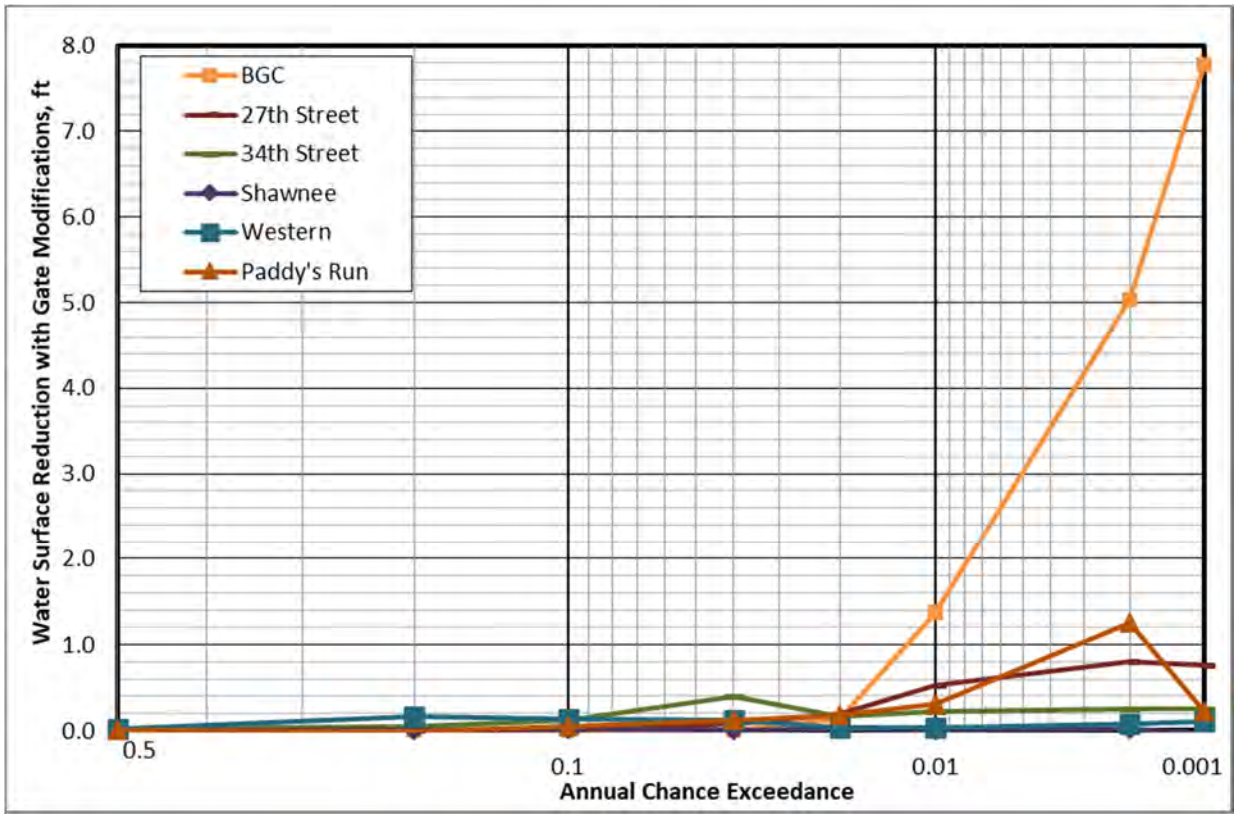

Figure 2-12. Water Surface Reductions with Gate Operation Modifications (versus E.C.)

2.5. Summary of Significant H&H Findings

Based upon the hydrologic analysis contained within this Appendix, it appears that the reduction in interior ponding frequencies as a result of increasing pumping station capacities is not sufficient to justify pump station capacity increases. For this reason, the capacity increase alternative was screened out of consideration. It should be noted that the Atlas 14 90% upper confidence limit precipitation frequency estimate was used for the analysis; reducing these precipitation values to the standard Atlas 14 median estimate would have no impact on the screening decision and would likely further reduce the effectiveness of pump station capacity increases.

Modification of the gate operation such that gates are opened when the interior water surface elevation exceeds the exterior elevation proved beneficial from a hydraulic perspective and reduces the risk of flood damages. Additionally it does not have the heavy economic cost associated with pump capacity increases. This gate operation modification is also already part of the official operation and maintenance (O&M) manual for the system, and should therefore be more thoroughly considered under circumstances when it would reduce the water surface on the interior of the levee. Risk of equipment failure during flood events should be considered when assessing the feasibility of gate operation modification.

A major finding of the study is that the pump station capacity increases considered at some stations are not statistically effective due to the inability of the current storm drainage system to deliver the additional flow to the station. This is particularly true of the in-line fed stations, and others with bridge or gate restrictions upstream. Increasing the interior drainage capacities of the system and subsequently the pumping capacities may in some basins prove to be valuable in reducing flood risk further than this study analyzed. Modification of the interior drainage system beyond the footprint of the levee system however is beyond the scope of this study, and even if performed, may still not prove to be economically/incrementally justified.

2.6. H&H Results Attachment and Plates

Plate No. 1 through Plate No. 4 on the following pages display data output from the InfoWorks stormwater hydrologic model for each pump station analyzed and the various scenarios previously discussed. Plate No. 5 displays similar results for Beargrass Creek computed using the HEC-HMS model. These results are in the form of interior ponding elevations in feet (NGVD29).

Plate No. 6 through Plate No. 8 below display data tables for the coincident frequency analysis as calculated by HEC-SSP; coincident frequency curves are also shown on the right sides of these plates.

2.7. Qualitative Assessment of Climate Change Impacts

Appendix I – Climate Change Analysis – Contains detailed information regarding qualitative impacts due to climate change as well as rational for selection of the Atlas 14 90% upper confidence limit precipitation frequency estimate as a basis of design.

2.8. References

Environmental Systems Research Institute Inc (ESRI), ArcGUS software http://www.esri.com

Federal Emergency Management Agency (FEMA), Flood Insurance Study, Louisville and Jefferson County, Kentucky and Incorporated Areas (2006). Flood Insurance Study Number 21111CV001A.

Fourth National Climate Assessment, Volume II, Chapter 2, National Topics: Our Changing Climate, 2018.

Fourth National Climate Assessment, Volume II, Chapter 3, National Topics: Water, 2018.

Fourth National Climate Assessment, Volume II, Chapter 19, Southeast Region, 2018.

Hydrologic Engineering Center, (September 2005), US Army Corps of Engineers, Davis, CA.

HEC-HMS Hydrologic Modeling System, Technical Reference Manual. Hydrologic Engineering Center, (March 2000), U.S. Army Corps of Engineers, Davis, CA.

HEC-HMS, User's Manual. Hydrologic Engineering Center, (December 2013), US Army Corps of Engineers, Davis, CA

HEC-GeoHMS, User's Manual. Hydrologic Engineering Center, (February 2013), US Army Corps of Engineers, Davis, CA

Innovyze, InfoWorks ICM Modeling Software: https://www.innovyze.com/en-us/products/infoworks-icm

Louisville Jefferson County Metropolitan Sewer District, 20-year Comprehensive Facility Plan: Critical Repair and Reinvestment Plan. June 2017. https://louisvillemsd.org/20-year-comprehensive-facility-plan

National Weather Service, Louisville Kentucky Forcast Office, "Climatology – Louisville, KY". https://www.weather.gov/lmk/clisdf

U.S. Army Corps of Engineers, Climate Hydrology Assessment Tool (CHAT). Issued 2016.

U.S. Army Corps of Engineers, Climate Preparedness and Resilience (CPR) Community of Practice (CoP) Applications Portal. https://maps.crrel.usace.army.mil/projects/rcc/portal.html

U.S. Army Corps of Engineers, Engineering and Construction Bulletin 2016-25 (Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects). Issued 16 September 2016.

U.S. Army Corps of Engineers, Engineering and Construction Bulletin 2018-14 (Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects). Issued 10 September 2018.

U.S. Army Corps of Engineers, Engineering Technical Letter (ETL) 1100-2-3. (Guidance for Detection of Nonstationarities in Annual Maximum Discharges.) Issued 28 April 2017.

U.S. Army Corps of Engineers, HEC-HMS Software: http://www.hec.usace.army.mil

U.S. Army Corps of Engineers, HEC-GeoHMS Software: http://www.hec.usace.army.mil

U.S. Army Corps of Engineers, Nonstationarity Detection (NSD) Tool and User Guide. Version 1.2. Issued May 2016, updated September 2018.

U.S. Army Corps of Engineers, Vulnerability Assessment (VA) Tool and User Guide. Version 1.1. Issued November 2016.

U.S. Army Corps of Engineers, Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions, Ohio Region 05. January 2015.

U.S. Army Corps of Engineers, Time Series Toolbox, Trend Analysis and Nonstationarity Detection. 2018.

U.S. Army Corps of Engineers website with climate impact analysis tools: https://maps.crrel.usace.army.mil/projects/rcc/portal.html

White K, Arnold J, CDM Smith (2015) Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions – Ohio Region 05.

Plate No. 1. InfoWorks Model Results for Existing Conditions Scenario. Interior Ponding Elevations (ft-NGVD29).

Upper Gage			4th Street - Gate 34 Open				
	Rec. Int.	Precip (in)	420	425	430	435	440
MH 75279	1000yr	17.5	447.139	452.121	452.184	455.754	455.809
	500yr	15.8	444.169	451.082	451.215	455.162	455.251
	100yr	12.4	438.880	445.880	446.062	451.563	451.759
	50yr	11.1	435.715	439.211	439.567	448.403	448.554
	25yr	9.9	432.396	432.711	432.981	444.554	444.834
	10yr	8.4	430.028	430.169	430.211	432.687	432.697
	5yr	7.3	429.068	429.318	429.320	430.011	430.027
	2yr	6	427.994	428.369	428.378	428.396	428.395
	1yr	5	427.509	427.821	427.823	427.827	427.827

Upper Gage			27th Street				
	Rec. Int.	Precip (in)	420	425	430	435	440
Flooding on Main Line near MH 07745 (08722-X)	1000yr	17.5	449.58	449.58	453.38	453.38	453.40
	500yr	15.8	448.66	448.66	453.05	453.04	453.06
	100yr	12.4	444.49	444.50	451.97	451.96	451.97
	50yr	11.1	443.11	443.11	450.80	450.78	450.76
	25yr	9.9	442.03	442.03	448.28	448.18	447.82
	10yr	8.4	441.18	441.18	442.67	442.60	442.28
	5yr	7.3	440.82	440.82	441.00	441.00	441.00
	2yr	6	440.25	440.25	440.41	440.41	440.41
	1yr	5	439.86	439.86	439.99	439.99	439.99

LOWER Gage			Shawnee				
	Rec. Int.	Precip (in)	410	420	425	430	435
MH 08597	1000yr	17.5	442.52	443.39	443.95	443.08	443.08
	500yr	15.8	442.22	443.12	443.70	442.74	442.75
	100yr	12.4	441.27	442.27	442.95	441.67	441.68
	50yr	11.1	440.36	441.54	442.42	440.60	440.61
	25yr	9.9	439.06	440.25	441.58	438.80	438.82
	10yr	8.4	436.34	437.07	439.44	434.44	434.48
	5yr	7.3	434.29	434.57	436.47	432.18	432.22
	2yr	6	432.27	432.39	433.31	431.15	431.16
	1yr	5	431.12	431.18	431.74	430.12	430.13

Upper Gage			17th Street				
	Rec. Int.	Precip (in)	420	425	430	435	440
MH 08740	1000yr	17.5	456.602	456.602	456.610	456.615	456.720
	500yr	15.8	456.425	456.425	456.434	456.439	456.540
	100yr	12.4	455.955	455.955	455.962	455.966	456.090
	50yr	11.1	455.695	455.695	455.703	455.707	455.850
	25yr	9.9	455.328	455.328	455.328	455.333	455.530
	10yr	8.4	454.742	454.742	454.742	454.748	455.020
	5yr	7.3	453.973	453.973	453.973	453.988	454.560
	2yr	6	450.022	450.022	450.022	450.055	452.410
	1yr	5	448.465	448.465	448.465	448.486	449.510

LOWER Gage			34th Street				
	Rec. Int.	Precip (in)	410	420	425	430	435
Upstream of 34th Street Gate (CSO019)	1000yr	17.5	429.32	430.47	438.31	438.31	438.31
	500yr	15.8	429.10	430.21	436.40	436.40	436.40
	100yr	12.4	428.45	429.42	430.88	430.88	430.88
	50yr	11.1	428.13	429.02	430.52	430.53	430.52
	25yr	9.9	427.80	428.55	430.10	430.10	430.10
	10yr	8.4	427.28	427.88	429.83	429.83	429.83
	5yr	7.3	426.88	427.37	429.28	429.28	429.28
	2yr	6	426.26	426.62	428.77	428.77	428.78
	1yr	5	425.85	426.13	428.50	428.50	428.50

LOWER Gage			Shawnee				
	Rec. Int.	Precip (in)	410	420	425	430	435
MH 08574	1000yr	17.5	441.53	441.62	441.72	443.69	443.69
	500yr	15.8	441.36	441.45	441.54	443.39	443.40
	100yr	12.4	440.81	440.93	441.06	442.57	442.58
	50yr	11.1	440.44	440.54	440.75	441.89	441.91
	25yr	9.9	440.08	440.18	440.27	440.77	440.79
	10yr	8.4	439.57	439.64	439.68	438.46	438.53
	5yr	7.3	439.10	439.15	439.20	437.62	437.64
	2yr	6	438.01	438.02	438.06	436.14	436.15
	1yr	5	436.96	436.97	437.00	434.84	434.85

LOWER Gage			Western				
	Rec. Int.	Precip (in)	410	420	425	430	435
Sewer Node 63913-T	1000yr	17.5	437.12	438.40	438.43	438.44	438.51
	500yr	15.8	436.77	438.01	438.04	438.04	438.10
	100yr	12.4	435.60	436.93	436.98	436.95	437.03
	50yr	11.1	434.47	436.32	436.40	436.33	436.41
	25yr	9.9	433.10	435.46	435.63	435.41	435.54
	10yr	8.4	431.03	433.92	434.17	433.79	433.94
	5yr	7.3	428.95	433.14	433.17	433.07	432.97
	2yr	6	426.05	429.99	430.04	429.56	430.19
	1yr	5	424.39	428.14	428.15	428.00	428.02

LOWER Gage			Paddy's Run				
	Rec. Int.	Precip (in)	410	420	425	430	435
Southwest Sluice Gate Chamber (50946-T)	1000yr	17.5	443.67	446.04	446.58	446.89	448.89
	500yr	15.8	441.30	444.11	445.62	446.42	448.27
	100yr	12.4	435.90	439.68	441.43	443.47	446.50
	50yr	11.1	433.32	437.87	439.93	441.94	445.81
	25yr	9.9	430.51	436.04	438.46	440.42	443.43
	10yr	8.4	425.27	432.37	435.95	438.35	437.38
	5yr	7.3	422.73	429.16	432.03	434.70	432.99
	2yr	6	420.23	425.22	427.78	430.55	428.78
	1yr	5	419.78	423.26	425.82	430.17	426.00

Plate No. 2. InfoWorks Model Results for Proposed Pumping Capacity (LOP5) with NO Conveyance Improvements Scenario. Interior Ponding Elevations (ft-NGVD29).

Upper Gage			4th Street - Gate 34 Open				
	Rec. Int.	Precip (in)	420	425	430	435	440
MH 75279	1000yr	17.5	447.139	449.930	450.115	454.290	454.376
	500yr	15.8	444.169	448.477	447.916	453.299	453.410
	100yr	12.4	438.880	438.506	438.805	448.292	448.557
	50yr	11.1	435.715	435.158	435.353	443.382	443.759
	25yr	9.9	432.396	432.335	432.519	435.983	435.935
	10yr	8.4	430.028	430.085	430.113	431.867	431.878
	5yr	7.3	429.068	429.371	429.371	429.786	429.864
	2yr	6	427.994	428.250	428.375	428.415	428.416
	1yr	5	427.509	427.821	427.699	427.709	427.715

Upper Gage			27th Street				
	Rec. Int.	Precip (in)	420	425	430	435	440
Flooding on Main Line near MH 07745 (08722-X)	1000yr	17.5	449.58	449.58	452.50	452.50	452.49
	500yr	15.8	448.66	448.66	452.04	452.04	452.00
	100yr	12.4	444.49	444.49	449.68	449.66	449.54
	50yr	11.1	443.11	443.11	446.83	446.75	446.35
	25yr	9.9	442.03	442.03	443.38	443.26	443.12
	10yr	8.4	441.18	441.18	441.47	441.47	441.48
	5yr	7.3	440.82	440.82	440.98	440.98	440.98
	2yr	6	440.25	440.25	440.41	440.41	440.41
	1yr	5	439.86	439.86	439.99	439.99	439.99

LOWER Gage			Shawnee				
	Rec. Int.	Precip (in)	410	420	425	430	435
MH 08597	1000yr	17.5	442.52	443.39	443.95	440.17	440.17
	500yr	15.8	442.22	443.12	443.69	440.91	439.85
	100yr	12.4	441.27	442.25	442.94	438.88	439.53
	50yr	11.1	440.36	441.51	442.40	439.10	438.75
	25yr	9.9	439.06	440.17	441.55	438.30	438.55
	10yr	8.4	436.34	436.91	439.34	433.87	433.90
	5yr	7.3	434.29	434.51	436.36	432.00	432.08
	2yr	6	432.27	432.38	433.29	430.88	430.89
	1yr	5	431.12	431.18	431.70	430.12	430.12

Upper Gage			17th Street				
	Rec. Int.	Precip (in)	420	425	430	435	440
MH 08740	1000yr	17.5	456.602	456.602	456.608	456.610	456.620
	500yr	15.8	456.425	456.425	456.431	456.435	456.440
	100yr	12.4	455.955	455.955	455.956	455.960	455.960
	50yr	11.1	455.695	455.695	455.695	455.699	455.710
	25yr	9.9	455.328	455.328	455.328	455.333	455.350
	10yr	8.4	454.742	454.742	454.742	454.748	454.770
	5yr	7.3	453.973	453.977	453.977	453.993	454.060
	2yr	6	450.022	450.022	450.022	450.055	450.200
	1yr	5	448.465	448.465	448.465	448.486	448.610

LOWER Gage			34th Street				
	Rec. Int.	Precip (in)	410	420	425	430	435
Upstream of 34th Street Gate (CSO019)	1000yr	17.5	429.32	430.47	438.31	438.31	438.31
	500yr	15.8	429.10	430.21	436.40	436.40	436.40
	100yr	12.4	428.45	429.42	430.88	430.88	430.88
	50yr	11.1	428.13	429.02	430.52	430.53	430.53
	25yr	9.9	427.80	428.55	430.10	430.10	430.10
	10yr	8.4	427.28	427.88	429.83	429.83	429.83
	5yr	7.3	426.88	427.38	429.30	429.28	429.30
	2yr	6	426.26	426.62	428.77	428.77	428.78
	1yr	5	425.85	426.13	428.50	428.50	428.50

LOWER Gage			Shawnee				
	Rec. Int.	Precip (in)	410	420	425	430	435
MH 08574	1000yr	17.5	441.53	441.61	441.71	441.05	441.27
	500yr	15.8	441.36	441.44	441.53	441.67	441.23
	100yr	12.4	440.81	440.92	441.04	440.48	440.74
	50yr	11.1	440.44	440.52	440.72	440.02	440.46
	25yr	9.9	440.08	440.16	440.23	439.47	439.72
	10yr	8.4	439.57	439.61	439.66	438.18	438.27
	5yr	7.3	439.10	439.13	439.16	437.44	437.57
	2yr	6	438.01	438.01	438.05	435.99	436.01
	1yr	5	436.96	436.96	436.99	434.85	434.85

LOWER Gage			Western				
	Rec. Int.	Precip (in)	410	420	425	430	435
Sewer Node 63913-T	1000yr	17.5	437.12	438.12	438.14	438.09	438.09
	500yr	15.8	436.77	437.87	437.89	437.85	437.86
	100yr	12.4	435.60	437.22	437.30	437.08	437.16
	50yr	11.1	434.47	436.59	436.69	436.44	436.53
	25yr	9.9	433.10	435.69	435.86	435.48	435.64
	10yr	8.4	431.03	433.57	433.85	433.31	433.70
	5yr	7.3	428.95	431.44	431.63	431.19	431.62
	2yr	6	426.05	429.37	429.38	429.37	429.21
	1yr	5	424.39	428.14	429.11	428.63	429.36

LOWER Gage			Paddy's Run				
	Rec. Int.	Precip (in)	410	420	425	430	435
Southwest Sluice Gate Chamber (50946A-T)	1000yr	17.5	443.67	446.04	446.58	446.89	447.56
	500yr	15.8	441.30	444.11	445.62	446.42	446.68
	100yr	12.4	435.90	439.68	441.43	443.47	442.89
	50yr	11.1	433.32	437.87	439.93	441.94	439.96
	25yr	9.9	430.51	436.04	438.46	440.42	438.17
	10yr	8.4	425.27	432.35	435.95	438.35	435.03
	5yr	7.3	422.73	429.16	432.03	434.69	431.70
	2yr	6	420.23	425.22	427.77	430.54	427.13
	1yr	5	419.78	423.25	425.82	430.17	423.54

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Plate No. 3. InfoWorks Model Results for Proposed Pumping Capacity (LOP5) WITH Conveyance Improvements Scenario. Interior Ponding Elevations (ft-NGVD29).

Upper Gage			4th Street - Gate 34 Open				
	Rec. Int.	Precip (in)	420	425	430	435	440
MH 75279	1000yr	17.5	447.139	449.729	449.852	454.040	454.042
	500yr	15.8	444.169	447.949	447.551	453.149	453.260
	100yr	12.4	438.880	438.140	438.414	448.056	448.284
	50yr	11.1	435.715	435.005	435.208	442.970	443.376
	25yr	9.9	432.396	432.244	432.401	435.818	435.730
	10yr	8.4	430.028	430.072	430.131	431.858	431.865
	5yr	7.3	429.068	429.374	429.331	429.819	429.807
	2yr	6	427.994	428.250	428.375	428.418	428.419
	1yr	5	427.509	427.697	427.699	427.709	427.710

Upper Gage			27th Street				
	Rec. Int.	Precip (in)	420	425	430	435	440
Flooding on Main Line near MH 07745 (08722-X)	1000yr	17.5	449.58	449.58	452.50	452.50	452.49
	500yr	15.8	448.66	448.66	452.04	452.03	452.00
	100yr	12.4	444.49	444.49	449.68	449.66	449.54
	50yr	11.1	443.11	443.11	446.83	446.75	446.35
	25yr	9.9	442.03	442.03	443.38	443.25	443.12
	10yr	8.4	441.18	441.18	441.47	441.47	441.48
	5yr	7.3	440.82	440.82	440.98	440.98	440.98
	2yr	6	440.25	440.25	440.41	440.41	440.41
	1yr	5	439.86	439.86	439.99	439.99	439.99

LOWER Gage			Shawnee				
	Rec. Int.	Precip (in)	410	420	425	430	435
MH 08597	1000yr	17.5	442.52	443.37	443.93	439.00	439.03
	500yr	15.8	442.22	443.10	443.67	438.70	438.70
	100yr	12.4	441.27	442.22	442.92	437.42	437.45
	50yr	11.1	440.36	441.47	442.38	436.33	436.05
	25yr	9.9	439.06	440.09	441.52	435.02	435.02
	10yr	8.4	436.34	436.82	439.28	433.32	433.32
	5yr	7.3	434.29	434.46	436.29	432.31	432.34
	2yr	6	432.27	432.32	433.17	430.91	430.92
	1yr	5	431.12	431.12	431.67	430.10	430.11

Upper Gage			17th Street				
	Rec. Int.	Precip (in)	420	425	430	435	440
MH 08740	1000yr	17.5	456.602	456.602	456.608	456.610	456.620
	500yr	15.8	456.425	456.425	456.431	456.435	456.440
	100yr	12.4	455.955	455.955	455.956	455.960	455.960
	50yr	11.1	455.695	455.695	455.695	455.699	455.710
	25yr	9.9	455.328	455.328	455.328	455.333	455.350
	10yr	8.4	454.742	454.742	454.742	454.748	454.770
	5yr	7.3	453.973	453.973	453.973	453.988	454.060
	2yr	6	450.022	450.022	450.022	450.055	450.200
	1yr	5	448.465	448.465	448.465	448.486	448.610

LOWER Gage			34th Street				
	Rec. Int.	Precip (in)	410	420	425	430	435
Upstream of 34th Street Gate (CSO019)	1000yr	17.5	429.32	430.47	438.31	438.31	438.31
	500yr	15.8	429.10	430.21	436.40	436.40	436.40
	100yr	12.4	428.45	429.42	430.87	430.88	430.88
	50yr	11.1	428.13	429.02	430.52	430.53	430.53
	25yr	9.9	427.80	428.55	430.10	430.10	430.10
	10yr	8.4	427.28	427.88	429.83	429.83	429.83
	5yr	7.3	426.88	427.37	429.28	429.28	429.28
	2yr	6	426.26	426.62	428.77	428.77	428.78
	1yr	5	425.85	426.13	428.50	428.51	428.50

LOWER Gage			Shawnee				
	Rec. Int.	Precip (in)	410	420	425	430	435
MH 08574	1000yr	17.5	441.53	441.59	441.68	437.22	437.22
	500yr	15.8	441.36	441.41	441.51	437.13	437.14
	100yr	12.4	440.81	440.90	441.02	436.80	436.83
	50yr	11.1	440.44	440.49	440.70	436.61	436.64
	25yr	9.9	440.08	440.14	440.21	436.39	436.41
	10yr	8.4	439.57	439.61	439.65	435.99	436.00
	5yr	7.3	439.10	439.12	439.17	435.61	435.61
	2yr	6	438.01	438.01	438.05	434.74	434.74
	1yr	5	436.96	436.96	436.99	433.99	433.99

LOWER Gage			Western				
	Rec. Int.	Precip (in)	410	420	425	430	435
Sewer Node 63913-T	1000yr	17.5	437.12	436.94	436.96	436.72	436.75
	500yr	15.8	436.77	436.61	436.63	436.36	436.40
	100yr	12.4	435.60	435.43	435.46	435.07	435.16
	50yr	11.1	434.47	434.51	434.56	434.03	434.13
	25yr	9.9	433.10	433.31	433.38	432.90	433.00
	10yr	8.4	431.03	431.90	432.08	431.53	431.62
	5yr	7.3	428.95	431.02	431.24	430.54	431.05
	2yr	6	426.05	427.84	427.84	427.60	427.66
	1yr	5	424.39	427.55	427.56	427.57	427.28

LOWER Gage			Paddy's Run				
	Rec. Int.	Precip (in)	410	420	425	430	435
Southwest Sluice Gate Chamber (50946A-T)	1000yr	17.5	443.67	446.04	446.58	446.89	447.56
	500yr	15.8	441.30	444.11	445.62	446.42	446.68
	100yr	12.4	435.90	439.68	441.43	443.47	442.86
	50yr	11.1	433.32	437.87	439.93	441.94	439.92
	25yr	9.9	430.51	436.04	438.46	440.42	438.14
	10yr	8.4	425.27	432.35	435.95	438.35	434.58
	5yr	7.3	422.73	429.16	432.03	434.69	431.70
	2yr	6	420.23	425.22	427.77	430.54	427.13
	1yr	5	419.78	423.25	425.82	430.17	423.53

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Plate No. 4. InfoWorks Model Results for Gate Modifications Scenario. Interior Ponding Elevations (ft-NGVD29).

Upper Gage			27th Street				
	Rec. Int.	Precip (in)	420	425	430	435	440
Flooding on Main Line near MH 07745 (08722-X)	1000yr	17.5	449.58	449.58	447.80	449.61	450.98
	500yr	15.8	448.66	448.67	446.79	448.89	450.67
	100yr	12.4	444.49	444.50	444.36	446.22	449.24
	50yr	11.1	443.11	443.11	443.37	444.67	448.07
	25yr	9.9	442.03	442.03	442.38	443.24	446.54
	10yr	8.4	441.18	441.18	441.37	441.76	442.31
	5yr	7.3	440.82	440.82	440.96	441.00	441.00
	2yr	6	440.25	440.25	440.41	440.41	440.41
	1yr	5	439.86	439.86	439.99	439.99	439.99

LOWER Gage			Shawnee				
	Rec. Int.	Precip (in)	410	420	425	430	435
MH 08597	1000yr	17.5	442.517	443.382	443.951	441.800	442.117
	500yr	15.8	442.224	443.110	443.699	441.523	441.815
	100yr	12.4	441.273	442.241	442.950	440.150	440.598
	50yr	11.1	440.364	441.496	442.423	438.769	439.358
	25yr	9.9	439.064	440.140	441.582	436.715	437.613
	10yr	8.4	436.336	436.880	439.439	433.754	433.796
	5yr	7.3	434.290	434.487	436.481	432.593	432.020
	2yr	6	432.266	432.328	433.330	430.949	431.162
	1yr	5	431.125	431.128	431.740	430.195	430.127

LOWER Gage			Western				
	Rec. Int.	Precip (in)	410	420	425	430	435
Sewer Node 63913-T	1000yr	17.5	437.120	437.824	438.154	438.160	438.315
	500yr	15.8	436.772	437.480	437.835	437.764	437.932
	100yr	12.4	435.603	436.462	436.920	436.627	436.454
	50yr	11.1	434.466	435.844	436.448	435.924	436.178
	25yr	9.9	433.100	434.890	435.877	434.873	435.204
	10yr	8.4	431.035	433.114	434.788	433.448	433.745
	5yr	7.3	428.954	431.324	433.264	433.094	432.963
	2yr	6	426.046	428.187	430.571	429.432	430.187
	1yr	5	424.391	426.184	429.023	427.982	428.024

LOWER Gage			34th Street				
	Rec. Int.	Precip (in)	410	420	425	430	435
Upstream of 34th Street Gate (CSO019)	1000yr	17.5	429.320	430.466	427.837	431.954	436.978
	500yr	15.8	429.102	430.212	427.520	431.934	436.402
	100yr	12.4	428.449	429.424	426.898	430.878	430.877
	50yr	11.1	428.134	429.017	426.655	430.527	430.524
	25yr	9.9	427.796	428.554	426.407	430.098	430.102
	10yr	8.4	427.277	427.878	426.188	429.833	429.832
	5yr	7.3	426.885	427.375	426.072	429.276	429.284
	2yr	6	426.264	426.622	426.047	428.773	428.777
	1yr	5	425.845	426.134	426.027	428.505	428.504

LOWER Gage			Shawnee				
	Rec. Int.	Precip (in)	410	420	425	430	435
MH 08574	1000yr	17.5	441.530	441.605	441.721	438.250	439.552
	500yr	15.8	441.360	441.430	441.546	438.051	439.382
	100yr	12.4	440.810	440.911	441.050	437.270	438.654
	50yr	11.1	440.440	440.504	440.744	436.744	438.100
	25yr	9.9	440.080	440.140	440.268	436.290	437.769
	10yr	8.4	439.570	439.601	439.680	435.903	437.532
	5yr	7.3	439.100	439.120	439.198	435.529	437.235
	2yr	6	438.010	438.009	438.059	434.708	436.151
	1yr	5	436.960	436.961	436.997	434.048	434.847

LOWER Gage			Paddy's Run				
	Rec. Int.	Precip (in)	410	420	425	430	435
Southwest Sluice Gate Chamber (50946-T)	1000yr	17.5	443.670	443.430	445.020	446.160	446.670
	500yr	15.8	441.300	441.312	442.810	444.669	446.040
	100yr	12.4	435.900	437.720	439.060	440.980	443.100
	50yr	11.1	433.320	437.040	437.790	439.788	441.940
	25yr	9.9	430.510	435.390	436.930	438.710	440.820
	10yr	8.4	425.270	431.470	434.540	436.560	437.390
	5yr	7.3	422.730	428.650	431.560	433.030	432.990
	2yr	6	420.230	425.250	427.750	428.740	428.780
	1yr	5	419.780	423.270	426.000	425.980	426.000

Plate No. 5. HMS Model Results for Beargrass Creek for Existing, Proposed, and Gate Modifications Conditions. Interior Ponding Elevations (ft-NGVD29).

Beargrass Creek Coincident Frequency Ponding Elevation Data (Variable C)
Water Surface Elevation Measured at the BGC Ponding area near the FPS

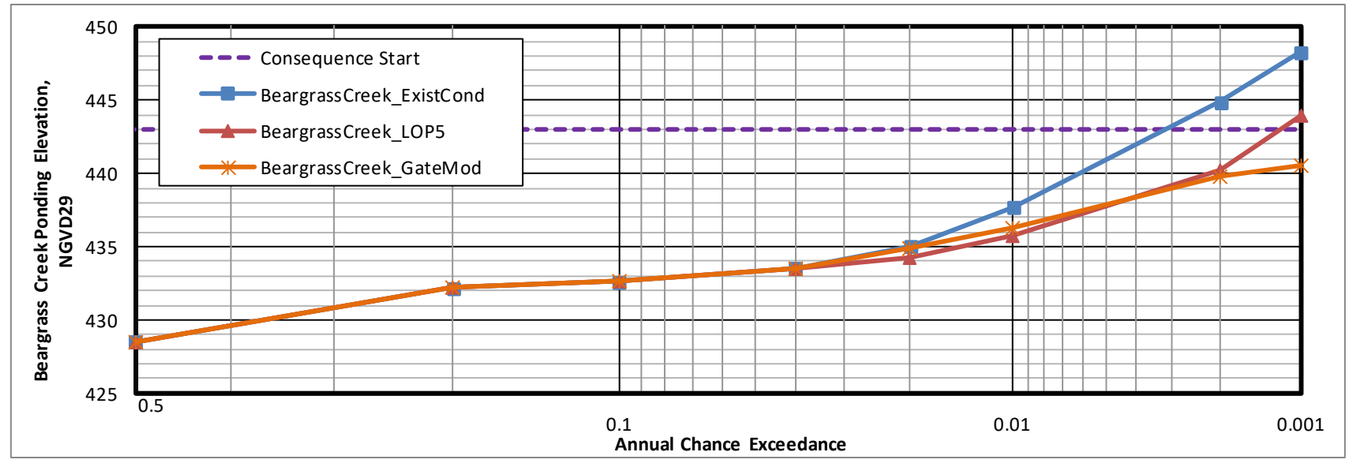
Existing Cond		Outlet Condition:	*Gravity*	*Gravity*	*Pump*	*Pump*
		Pool Elev. (Var. B):	**420.482**	**431.482**	**435.482**	**440.482**
Rec. Int. (yr)	***ACE***	***Precipitation (in) (Variable A)***	*C=f(A,420.482)*	*C=f(A,431.482)*	*C=f(A,435.482)*	*C=f(A,440.482)*
1000	*0.1%*	**17.5**	438.5	438.7	463.9	463.9
500	*0.2%*	**15.8**	437.1	437.5	462.1	462.1
100	*1%*	**12.4**	434.1	435.3	457.1	457.1
50	*2%*	**11.1**	432.6	434.4	454.1	454.1
25	*4%*	**9.88**	431.2	433.7	451.5	451.5
10	*10%*	**8.36**	429.4	433.0	447.7	447.7
5	*20%*	**7.30**	427.9	432.6	444.1	444.1
2	*50%*	**6.00**	425.6	432.1	438.9	438.9
1	*100%*	**5.03**	423.9	431.8	434.4	434.4

LOP5		Outlet Condition:	*Gravity*	*Gravity*	*Pump*	*Pump*
		Pool Elev. (Var. B):	**420.482**	**431.482**	**435.482**	**440.482**
Rec. Int. (yr)	***ACE***	***Precipitation (in) (Variable A)***	*C=f(A,420.482)*	*C=f(A,431.482)*	*C=f(A,435.482)*	*C=f(A,440.482)*
1000	*0.1%*	**17.5**	438.5	438.7	462.0	462.0
500	*0.2%*	**15.8**	437.1	437.5	460.4	460.4
100	*1%*	**12.4**	434.1	435.3	453.6	453.6
50	*2%*	**11.1**	432.6	434.4	451.1	451.1
25	*4%*	**9.88**	431.2	433.7	447.9	447.9
10	*10%*	**8.36**	429.4	433.0	443.2	443.2
5	*20%*	**7.30**	427.9	432.6	439.4	439.4
2	*50%*	**6.00**	425.6	432.1	434.1	434.1
1	*100%*	**5.03**	423.9	431.8	433.6	433.6

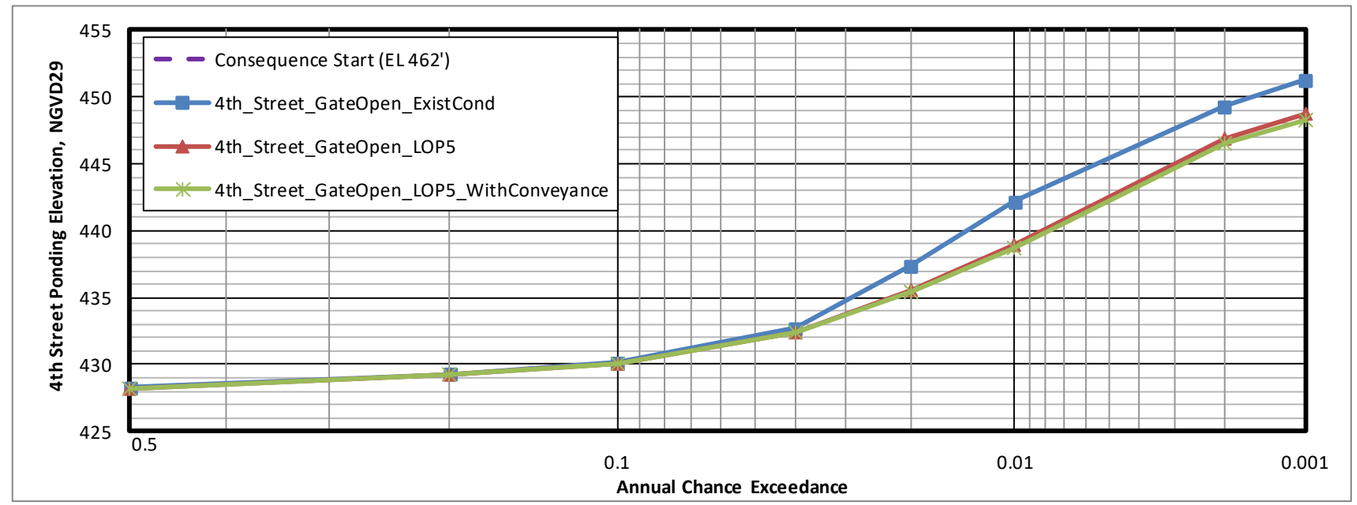
Gate Mod		Outlet Condition:	*Gravity*	*Gravity*	*Pump*	*Pump*
		Pool Elev. (Var. B)	**420.482**	**431.482**	**435.482**	**440.482**
Rec. Int. (yr)	***ACE***	***Precipitation (in) (Variable A)***	*C=f(A,420.482)*	*C=f(A,431.482)*	*C=f(A,435.482)*	*C=f(A,440.482)*
1000	*0.1%*	**17.5**	438.5	438.7	438.7	442.5
500	*0.2%*	**15.8**	437.1	437.5	437.8	442.1
100	*1%*	**12.4**	434.1	435.3	436.7	441.3
50	*2%*	**11.1**	432.6	434.4	436.3	441.0
25	*4%*	**9.88**	431.2	433.7	436.0	440.8
10	*10%*	**8.36**	429.4	433.0	435.8	440.6
5	*20%*	**7.30**	427.9	432.6	435.6	440.5
2	*50%*	**6.00**	425.6	432.1	435.5	438.9
1	*100%*	**5.03**	423.9	431.8	434.4	434.4

Plate No. 6. Weighted Probability Coincident Frequency Curves and Data tables for Beargrass Creek, 4th Street, and 17th Street Pumping Stations

Beargrass Creek Water Surface Elevations (ft NGVD29)			
A.C.E.	Existing Conditions	Proposed Pumping Capacity (LOP5) with NO Conveyance Improvements	Gate Modification
0.1%	448.323	443.971	440.544
0.2%	444.876	440.219	439.833
1%	437.697	435.795	436.33
2%	435.039	434.285	434.899
4%	433.528	433.517	433.528
10%	432.621	432.621	432.621
20%	432.184	432.184	432.184
50%	428.554	428.554	428.554
99%	424.063	424.063	424.063



4th Street Water Surface Elevations (ft NGVD29)			
A.C.E.	Existing Conditions	Proposed Pumping Capacity (LOP5) with NO Conveyance Improvements	Proposed Pumping Capacity (LOP5) WITH Conveyance Improvements
0.1%	451.305	448.715	448.267
0.2%	449.287	446.852	446.542
1%	442.173	438.893	438.751
2%	437.391	435.543	435.459
4%	432.685	432.447	432.396
10%	430.152	430.091	430.085
20%	429.246	429.27	429.27
50%	428.297	428.217	428.212
99%	427.569	427.568	427.564



17th Street Water Surface Elevations (ft NGVD29)			
A.C.E.	Existing Conditions	Proposed Pumping Capacity (LOP5) with NO Conveyance Improvements	Proposed Pumping Capacity (LOP5) WITH Conveyance Improvements
0.1%	456.602	456.602	456.602
0.2%	456.426	456.425	456.425
1%	455.956	455.955	455.955
2%	455.696	455.695	455.695
4%	455.33	455.328	455.328
10%	454.745	454.742	454.742
20%	453.976	453.974	453.973
50%	450.062	450.031	450.031
99%	448.468	448.468	448.468

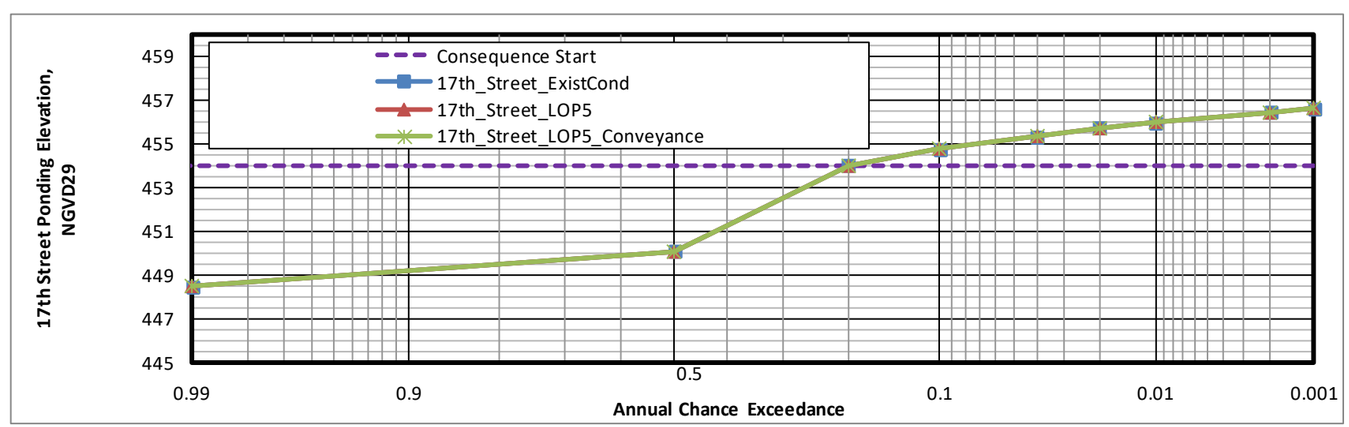


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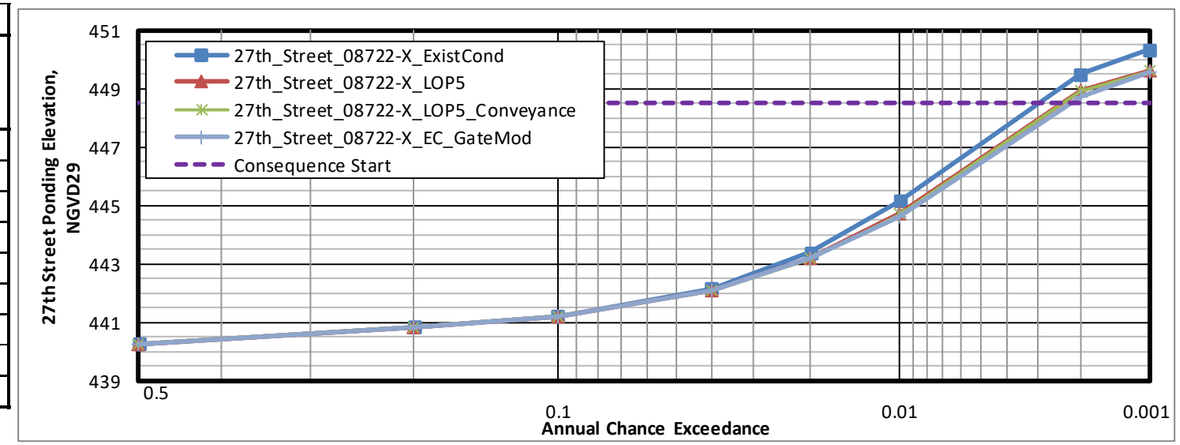
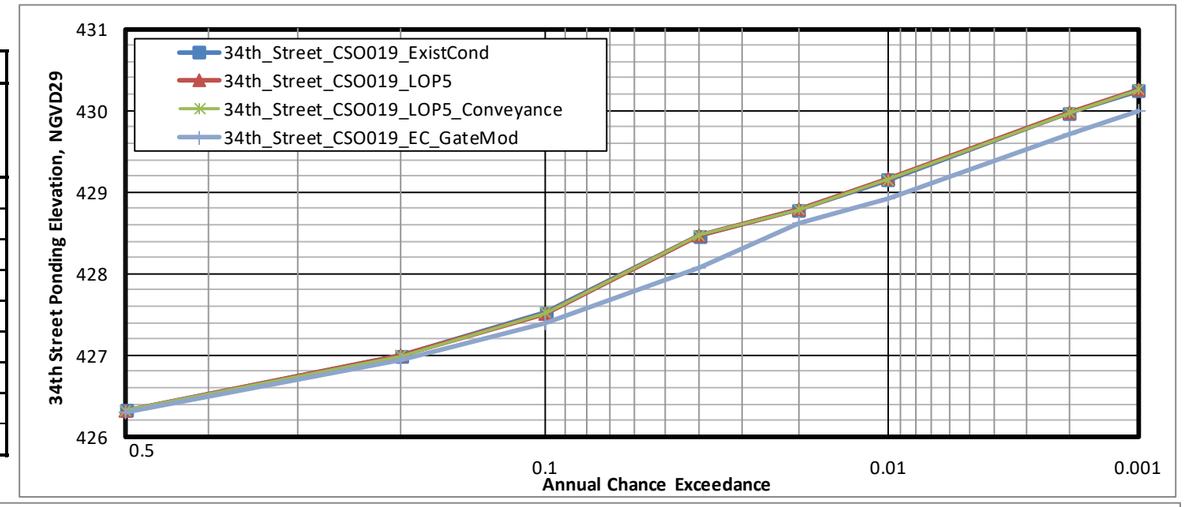
Plate No. 7. Weighted Probability Coincident Frequency Curves and Data tables for 27th Street, 34th Street, and Shawnee Pumping Stations

27th Street Water Surface Elevations (ft NGVD29)				
A.C.E.	Existing Conditions	Proposed Pumping Capacity (LOP5) with NO Conveyance Improvements	Proposed Pumping Capacity (LOP5) WITH Conveyance Improvements	Gate Modifications
0.1%	450.336	449.597	449.596	449.58
0.2%	449.497	448.926	448.925	448.697
1%	445.143	444.701	444.704	444.617
2%	443.382	443.195	443.191	443.182
4%	442.152	442.082	442.081	442.077
10%	441.211	441.198	441.198	441.199
20%	440.828	440.827	440.827	440.827
50%	440.267	440.267	440.27	440.267
99%	439.862	439.862	439.86	439.862



34th Street Water Surface Elevations (ft NGVD29)				
A.C.E.	Existing Conditions	Proposed Pumping Capacity (LOP5) with NO Conveyance Improvements	Proposed Pumping Capacity (LOP5) WITH Conveyance Improvements	Gate Modifications
0.1%	450.336	449.597	449.596	449.58
0.2%	449.497	448.926	448.925	448.697
1%	445.143	444.701	444.704	444.617
2%	443.382	443.195	443.191	443.182
4%	442.152	442.082	442.081	442.077
10%	441.211	441.198	441.198	441.199
20%	440.828	440.827	440.827	440.827
50%	440.267	440.267	440.27	440.267
99%	439.862	439.862	439.86	439.862



Shawnee Water Surface Elevations (ft NGVD29)			
A.C.E.	Existing Conditions	Proposed Pumping Capacity (LOP5) WITH Conveyance Improvements	Gate Modifications
0.1%	442.587	442.603	442.611
0.2%	442.373	442.351	442.356
1%	441.345	441.33	441.336
2%	440.46	440.431	440.446
4%	439.144	439.11	439.131
10%	436.407	436.364	436.387
20%	434.332	434.31	434.322
50%	432.298	432.283	432.286
99%	430.991	431.123	431.032

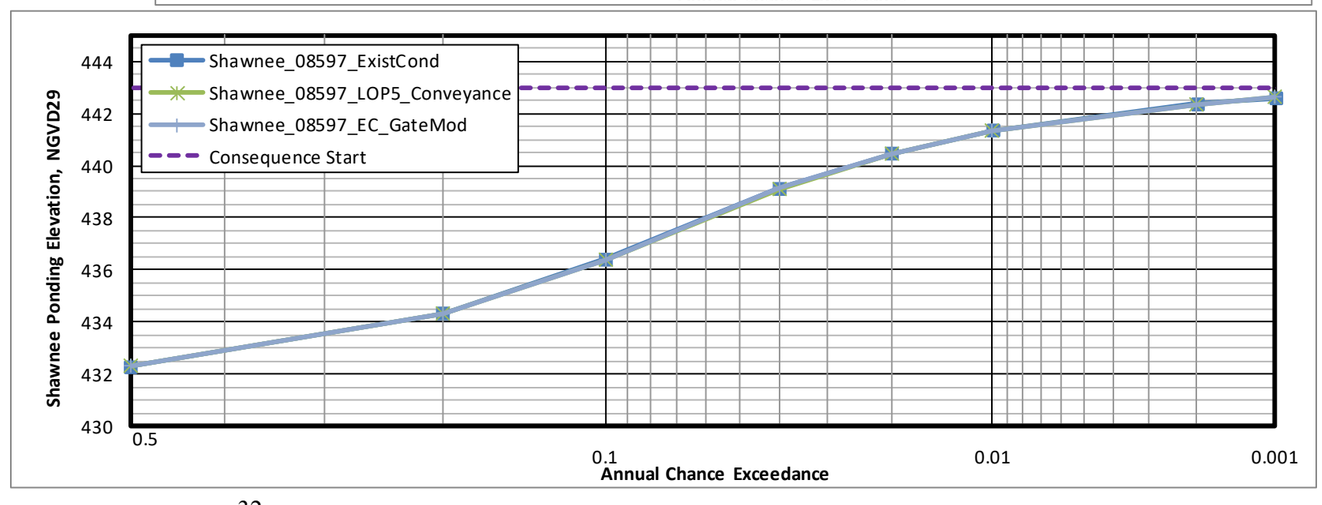


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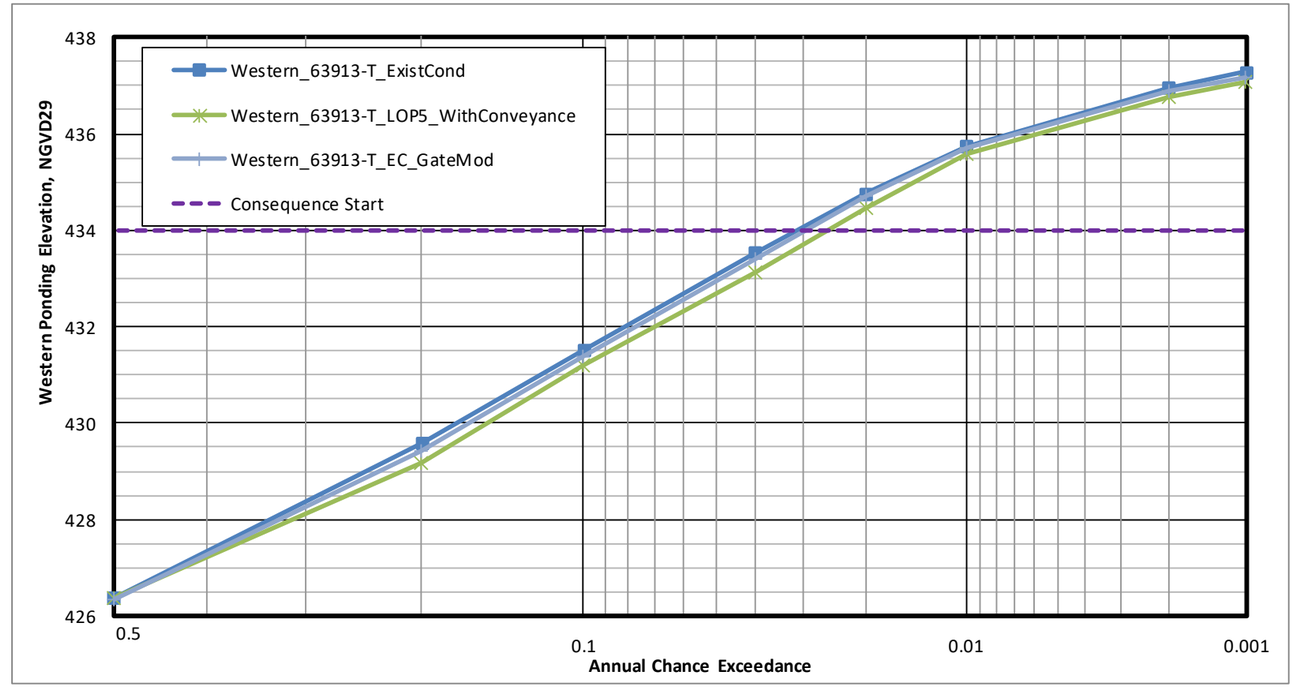
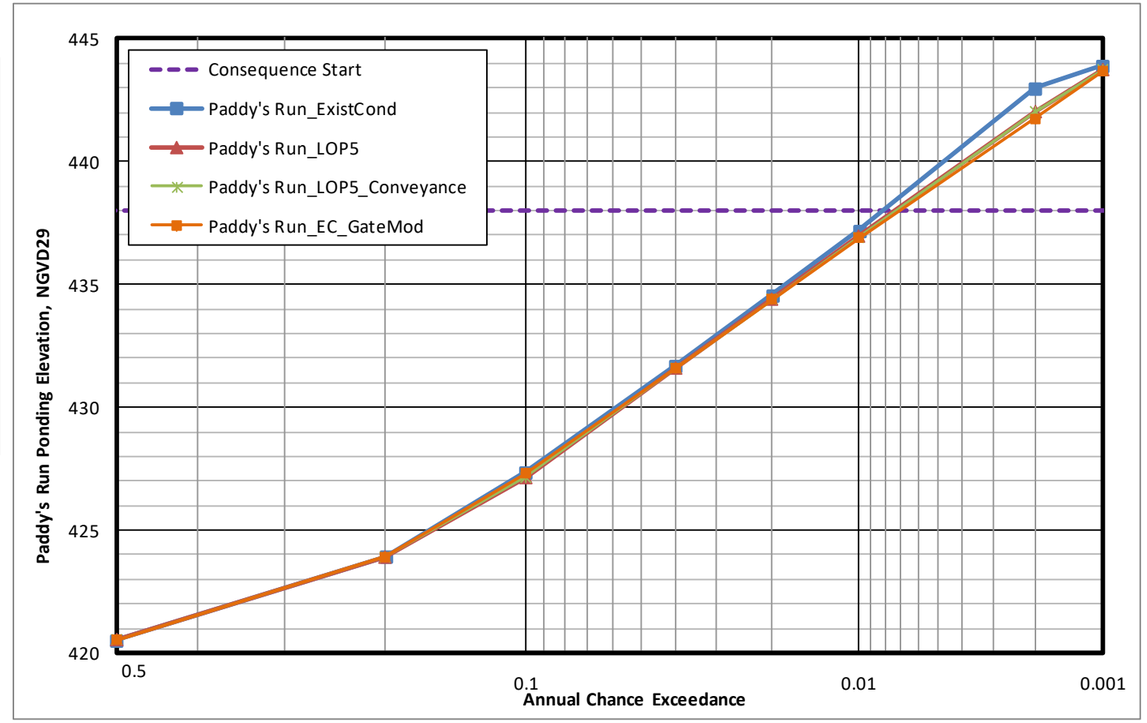
Plate No. 8. Weighted Probability Coincident Frequency Curves and Data tables for Western and Paddy's Run Pumping Stations

Western Water Surface Elevations (ft NGVD29)			
A.C.E.	Existing Conditions	Proposed Pumping Capacity (LOP5) WITH Conveyance Improvements	Gate Modifications
0.1%	437.28	437.086	437.165
0.2%	436.952	436.754	436.873
1%	435.751	435.578	435.715
2%	434.765	434.464	434.722
4%	433.539	433.117	433.413
10%	431.514	431.183	431.37
20%	429.592	429.159	429.419
50%	426.377	426.372	426.353
99%	424.411	424.411	424.411



Paddy's Run Water Surface Elevations (ft NGVD29)				
A.C.E.	Existing Conditions	Proposed Pumping Capacity (LOP5) with NO Conveyance Improvements	Proposed Pumping Capacity (LOP5) WITH Conveyance Improvements	Gate Modifications
0.1%	443.904	443.72	443.72	443.684
0.2%	442.983	442.009	442.006	441.731
1%	437.199	436.944	436.93	436.891
2%	434.574	434.427	434.396	434.393
4%	431.701	431.576	431.576	431.574
10%	427.367	427.17	427.17	427.317
20%	423.905	423.928	423.926	423.908
50%	420.521	420.521	420.521	420.521
99%	419.785	419.785	419.785	419.785



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APPENDIX C - Mechanical
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3. Appendix C – Mechanical

This appendix lists and describes the current condition of the levee with respect to features considered for reconstruction, the mechanical considerations that were part of the feasibility study and the formulation of the alternatives. Listed below are specific measures where mechanical considerations were applied, the information available, analyses performed, the assumptions, future information needed, and the project risk involved with the information and assumptions utilized.

3.1. Beargrass Creek Pump Station Condition Summary

Beargrass creek has 6 pumps that pump 350,000 GPM at 27.5 ft of head, 1 pump that pumps 300,000 GPM at 25.8 ft of head, and 1 pump that pumps 52,750 GPM at 43 ft of head. The pumps at Beargrass Creek pumping station were installed in 1953. In 2017, a detailed pump inspection was conducted by HDR, which concluded that the pumps may last another 5-10 years with proper maintenance. In 2018, two pumps had to be taken out of service for bearing repairs.

Because the pumps have operated well beyond their design life and unscheduled outages are becoming more common, it is recommended that each pump be completely disassembled and reconditioned back to manufacturer specifications. Phasing was not heavily considered during this analysis, but will need to be looked into further during design. Pump reconditioning will need to be phased to maintain a minimum pumping capacity. Seasonal weather effects and refurbishment times will need to be considered when making a phasing schedule.

3.1.1. Beargrass Creek Roller Gates

The current roller gate machinery appears to be in good operating condition, but is not designed to lift the gates against much, if any, head. It was identified during the 2019 PFMA that the gates may be required to lift against a low interior head to alleviate interior flooding. See Appendix B, section 1.4.2.1 for hydraulics and hydrology analysis of gate operation. The current system allows only a very small differential head applied to the gate, when using conservative friction factors for the sheaves and roller bearings. To accommodate lifting with a differential head, it is recommended to upgrade all operating machinery be upgraded. The operating machinery can likely be upgraded within the current size limitations to lift about 195,000 lbs. 195,000 lbs is equal to about 7.5 feet of head, when a friction coefficient for the rollers and sheaves is assumed to be 0.30. It should be stressed this is only a conservative design as long as the rollers and sheaves are maintained and greased. Improper maintenance of the rollers may lower the static head level that the equipment can lift.

Because drum, gear and sheave diameters will likely determine whether or not the equipment can be upgraded in the current space limitations, it is recommended to use a similar system with the sheave block providing mechanical advantage. If a similar style system is used to lift the gate, one of the identified limitations is that the cable drives the sheave selection. The proposed design for feasibility is as follows: A 1.125” diameter, 6x36 EEIPS wire rope can be used with 26 ¼” diameter sheaves. New sheaves, with larger grooves, will need to be installed to accommodate the larger diameter cables and the widths will change. This may result in an overall larger footprint for the sheaves, and may require enlarging the opening for the cables to pass through the floor. A third sheave should be installed on the gate, resulting in a 6 part cable system to increase the mechanical advantage. The motor will need to be changed to a 10 HP motor, and the gearbox will need to be approximately a 400:1 gear ratio rated for 10 HP. The open gears can stay the same ratio, may need to be swapped out for the higher torque. All unmentioned parts will likely need to be changed to handle the higher torque.

For this analysis, hydrodynamic forces were neglected, but should be included during final design. Calculations for the lifting force of the gate are as follows:

Define: HP is motor horsepower, τ_m is motor torque, ω_m is motor speed, r_{gb} is the gearbox ratio, ε_{gb} is the gearbox efficiency, N_g is number of gear teeth, N_p is number of pinion teeth, ε_{og} is efficiency of open gears, D_d is pitch diameter of the drum, τ_d is the torque at the drum, D_s is diameter of sheave, D_b is diameter of bearing, and T_n is tension in a given cable segment.

Calculate motor torque:

$$\tau_m = 5250 * HP/\omega_m$$

$$\tau_m = 5250 * \frac{10hp}{1655rpm} = 31.72\ ft\ lbs$$

The torque coming out of the gearbox splits in two directions, one to each side of the gate. Torque at the gearbox is calculated below:

$$\tau_{gb} = \tau_m * \frac{(r_{gb} * \varepsilon_{gb})}{2}$$

$$\tau_{gb} = 31.72 * \frac{(400 * 0.97)}{2} = 6{,}154\ ft\ lbs$$

At the drum, there is a gear and pinion. The gear has 82 teeth and the pinion has 15. The assumed efficiency is 88%.

$$\tau_d = \tau_{gb} * \left(\frac{N_g}{N_p} * \varepsilon_{og}\right)$$

$$\tau_d = 6{,}154\ ft\ lbs * \left(\frac{82}{15} * 0.88\right) = 29{,}605\ ft\ lbs$$

Calculate tension in first, and highest loaded cable:

$$T_n = \tau_d / \frac{D_d}{2}$$

$$T_n = 29605\ ft\ lbs / (\frac{2.19\ ft}{2}) = 27{,}068\ lbs$$

Each subsequent cable tension is given by rearranging the equation:

$$T + \Delta T = T(\frac{D_s + \mu D_b}{D_s - \mu D_b})$$

Where T is the frictionless tension, and ΔT is the increased tension due to friction. $T + \Delta T$ becomes the cable pulling against the friction and T becomes the cable being pulled. Simplifying the constant:

$$\left(\frac{D_s + \mu D_b}{D_s - \mu D_b}\right) = \left(\frac{26.25 + 0.3 * 5}{26.25 - 0.3 * 5}\right) = 1.121$$

With the simplified tension equation, the other tensions are found:

$$\frac{T_n}{1.121} = T_{n+1}$$

$$T_2 = \frac{T_1}{1.121} = \frac{27{,}068\ lbs}{1.121} = 24{,}141\ lbs$$

$$T_3 = 21{,}532\ lbs$$
$$T_4 = 19{,}204\ lbs$$
$$T_5 = 17{,}128\ lbs$$
$$T_6 = 15{,}276\ lbs$$
$$T_7 = 13{,}625\ lbs$$
$$T_8 = 12{,}152\ lbs$$

Using a 6 part cable system, the last 6 cables tensions are used to hoist the gate. The other parts are used for alignment, see drawings.

Hoist capacity becomes two times the sum of the 6 hoisting cables, to account for both sides:

$$2 * (T_3 + T_4 + T_5 + T_6 + T_7 + T_8) = 197{,}830\ lbs$$

To calculate the maximum head that the machinery can operate with, conservatively assume the gate is fully submerged on both sides. The triangular pressure distribution is equal on both sides, and the equation simplifies to just the head differential multiplied by the area of the gate. The gate is equipped with rollers, which are on the river side of the gate, providing benefit when the gate is loaded from the land-side. The rubber seals are located on the land-side of the gate and only seal when loaded from the river-side, so will have no impact on this calculation.

Let F_h be the hoist capacity, F_f be the friction force applied to the gate, W be the weight of the gate, F_n be the normal force applied to the gate, μ be the weight of the gate, and A be the area of the gate.

Gate Width is 33.5', Gate Height is 23.0', Area A = 770.5 ft^2. Gate weight is W = 85,000 lbs.

$$F_h = F_f + W$$

$$F_f = F_h - W$$

$$\mu * F_n = F_h - W$$

$$\mu * (P * A) = F_h - W$$

$$\mu * (62.4 \frac{lbs}{ft^3} * h * A) = F_h - W$$

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$$h = \frac{F_h - W}{\mu * \left(62.4 \frac{lbs}{ft^3} * A\right)}$$

$$h = \frac{197{,}830\ lbs - 85{,}000\ lbs}{0.3 * (62.4 \frac{lbs}{ft^3} * 770\ ft^2)} = \frac{112{,}830\ lbs}{14{,}414 \frac{lbs}{ft}} = \mathbf{7.8ft}$$

3.2. Starkey Pump Station Condition Summary

Starkey (formerly Buchanan Street Pump Station) has 4 pumps that pump 24,500 GPM at 65 ft of head. The original pumps were replaced with Flygt submersible pumps in 2003. The pumps operate as sanitary and flood protection pumps. Because they operate very regularly, it is recommended that they are pulled and rebuilt.

3.3. Fourth Street Pump Station Condition Summary

Fourth Street pumping station has 3 flood protection pumps that operate at 31,580 GPM at 41.3 ft of head. New pumps have been installed around 2017, and no action is being recommended.

3.4. Fifth Street Pump Station Condition Summary

Fifth Street pumping station has 3 pumps that operate at 11,070 GPM at 5.9 ft of head and 1 pump that operates at 3,000 GPM at 28.16 ft of head. The pumps were installed in 1952. Due to the age of the pumps, it is recommended that the pumps are reconditioned or replaced. Due to the small size of the pumps, it is recommended that the flood pumps are replaced with submersible column pumps and the dewatering pump replaced with a submersible pump. Replacing the pumps will likely reduce contract time, simplify the contract, and reduce the likelihood of mods. Submersible column pumps are recommended because the relatively low installation cost and the ease of removal and installation for maintenance and repairs. The selected pumps should be able to be removed and reinstalled for maintenance while the station is in operation, and not affected by water levels. New pump columns will have to be installed for the submersible column pumps, and will connect into the current discharge piping at the flexible coupling within the wet well. The submersible dewatering pump will require new discharge piping installed up to the flexible coupling. In both cases, a new flexible coupling will be installed. The dewatering pump will require a new discharge elbow with rail guides that accommodate the installation and removal of the pump without unbolting the pump from the discharge elbow. The current crane has a 3 ton capacity and is believed to be in good condition. The new submersible pumps are estimated to be 3,100 lbs, which is well below the crane capacity. The crane hook height is 10’ 11”, while the tallest new pump will be 7’ 6”. Height considerations will have to be carried through to final pump selection and column design to ensure the pumps can be installed and removed with the current hoist. Phasing is not anticipated to be a concern, due to a relatively short removal and installation process, as long as no demolition begins until pumps are on-site and ready for installation.

3.5. Tenth Street Pump Station Condition Summary

Tenth Street pumping station has 3 pumps that operate at 19,950 GPM at 30 ft of head and 1 dewatering pump that operates at 1,530 GPM at 40.1 ft of head. All the pumps were installed in 1952. Due to the age of the pumps, it is recommended that the pumps be reconditioned or replaced. Due to

the small size of the pumps, it is recommended that the flood pumps are replaced with submersible column pumps and the dewatering pump replaced with a submersible pump. Replacing the pumps will likely reduce contract time, simplify the contract, and reduce the likelihood of mods. Submersible column pumps are recommended because the relatively low installation cost and the ease of removal and installation for maintenance and repairs. The selected pumps should be able to be removed and reinstalled for maintenance while the station is in operation, and not affected by water levels. The submersible column pumps will require new pump columns to connect into existing discharge pipe at the flexible couplings within the wet well. New flexible couplings will be installed. The submersible dewatering pump will require a new discharge elbow and some new discharge pipe to accommodate dimensions of support elbow. The discharge elbow will be the automatic connection type with rail guides to allow installation and removal without unbolting the pump from the discharge. The current crane has a 6 ton capacity and is believed to be in good condition. The new submersible pumps are estimated to be 8,000 lbs each, which is well below the crane capacity. The hoist hook height is 14' 2", while the taller pumps are 10' 6". The current crane should be capable of installation and removal of the selected pumps, but the height considerations should be carried forward through final design to ensure the crane is adequate. Phasing is not anticipated to be a concern, due to a relatively short removal and installation process, as long as no demolition begins until pumps are on-site and ready for installation.

3.6. Seventeenth Street Pump Station Condition Summary

Seventeenth Street pumping station has 3 pumps that operate at 11,400 GPM at 7.1 ft of head and 1 dewatering pump that operates at 1,300 GPM at 13.6 ft of head. All the pumps were installed in 1952. Due to the age of the pumps, it is recommended that the pumps be reconditioned or replaced. Due to the small size of the pumps, it is recommended that the flood pumps are replaced with submersible column pumps and the dewatering pump replaced with a submersible pump. Replacing the pumps will likely reduce contract time, simplify the contract, and reduce the likelihood of mods. Submersible column pumps are recommended because the relatively low installation cost and the ease of removal and installation for maintenance and repairs. The selected pumps should be able to be removed and reinstalled for maintenance while the station is in operation, and not affected by water levels. The submersible column pumps will require new pump columns to connect into the existing discharge pipe at the flexible couplings within the wet well. New flexible coupling will be installed. The dewatering pump will have a new discharge elbow and guides to facilitate removal without entering the wet well. New discharge piping from the pump elbow to the butterfly valve may be required to accommodate new dimensions of the discharge elbow. The current crane has a 4 ton capacity and is believed to be in good condition. The new submersible pumps are estimated to be 3,100 lbs each, which is well below the crane capacity. The crane hook height is 11', while the taller pumps are 7' 6". The crane adequate for the current pump selection, but height considerations should be carried forward through final design to ensure the crane is adequate. Phasing is not anticipated to be a concern, due to a relatively short removal and installation process, as long as no demolition begins until pumps are on-site and ready for installation.

3.7. Twenty-Seventh Street Pump Station Condition Summary

Twenty-Seventh Street pumping station has 4 pumps that operate at 40,000 GPM at 31.5 ft of head and 1 dewatering pump that operates at 5,710 GPM at 32 ft of head. All the pumps were installed in 1952. Due to the age of the pumps, it is recommended that the pumps be reconditioned or replaced. Due to the relatively small size of the pumps, it is recommended that the flood pumps are replaced with submersible column pumps and the dewatering pump replaced with a submersible pump. Replacing the pumps will likely reduce contract time, simplify the contract, and reduce the likelihood of mods. Submersible column pumps are recommended because the relatively low installation cost

and the ease of removal and installation for maintenance and repairs. The selected pumps should be able to be removed and reinstalled for maintenance while the station is in operation, and not affected by water levels. The new submersible column pumps will require new pump columns to connect into the existing discharge piping at the flexible couplings within the wet well. The new dewatering pump will have a new discharge elbow with guide rails to facilitate removal of the pump without entering the wet well. New discharge piping for the dewatering pump will be installed to accommodate placement of the pump. The new discharge piping will tie into the existing at the flexible coupling nearest the wall penetration, and all flexible couplings will be replaced. The current crane has a 10 ton capacity, a hook height of 17' and is believed to be in good condition. The new submersible pumps are estimated to be 9,100 lbs each, and are 11' 3". The current crane is capable of installation and removal of the new pumps, but limitations should be carried through design to ensure current crane is sufficient for the final design. Phasing is not anticipated to be a concern, due to a relatively short removal and installation process, as long as no demolition begins until pumps are on-site and ready for installation.

3.8. Thirty-Fourth Street Pump Station Condition Summary

Thirty-Fourth Street pumping station has 4 pumps that operate at 15,600 GPM at 34 ft of head. The pumps were installed in 1951. Due to the age of the pumps, it is recommended that the pumps be reconditioned or replaced. Due to the relatively small size of the pumps, it is recommended that the flood pumps are replaced with submersible column pumps. Replacing the pumps will likely reduce contract time, simplify the contract, and reduce the likelihood of mods. Submersible column pumps are recommended because the relatively low installation cost and the ease of removal and installation for maintenance and repairs. The selected pumps should be able to be removed and reinstalled for maintenance while the station is in operation, and not affected by water levels. New pump columns will be installed and connected to the existing discharge pipe at the flexible couplings, and new flexible couplings will be installed. The current crane has a 5 ton capacity, 13' 4" hook height, and is believed to be in good condition. The new submersible pumps are estimated to be 7,250 lbs each, and a height of 10'. The crane is capable of installing and removing the selected pumps, but the limitations should be considered during design to ensure that pump selection during the final design does not exceed the crane's capacities. Phasing is not anticipated to be a concern, due to a relatively short removal and installation process, as long as no demolition begins until pumps are on-site and ready for installation.

3.9. Shawnee Park Pump Station Condition Summary

Shawnee Park has 7 pumps that were installed in 1951. The flood pumps are designed for 103,500 GPM at 20.9 ft of head. Pump 1 is designed for 9,000 GPM at 8.7 ft of head. The dewatering pump is designed for 800 GPM at 54 ft of head. Due to the age of the pumps, it is recommended that all pumps are reconditioned or replaced. It is recommended that pump 1 is replaced with a submersible column pump, pump 7 replaced with a submersible pump, and pumps 2-6 reconditioned. Pumps 2-6 are too large to be replaced with submersible column pumps, and replacing in-kind would likely be costlier with similar contract times. A new column will be installed for pump 1, which will be connected into the existing discharge pipe the flexible coupling nearest the pump and the flexible coupling will be replaced. The overhead crane has a 24 ton capacity and a 16' 4" hook height, which is capable of installation and removal of the new pumps. Phasing was not heavily considered during this analysis, but will need to be looked into further during design. Pump reconditioning will need to be phased to maintain a minimum pumping capacity. Seasonal weather effects and refurbishment times will need to be considered when making a phasing schedule.

3.10. Western Parkway Pump Station Condition Summary

Western Parkway pumping station has 7 pumps that were replaced in 2012. Pumps 1-3 pump 54,000 GPM at 19 ft of head. Pumps 4-7 pump 162,000 GPM at 20.5 ft of head. Due to the recent replacement and regular maintenance, no action is being recommended.

3.11. Paddy's Run Pump Station Condition Summary

Paddy's Run pumping station has 6 pumps installed in 1953. Pumps 1-2 operate at 60,750 GPM at 55.3 ft of head. Pumps 3-6 operate at 121,500 GPM at 29.9 ft of head. The pumps and pump columns are in very poor condition. Some columns are noted to have holes completely through the column. During the 2018 event, one pump had an unplanned outage due to mechanical failure. Due to the age and deterioration, it is recommended that completely new pumps are fabricated and installed. All the pumps are too large to consider submersible pumps, and will need new column pumps. It is recommended that a centralized automatic greaser be installed to grease all the pumps in order to reduce the amount of manual greasing.

The trash rake (trash crane) at Paddy's Run has rust covering the entire system. The mechanical and electrical components on the rake have failed and the rake has been out of service for an extended period of time. It is assumed that a full replacement of the entire trash rake will be necessary to get the station back to being fully operational as per the original design. Because the trash rake has been out of service for an extended period, it should be investigated during design to determine how critical the trash rake is to the station's performance, and, if necessary, what the best method for refurbishment/replacement is.

3.12. Riverport Pump Station Condition Summary

Riverport pumping station has 3 pumps sized for 28,050 GPM at 42.2 ft of head. The pumps were installed in 1981. The station is seldom used and well maintained. Due to the good condition and low usage, no action is being recommended for this station.

3.13. Lower Mill Creek Pump Station Condition Summary

Lower Mill Creek pumping station has 3 pumps sized for 73,500 GPM at 47.1 ft of head. The pumps were installed in 1980. The pumps have exceeded the minimum design life of 35 years, so it is recommended that they are disassembled and rebuilt to the manufacturer's original specifications. A new centralized greasing system is being recommended to automate greasing at regular intervals during operation. Phasing was not heavily considered during this analysis, but will need to be looked into further during design. Pump reconditioning will need to be phased to maintain a minimum pumping capacity. Seasonal weather effects and refurbishment times will need to be considered when making a phasing schedule.

3.14. Upper Mill Creek Pump Station Condition Summary

Upper Mill Creek pumping station has 3 pumps sized for 173,000 GPM at 48.6 ft of head. The pumps were installed in 1983. The pumps have exceeded the minimum design life of 35 years, so it is recommended that they are disassembled and rebuilt to the manufacturer's original specifications. A new centralized greasing system is being recommended to automate greasing at regular intervals during operation. Phasing was not heavily considered during this analysis, but will need to be looked

into further during design. Pump reconditioning will need to be phased to maintain a minimum pumping capacity. Seasonal weather effects and refurbishment times will need to be considered when making a phasing schedule.

3.15. Pond Creek Pump Station Condition Summary

Pond Creek pumping station has 4 pumps sized for 460,000 GPM at 36 ft of head. The pumps were installed in 1988. The pumps are nearing the end of the minimum design life. During the 2018 event, the suction bell from pump 1 fell to the floor and pump 2 vibrated excessively. There have been problems with unplanned outages due to the bell in 2011 and 2015 as well. There has been some documentation of the excessive vibration causing damages to the concrete at the support connection. MSD is currently repairing pump 2. It is recommended that pumps 1, 3 and 4 are disassembled and rebuilt to ensure they function for another 35 years. It is also recommended that the capability to trend bearing temperatures, vibration readings, and ponding elevation be added to all pumps to provide data necessary to optimize the life of the pumps. To address the excessive vibration while still maintaining the ability to pump down to the current pump stop elevation, a Formed Suction Intake (FSI) is being recommended for all pumps. Phasing was not heavily considered during this analysis, but will need to be looked into further during design. Pump reconditioning will need to be phased to maintain a minimum pumping capacity. Seasonal weather effects and refurbishment times will need to be considered when making a phasing schedule.

3.16. Gate Condition Summary

Most sluice gates were operated during the 2019 PI. The interior drainage sluice gates were given an overall rating of minimally acceptable due to some gates having corrosion leading to section loss. Gates listed for refurbishment have a heavily corroded gate and/or frame and will need further inspection to determine extent of section loss and damage. Further inspection to refine scope may be necessary during design. Recommended actions for sluice gates are listed below:

Table 3-1: Gate condition summary

Gate Number	Gate Size	Gate Type	Actuator Type	Modification
3	102”x102”	Sluice	Electric	Refurbish and replace missing railing
6A	60"x60"	Sluice	Manual	Replace stem
9	42"	Flapgate	Flapgate	Repair the concrete gate structure
16	162”x114”	Flapgate	Flapgate	Refurbish and realign gate
16C	15”	Flapgate	Flapgate	Replace rebar & patch concrete
22	60”x60”	Sluice	T-handle	Patch Concrete, replace ladder rungs
24	20"	Sluice	T-handle	Remove & replace entire gate
30	60"x60"	Sluice	T-handle	Replace actuator/gearbox, refurbish gate
36	36"	Sluice	T-handle	Replace gate due to heavy corrosion and poor seal condition
39	36”	Sluice	T-handle	Refurbish Gate
49	16"	Sluice	T-handle	Replace Gate
63	15”	Flapgate	Flapgate	Replace Gate
64	96”	Sluice		Refurbish Gate
69	24"	Flapgate	Flapgate	Replace Gate
70	60”x60”	Sluice		Refurbish Gate
79	12"	Sluice	T-handle	Replace the entire gate

85	132”x144”	Sluice		Refurbish Gate
86	2-5' x5'	Sluice	T-handle	Replace actuator
91	5' x5'	Sluice	T-handle	Replace actuator
94	18"	Sluice	T-handle	Replace Gate
95	18"	Sluice	T-handle	Replace Gate
96	15"	Sluice	T-handle	Replace Gate
97	15"	Sluice	T-handle	Replace Gate
98	12"	Sluice	T-handle	Replace Gate
102	10' x 14'	Sluice	Electric	Heavily Rusted, Refurbish/Replace
103	8' x 8'	Sluice	Electric	Heavily Rusted, Refurbish
107	12”	Flapgate	Flapgate	Repair the concrete gate structure
109	18"	Sluice	N/A	Replace Gate
122	7' X 7'	Sluice	Electric	Heavily rusted, Refurbish. Repair/Replace Actuator
138	6'x 6'	Sluice	Electric	Repair/Replace Actuator
139	78" x 78"	Sluice	Electric	Replace actuator
140	54"	Sluice	Electric	Replace actuator
141	36" x 36"	Sluice	Electric	Replace actuator
142	30" x 30"	Sluice	Electric	Replace actuator
143	48" x 48"	Sluice	Electric	Replace actuator
144	36" x 36"	Sluice	Electric	Refurbish/replace gate. Replace actuator
146	42" x 42"	Sluice	Electric	Replace actuator
147	8' x 8'	Sluice	Electric	Replace actuator
149	48" x 48"	Sluice	Electric	Replace actuator

te Number	**Gate Size**	**Gate Type**	**Actuator Type**	**Modification**
3	102”x102”	Sluice	Electric	Refurbish and replace missing railing
6A	60"x60"	Sluice	Manual	Replace stem
9	42"	Flapgate	Flapgate	Repair the concrete gate structure
16	162”x114”	Flapgate	Flapgate	Refurbish and realign gate
16C	15”	Flapgate	Flapgate	Replace rebar & patch concrete
22	60”x60”	Sluice	T-handle	Patch Concrete, replace ladder rungs
24	20"	Sluice	T-handle	Remove & replace entire gate
30	60"x60"	Sluice	T-handle	Replace actuator/gearbox, refurbish gate
36	36"	Sluice	T-handle	Replace gate due to heavy corrosion and poor seal condition
39	36”	Sluice	T-handle	Refurbish Gate
49	16"	Sluice	T-handle	Replace Gate
63	15”	Flapgate	Flapgate	Replace Gate
64	96”	Sluice		Refurbish Gate
69	24"	Flapgate	Flapgate	Replace Gate
70	60”x60”	Sluice		Refurbish Gate
79	12"	Sluice	T-handle	Replace the entire gate
85	132”x144”	Sluice		Refurbish Gate
86	2-5' x5'	Sluice	T-handle	Replace actuator

91	5' x5'	Sluice	T-handle	Replace actuator
94	18"	Sluice	T-handle	Replace Gate
95	18"	Sluice	T-handle	Replace Gate
96	15"	Sluice	T-handle	Replace Gate
97	15"	Sluice	T-handle	Replace Gate
98	12"	Sluice	T-handle	Replace Gate
102	10' x 14'	Sluice	Electric	Heavily Rusted, Refurbish/Replace
103	8' x 8'	Sluice	Electric	Heavily Rusted, Refurbish
107	12”	Flapgate	Flapgate	Repair the concrete gate structure
109	18"	Sluice	N/A	Replace Gate
122	7' X 7'	Sluice	Electric	Heavily rusted, Refurbish. Repair/Replace Actuator
138	6'x 6'	Sluice	Electric	Repair/Replace Actuator
139	78" x 78"	Sluice	Electric	Replace actuator
140	54"	Sluice	Electric	Replace actuator
141	36" x 36"	Sluice	Electric	Replace actuator
142	30" x 30"	Sluice	Electric	Replace actuator
143	48" x 48"	Sluice	Electric	Replace actuator
144	36" x 36"	Sluice	Electric	Refurbish/replace gate. Replace actuator
146	42" x 42"	Sluice	Electric	Replace actuator
147	8' x 8'	Sluice	Electric	Replace actuator
149	48" x 48"	Sluice	Electric	Replace actuator

3.17. Submersible Pump Selection

Initial selections were made to verify pumps were available to meet the project intent. Selection is used for feasibility estimations only. There will be other considerations that will need to be addressed during the design phase to optimize the pump selection and ensure a long operating life. The Sponsor has expressed interest in attempting to standardize the pumps as much as is feasible across the pump stations. It should be feasible for Fifth Street and Seventeenth Street pumping stations to use interchangeable pumps with minimal oversizing and changes. It may be possible for Thirty-Fourth Street and Tenth Street to use interchangeable pumps, but would need to be scrutinized in detail during design.

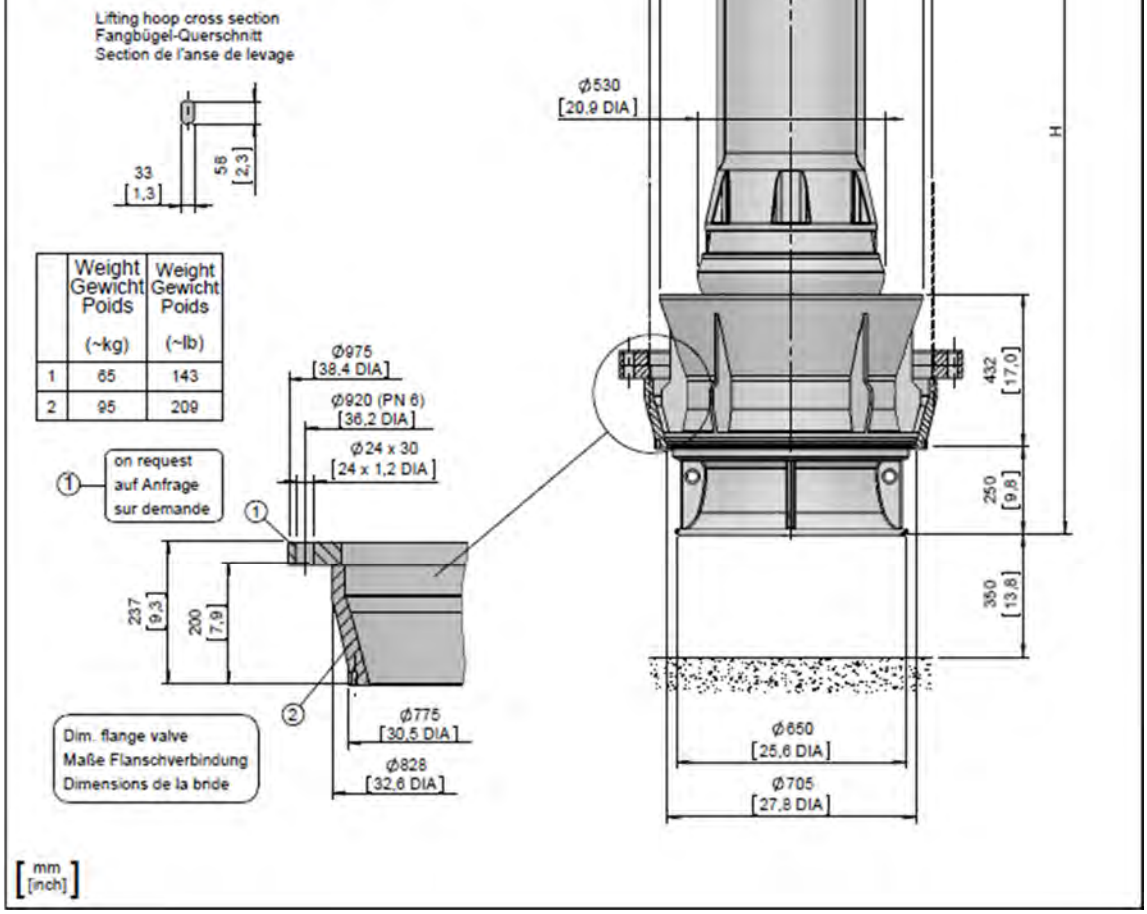
3.17.1. Fifth Street Pump Station, Pumps 1-3

No: M-10.2112 - 06	2	VUPX 0601/2
Dat/Nam.: 26.09.2016 / K. Srb		Dimension sheet PE5
Cad Code: M_102112		Maßblatt PE5
Technical changes reserved Änderungen vorbehalten Sous réserve de modifications		Plan d'encombrement PE5

SULZER

Type Typ Type 50Hz	Type Typ Type 60Hz	Weight Gewicht Poids		H		Size
		(~kg)	(~lb)	(mm)	(inch)	
PE 450/6		1245	2745	2168	85.4	A
PE 550/6		1335	2944	2288	90.1	B
PE 750/6		1425	3142			
PE 900/6		1470	3241			
PE 1090/6		1470	3241			
PE 370/8	PE 430/8-60	1270	2800	2168	85.4	A
PE 450/8	PE 520/8-60	1370	3021	2288	90.1	B
PE 550/8	PE 630/8-60	1415	3120			
PE 750/8	PE 860/8-60	1460	3219			
PE 300/10	PE 350/10-60	1395	3076			
PE 370/10	PE 430/10-60	1440	3175			
	PE 520/10-60	1485	3274			
	PE 630/10-60	1485	3274			

Weight: Includes pump and 10m cable
Gewicht: Beinhaltet Pumpe und 10m Kabel
Poids: Pompe et 10m de câble
For different cable length see IOM, chapter 1.5
Für abweichende Kabellänge siehe EBA, Kapitel 1.5
Pour des longueurs supérieures, voir la section 1.5 du manuel



	Weight Gewicht Poids (~kg)	Weight Gewicht Poids (~lb)
1	65	143
2	95	209

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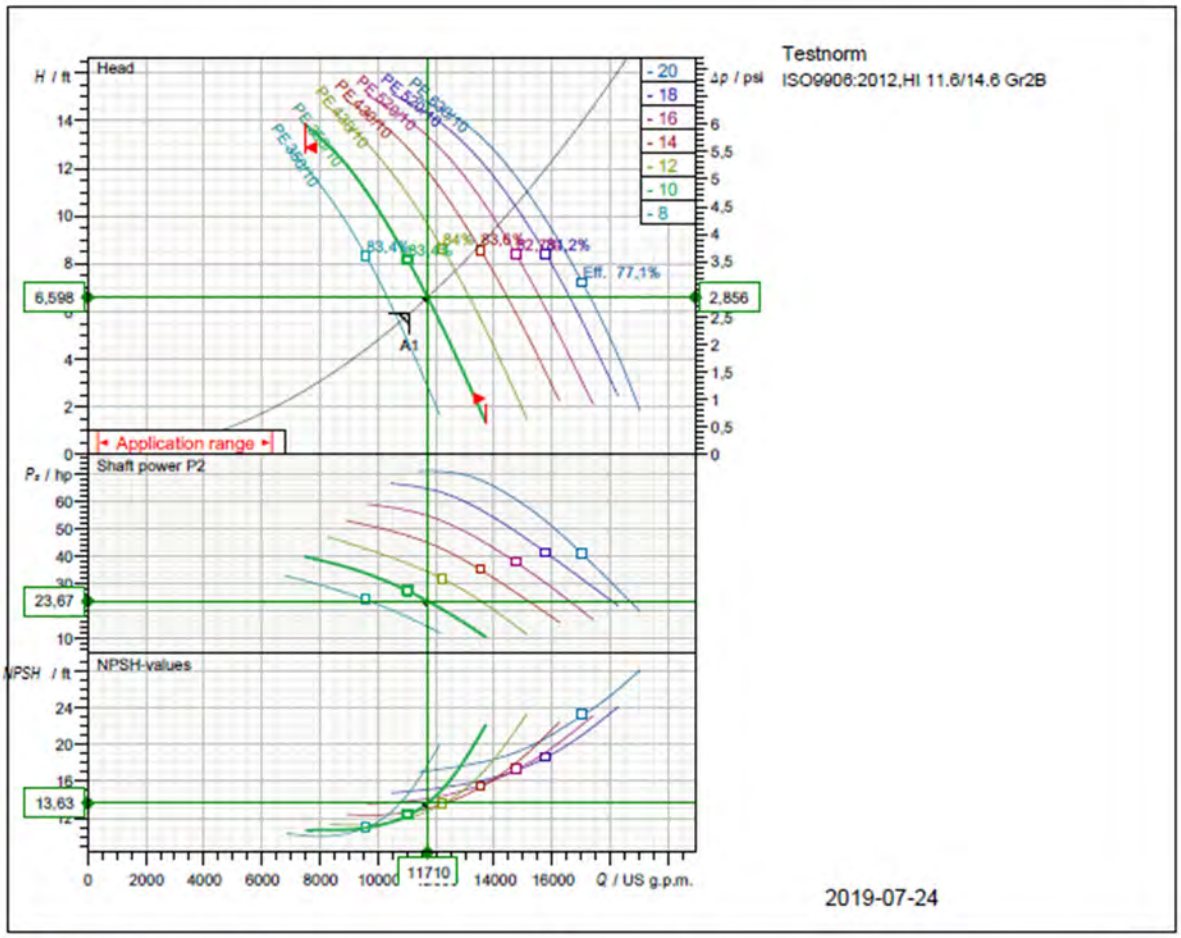
SULZER

VUPX 0601 60 HZ



Operating data specification			
Flow	11700 US g.p.m.	Power input	25,5 hp
Efficiency	82,3 %	Head	6,6 ft
NPSH	13,6 ft	Rated power	23,7 hp
Temperature	68 °F	Fluid	Water
No. of pumps	1	Nature of system	Single head pump
Pump data			
Type	VUPX 0601 60 HZ	Make	SULZER
Series	VUPX	Impeller	Propeller
N° of vanes	3	Impeller size	21,3 inch
Free passage	6,57 inch	Suction flange	
Discharge flange	DN800	Type of installation	
Moment of inertia	14,9 lb ft²		installation with steel riser pipe PE
Motor data			
Rated voltage	480 V	Frequency	60 Hz
Rated power P2	46,9 hp	Nominal Speed	708 rpm
Number of poles	10	Efficiency	93,2 %
Power factor	0,766	Rated current	59 A
Starting current	407 A	Rated torque	348 lbf ft
Starting torque	592 lbf ft	Degree of protection	IP 68
Insulation class	H(140)	No. starts per hour	10

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Data version Jan 2019

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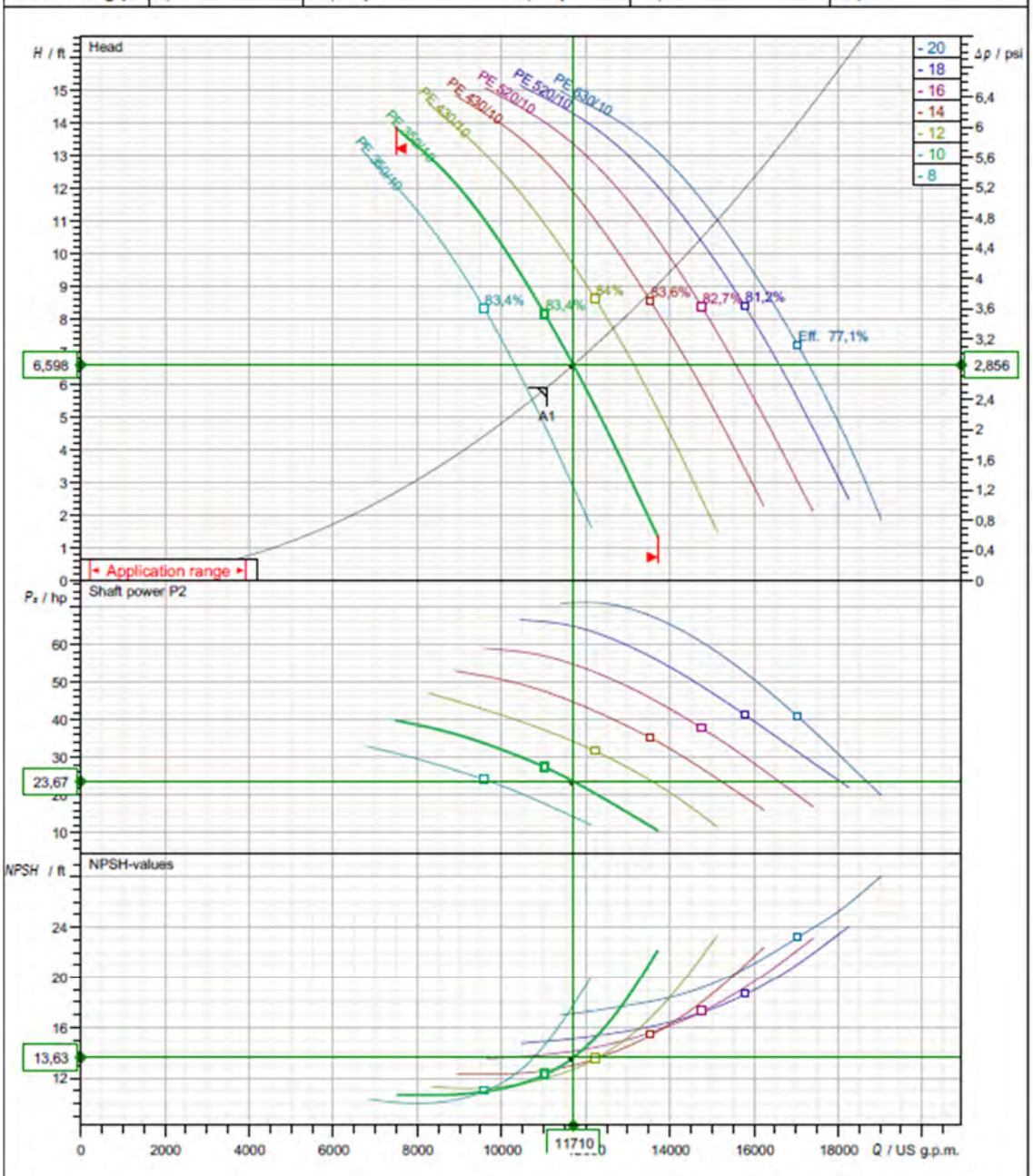
Curve number	Pump performance curves	SULZER
Reference curve VUP 0601 60 HZ	VUPX 0601 60 HZ	

				Discharge DN800	Frequency 60 Hz
Density 62,32 lb/ft³	Viscosity 1,082E-5 ft²/s	Testnorm ISO9906:2012,HI 11.6/14.6 Gr2B		Rated speed 713,8 rpm	Date 2019-07-24
Flow 11700 US g.p.n	Head 6,6 ft	Rated power 23,7 hp	Power input 25,5 hp	Hydraulic efficiency 82,3 %	NPSH 13,6 ft



Impeller size	N° of vanes	Impeller	Solid size	Revision
21,3 inch	3	Propeller	6,57 inch	

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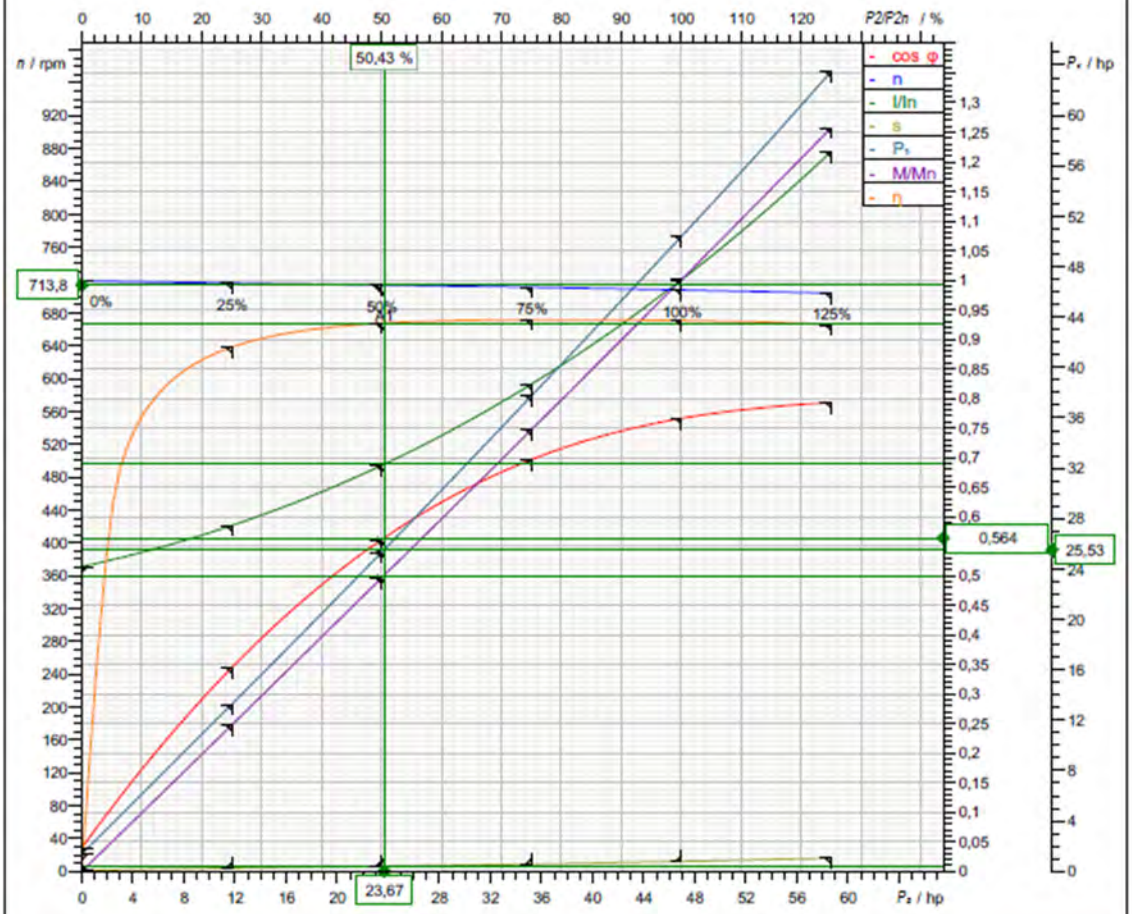
Frequency	PE5
60 Hz	

Motor performance curve

PE 350/10

SULZER

Rated power	Service factor	Nominal Speed	Number of poles	Rated voltage	Date
46,9 hp	1,3	708 rpm	10	480 V	2019-07-24



Symbol	No load	25 %	50 %	75 %	100 %	125 %
P_2 / hp	0	11,73	23,47	35,2	46,94	58,67
P_1 / hp	1,355	13,24	25,32	37,73	50,38	63,48
η / %	0	88,64	92,7	93,3	93,17	92,42
n / rpm	719	716,1	713,8	711,2	707,9	704
cos φ	0,03997	0,3441	0,5607	0,6963	0,7659	0,793
I / A	30,4	34,5	40,5	48,6	59	71,8
s / %	0,1416	0,5418	0,8609	1,222	1,68	2,219
M / lbf ft	0	86,06	172,7	260	348,2	437,7

Tolerance according to VDE 0530 T1 12.84 for rated power

Starting current	Starting torque	Moment of inertia	No. starts per hour
407 A	592 lbf ft	48,4 lb ft²	10

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Data version Jan 2019

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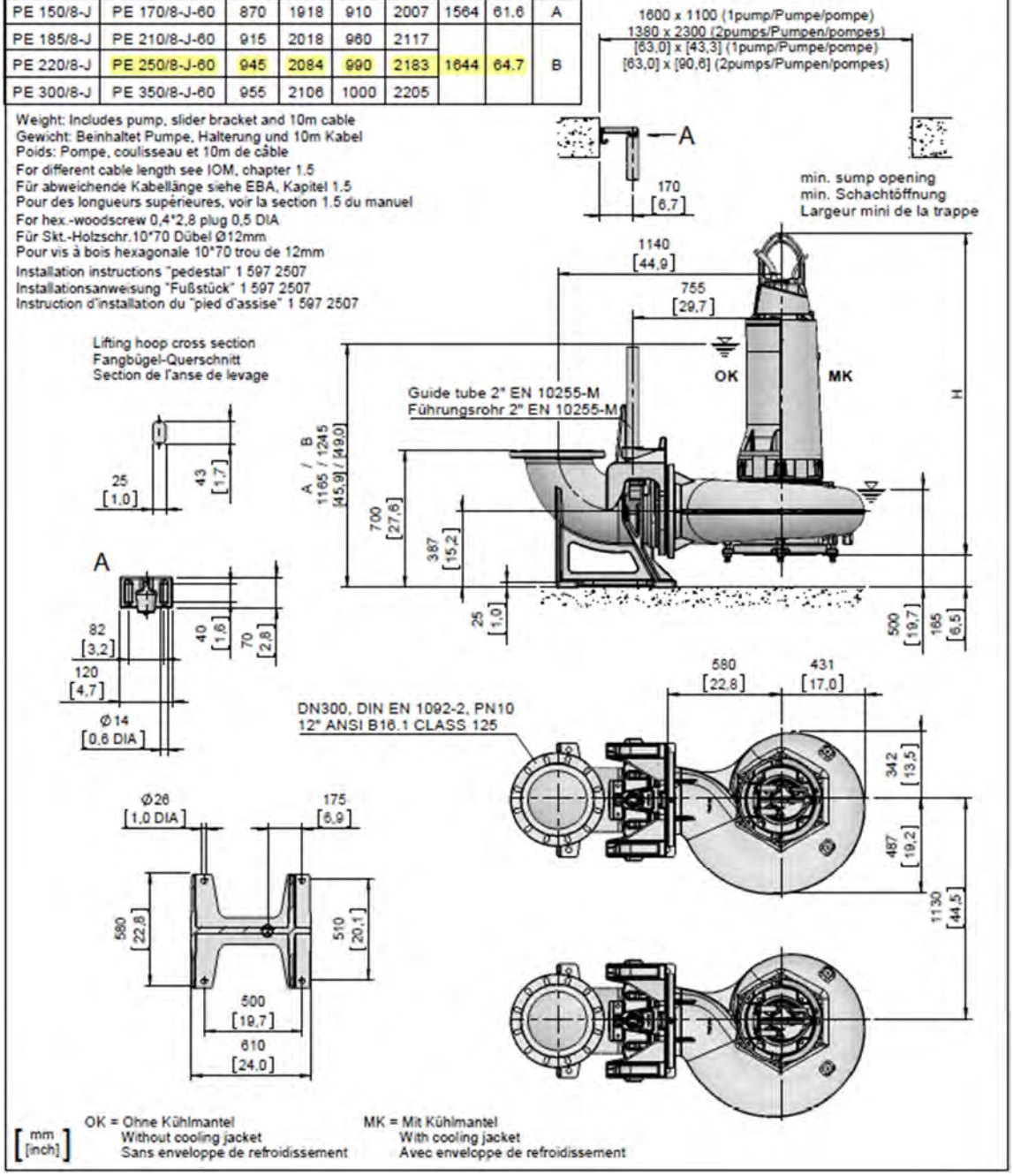
3.17.2. Fifth Street Pump Station, Pump 4

No: M-02.2876 - 02	2	XFP 305J-CB2
Dat/Nam.: 19.04.2016 / K. Srb		Dimension sheet PE4 WET WELL Installation
Cad Code: M_022876		Maßblatt PE4 Nassinstallation
Technical changes reserved Änderungen vorbehalten Sous réserve de modifications		Plan d'encombrement PE4 installation submersible

SULZER

Type Typ Type 50Hz	Type Typ Type 60Hz	Weight Gewicht Poids OK		Weight Gewicht Poids MK		H		Size
		(~kg)	(~lb)	(~kg)	(~lb)	(mm)	(inch)	
PE 185/6-J		855	1885	895	1973	1564	61.6	A
PE 220/6-J	PE 250/6-J-60	895	1973	935	2062			
PE 300/6-J	PE 350/6-J-60	945	2084	990	2183	1644	64.7	B
PE 370/6-J	PE 430/6-J-60	955	2106	1000	2205			
PE 150/8-J	PE 170/8-J-60	870	1918	910	2007	1564	61.6	A
PE 185/8-J	PE 210/8-J-60	915	2018	960	2117			B
PE 220/8-J	PE 250/8-J-60	945	2084	990	2183	1644	64.7	
PE 300/8-J	PE 350/8-J-60	955	2106	1000	2205			

Weight: Includes pump, slider bracket and 10m cable
Gewicht: Beinhaltet Pumpe, Halterung und 10m Kabel
Poids: Pompe, coulisseau et 10m de câble
For different cable length see IOM, chapter 1.5
Für abweichende Kabellänge siehe EBA, Kapitel 1.5
Pour des longueurs supérieures, voir la section 1.5 du manuel
For hex.-woodscrew 0,4*2,8 plug 0,5 DIA
Für Skt.-Holzschr.10*70 Dübel Ø12mm
Pour vis à bois hexagonale 10*70 trou de 12mm
Installation instructions "pedestal" 1 597 2507
Installationsanweisung "Fußstück" 1 597 2507
Instruction d'installation du "pied d'assise" 1 597 2507



[mm / [inch]]

OK = Ohne Kühlmantel
Without cooling jacket
Sans enveloppe de refroidissement

MK = Mit Kühlmantel
With cooling jacket
Avec enveloppe de refroidissement

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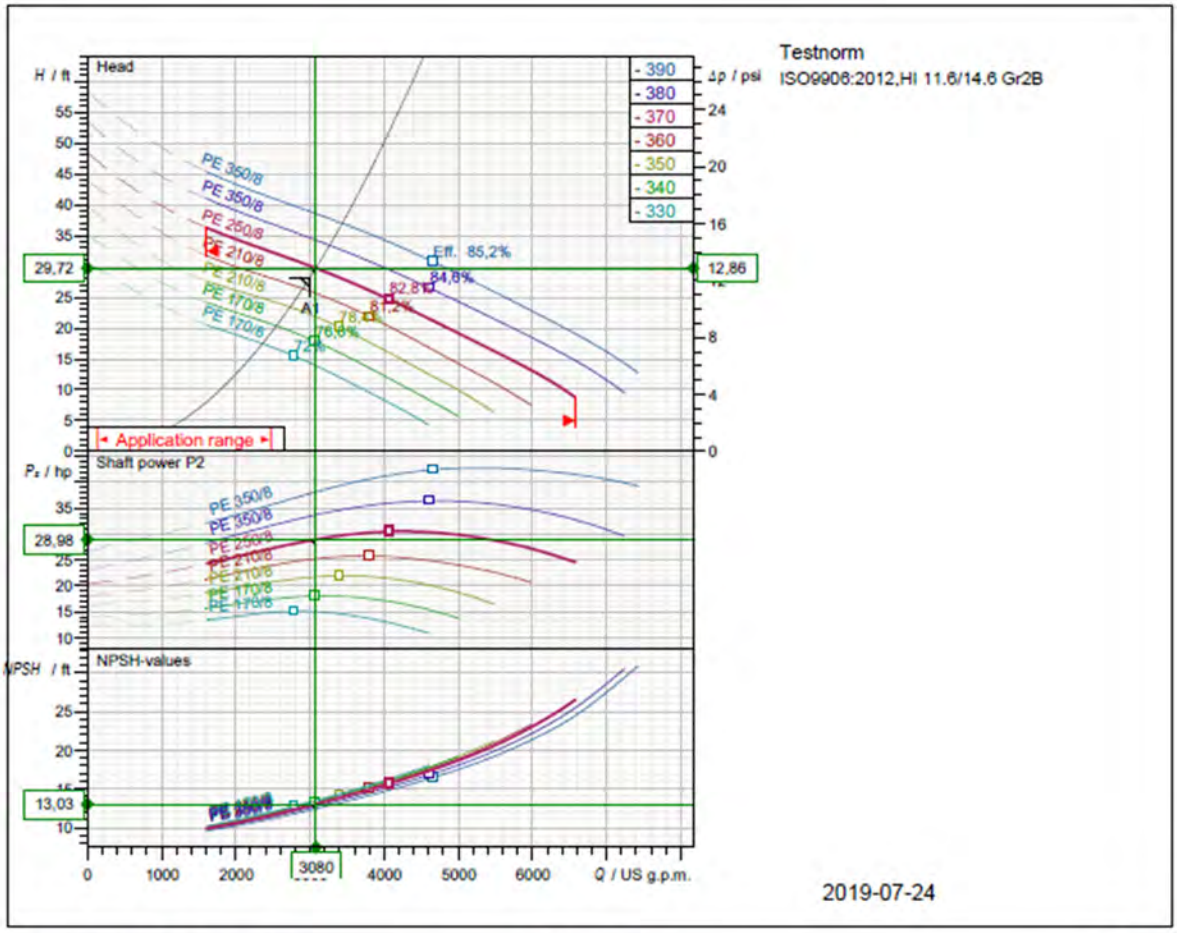
SULZER

XFP 305J-CB2 60 HZ



Operating data specification			
Flow	3080 US g.p.m.	Power input	31,7 hp
Efficiency	79,9 %	Head	29,7 ft
NPSH	13 ft	Rated power	29 hp
Temperature	68 °F	Fluid	Water
No. of pumps	1	Nature of system	Single head pump
Pump data			
Type	XFP 305J-CB2 60 HZ	Make	SULZER
Series	XFP PE4-PE7	Impeller	Contrablock Plus impeller
N° of vanes	2	Impeller size	14,6 inch
Free passage	4,72 x 6,3 inch	Suction flange	DN300
Discharge flange	DN300	Type of installation	wet well vertical installation 2"
Moment of inertia			
Motor data			
Rated voltage	480 V	Frequency	60 Hz
Rated power P2	33,5 hp	Nominal Speed	884 rpm
Number of poles	8	Efficiency	91,4 %
Power factor	0,741	Rated current	43,4 A
Starting current	221 A	Rated torque	199 lbf ft
Starting torque	378 lbf ft	Degree of protection	IP 68
Insulation class	H(140)	No. starts per hour	10

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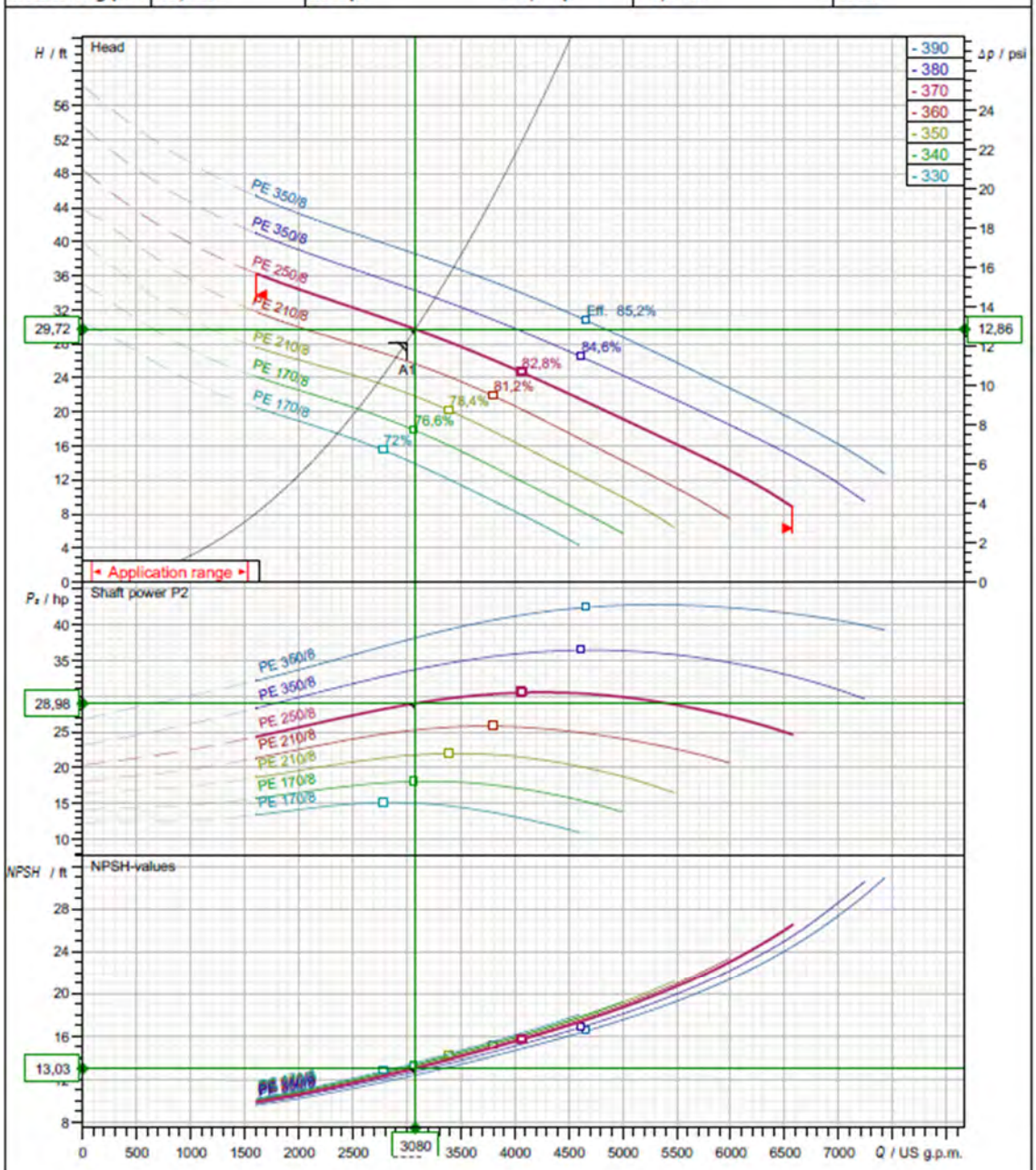
Curve number	Pump performance curves	SULZER
Reference curve XFP 305J-CB2 60 HZ	**XFP 305J-CB2 60 HZ**	

				Discharge DN300	Frequency 60 Hz
Density 62,32 lb/ft³	Viscosity 1,082E-5 ft²/s	Testnorm ISO9906:2012,HI 11.6/14.6 Gr2B		Rated speed 886,6 rpm	Date 2019-07-24
Flow 3080 US g.p.m.	Head 29,7 ft	Rated power 29 hp	Power input 31,7 hp	Hydraulic efficiency 79,9 %	NPSH 13 ft



Impeller size	N° of vanes	Impeller	Solid size	Revision
14,6 inch	2	Contrablock Plus impeller	4,72 x 6,3 inch	

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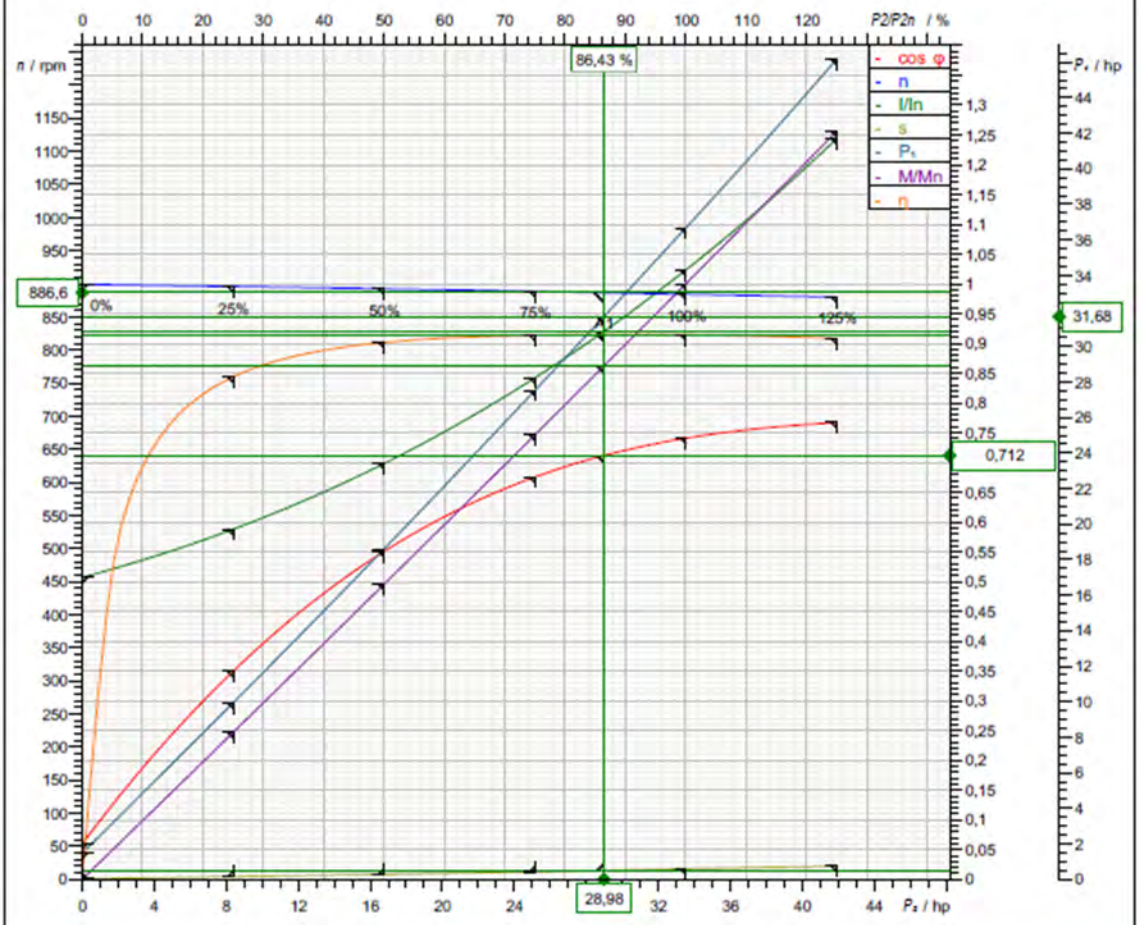
Frequency	PE4
60 Hz	

Motor performance curve

PE 250/8

SULZER

Rated power	Service factor	Nominal Speed	Number of poles	Rated voltage	Date
33,5 hp	1,3	884 rpm	8	480 V	2019-07-24



Symbol	No load	25 %	50 %	75 %	100 %	125 %
P_2 / hp	0	8,381	16,76	25,14	33,53	41,91
P_1 / hp	1,471	9,934	18,59	27,52	36,67	46,16
η / %	0	84,37	90,15	91,36	91,43	90,78
n / rpm	899	895,8	892,4	888,6	884,2	880
cos φ	0,05995	0,3493	0,5505	0,6755	0,7407	0,7671
I / A	22	25,51	30,3	36,54	44,4	53,98
s / %	0,1063	0,4687	0,8404	1,271	1,754	2,227
M / lbf ft	0	49,14	98,66	148,6	199,1	250,1

Tolerance according to VDE 0530 T1 12.84 for rated power

Starting current	Starting torque	Moment of inertia	No. starts per hour
221 A	378 lbf ft	13,6 lb ft²	10

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Data version Jan 2019

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3.17.3. Tenth Street Pump Station, Pump 1

No: M-02.2814 - 01	2	XFP 206J-CB2
Dat/Nam.: 11.04.2016 / K. Srb		Dimension sheet PE4 WET WELL Installation dual guide rail 2"
Cad Code: M_022814		Maßblatt PE4 Nassinstallation Zwei-Rohrführung 2"
Technical changes reserved Änderungen vorbehalten Sous réserve de modifications		Plan d'encombrement PE4 installation submersible Double barre de guidage 2"

SULZER

Type Typ Type 50Hz	Type Typ Type 60Hz	Weight Gewicht Poids OK		Weight Gewicht Poids MK		H		Size
		(~kg)	(~lb)	(~kg)	(~lb)	(mm)	(inch)	
PE 300/4-J		680	1499	720	1588	1481	58.3	A
PE 370/4-J		715	1577	760	1676	1561	61.5	B
PE 450/4-J		745	1643	790	1742			
PE 185/6-J	PE 210/6-J-60	650	1433	690	1521	1481	58.3	A
PE 220/6-J	PE 250/6-J-60	690	1521	730	1610			
PE 300/6-J	PE 350/6-J-60	740	1632	785	1731	1561	61.5	B
PE 370/6-J	PE 430/6-J-60	750	1654	795	1753			

Weight: Includes pump, slider bracket and 10m cable
Gewicht: Beinhaltet Pumpe, Halterung und 10m Kabel
Poids: Pompe, coulisseau et 10m de câble
For different cable length see IOM, chapter 1.5
Für abweichende Kabellänge siehe EBA, Kapitel 1.5
Pour des longueurs supérieures, voir la section 1.5 du manuel
For hex.-woodscrew 0,4*2,8 plug 0,5 DIA
Für Skt.-Holzschr.10*70 Dübel Ø12mm
Pour vis à bois hexagonale 10*70 trou de 12mm
Installation instructions "pedestal" 1 597 2507
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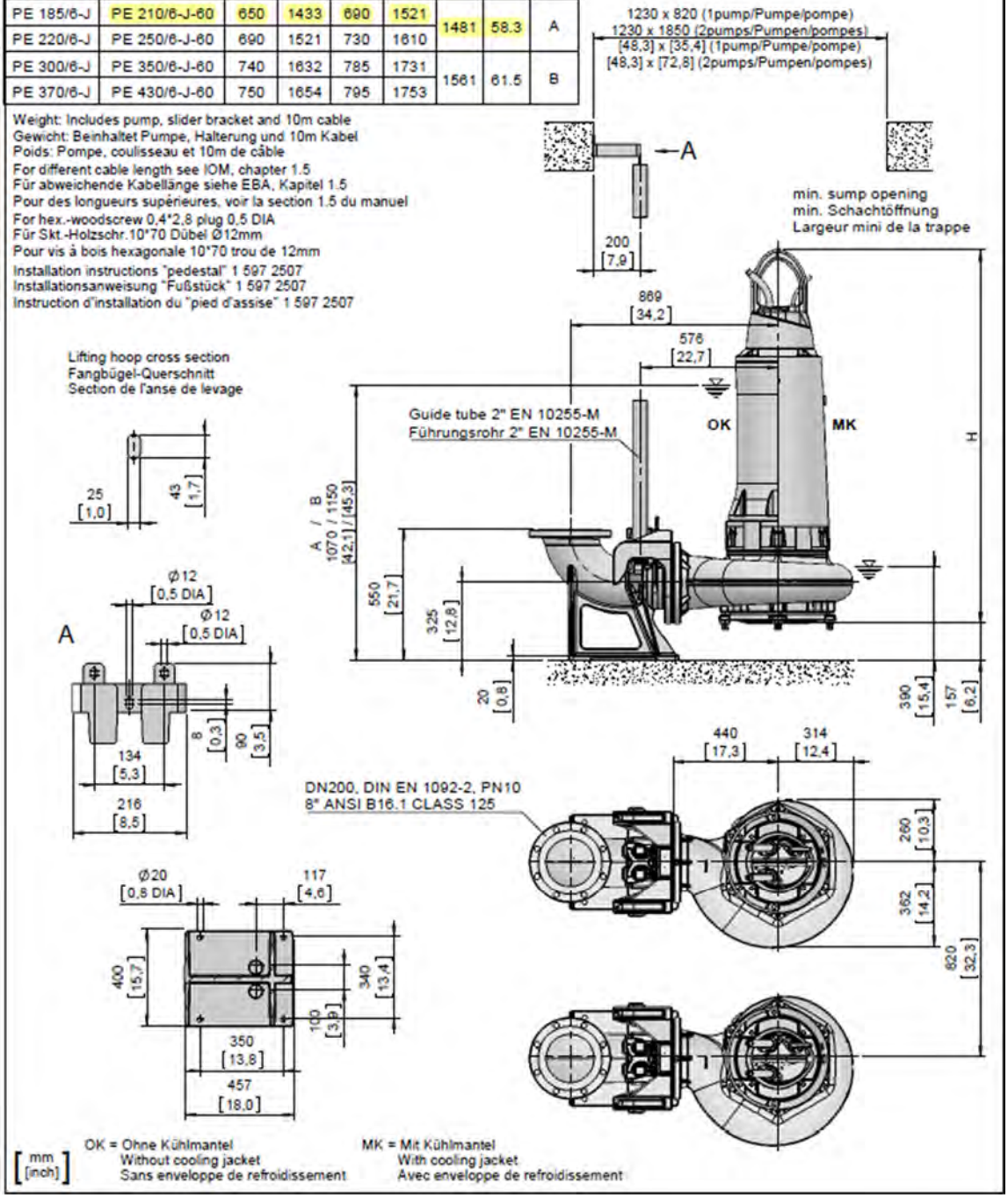
Instruction d'installation du "pied d'assise" 1 597 2507



[mm / [inch]]

OK = Ohne Kühlmantel
Without cooling jacket
Sans enveloppe de refroidissement

MK = Mit Kühlmantel
With cooling jacket
Avec enveloppe de refroidissement

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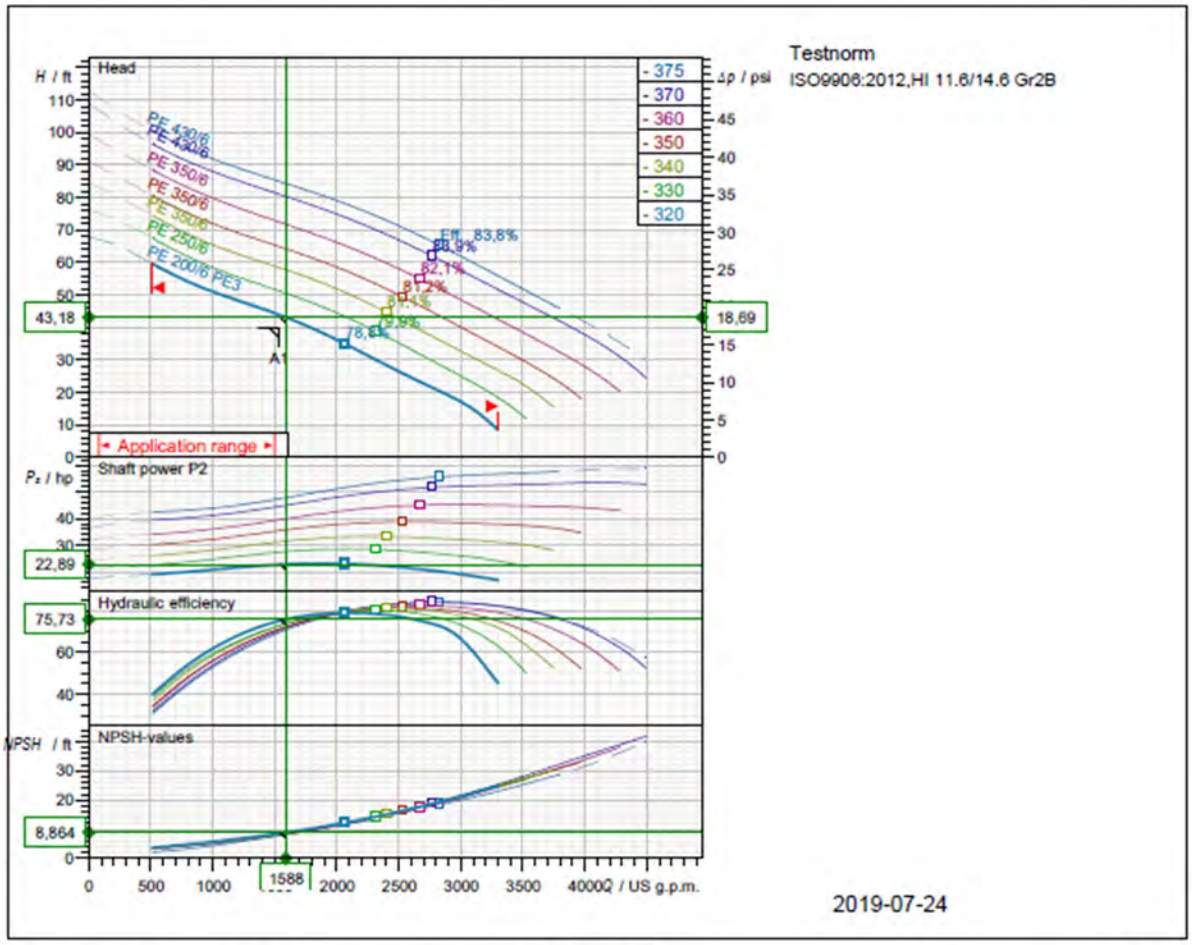
SULZER

XFP 206J-CB2 60 HZ



Operating data specification			
Flow	1590 US g.p.m.	Power input	24,6 hp
Efficiency	75,7 %	Head	43,2 ft
NPSH	8,86 ft	Rated power	22,9 hp
Temperature	68 °F	Fluid	Water
No. of pumps	1	Nature of system	Single head pump
Pump data			
Type	XFP 206J-CB2 60 HZ	Make	SULZER
Series	XFP PE4-PE7	Impeller	Contrablock Plus impeller
N° of vanes	2	Impeller size	12,6 inch
Free passage	3,54 x 4,33 inch	Suction flange	DN200
Discharge flange	DN200	Type of installation	
Moment of inertia	10,4 lb ft²		wet well vertical installation 2"
Motor data			
Rated voltage	460 V	Frequency	60 Hz
Rated power P2	26,8 hp	Nominal Speed	1180 rpm
Number of poles	6	Efficiency	93 %
Power factor	0,826	Rated current	32,7 A
Starting current	233 A	Rated torque	120 lbf ft
Starting torque	312 lbf ft	Degree of protection	IP 68
Insulation class	H	No. starts per hour	15

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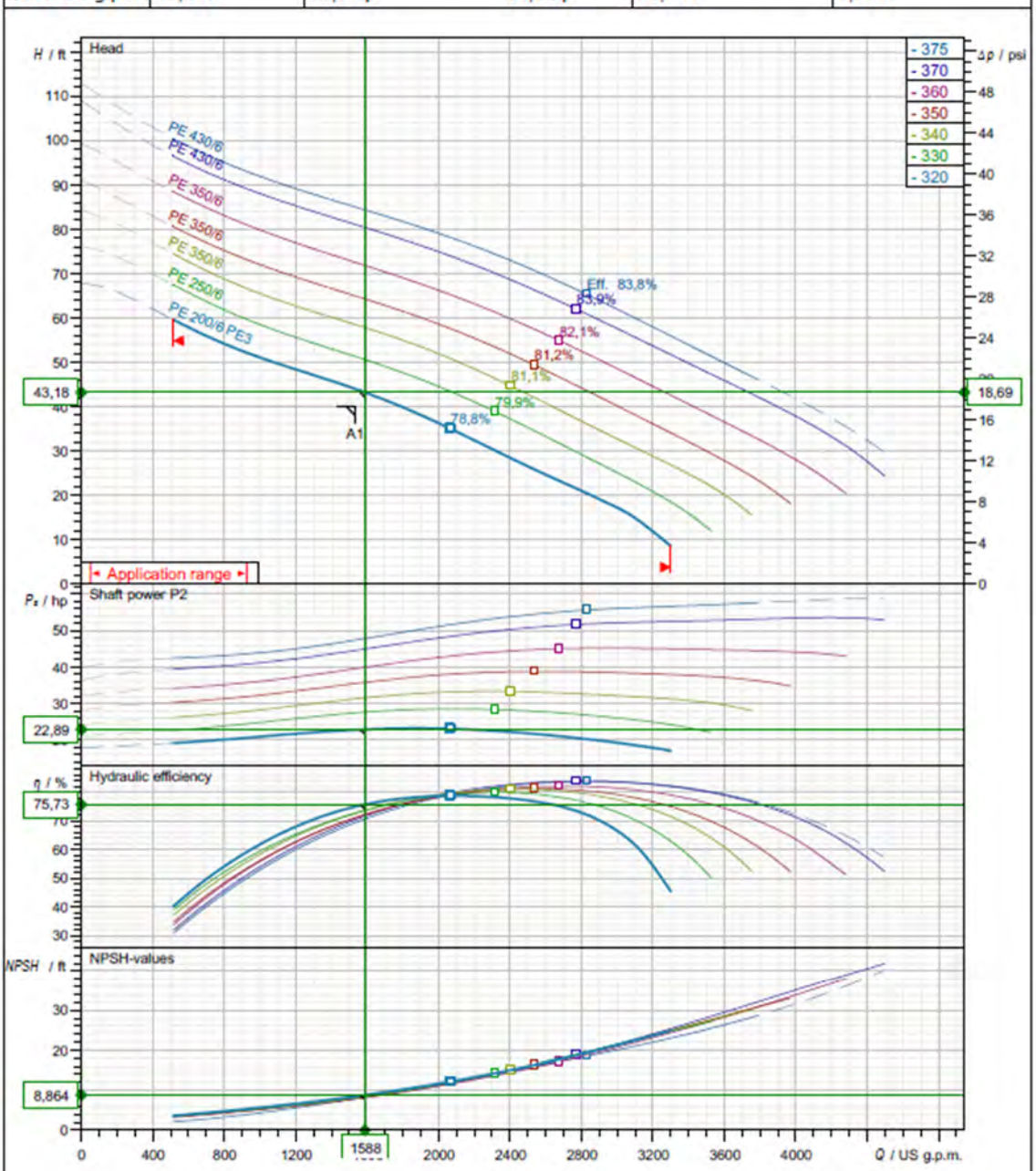
Data version Jan 2019

Curve number	Pump performance curves	SULZER
Reference curve XFP 206J-CB2 60 HZ	**XFP 206J-CB2 60 HZ**	

				Discharge DN200	Frequency 60 Hz
Density 62,32 lb/ft³	Viscosity 1,082E-5 ft²/s	Testnorm ISO9906:2012,HI 11.6/14.6 Gr2B		Rated speed 1180 rpm	Date 2019-07-24
Flow 1590 US g.p.m.	Head 43,2 ft	Rated power 22,9 hp	Power input 24,6 hp	Hydraulic efficiency 75,7 %	NPSH 8,86 ft



Impeller size	N° of vanes	Impeller	Solid size	Revision
12,6 inch	2	Contrablock Plus impeller	3,54 x 4,33 inch	

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Data version Jan 2019

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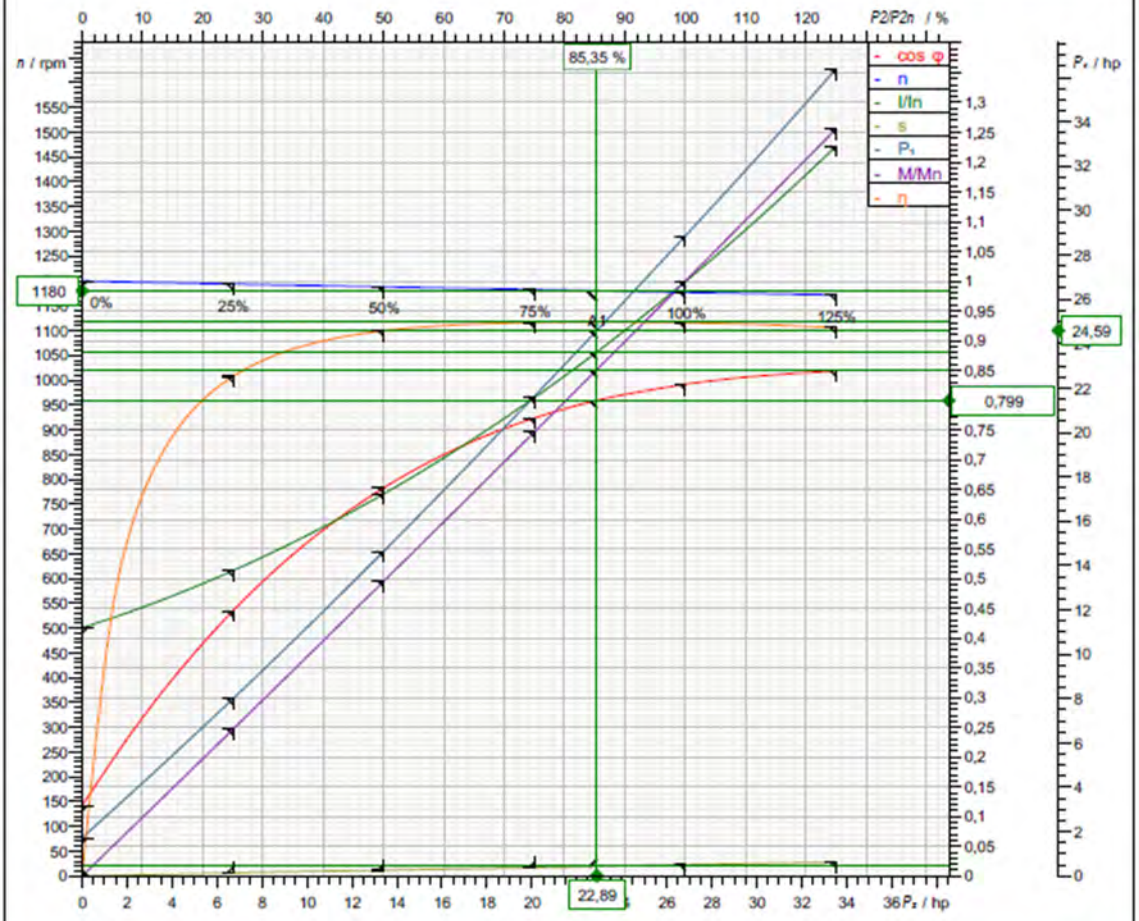
Frequency	PE3
60 Hz	

Motor performance curve

PE 200/6 PE3

SULZER

Rated power	Service factor	Nominal Speed	Number of poles	Rated voltage	Date
26,8 hp	1,3	1180 rpm	6	460 V	2019-07-24



Symbol	No load	25 %	50 %	75 %	100 %	125 %
P_2 / hp	0	6,705	13,41	20,12	26,82	33,53
P_1 / hp	1,721	7,985	14,63	21,62	28,84	36,38
η / %	0	83,97	91,64	93,03	92,98	92,16
n / rpm	1200	1194	1188	1183	1177	1172
cos φ	0,1181	0,4454	0,6522	0,7698	0,8266	0,8489
I / A	13,64	16,78	21	26,29	32,66	40,11
s / %	0	0,5115	0,9769	1,44	1,905	2,336
M / lbf ft	0	29,5	59,28	89,33	119,7	150,2

Tolerance according to VDE 0530 T1 12.84 for rated power

Starting current	Starting torque	Moment of inertia	No. starts per hour
233 A	312 lbf ft	10,4 lb ft²	15

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Data version Jan 2019

3.17.4. Tenth Street Pump Station, Pumps 2-4

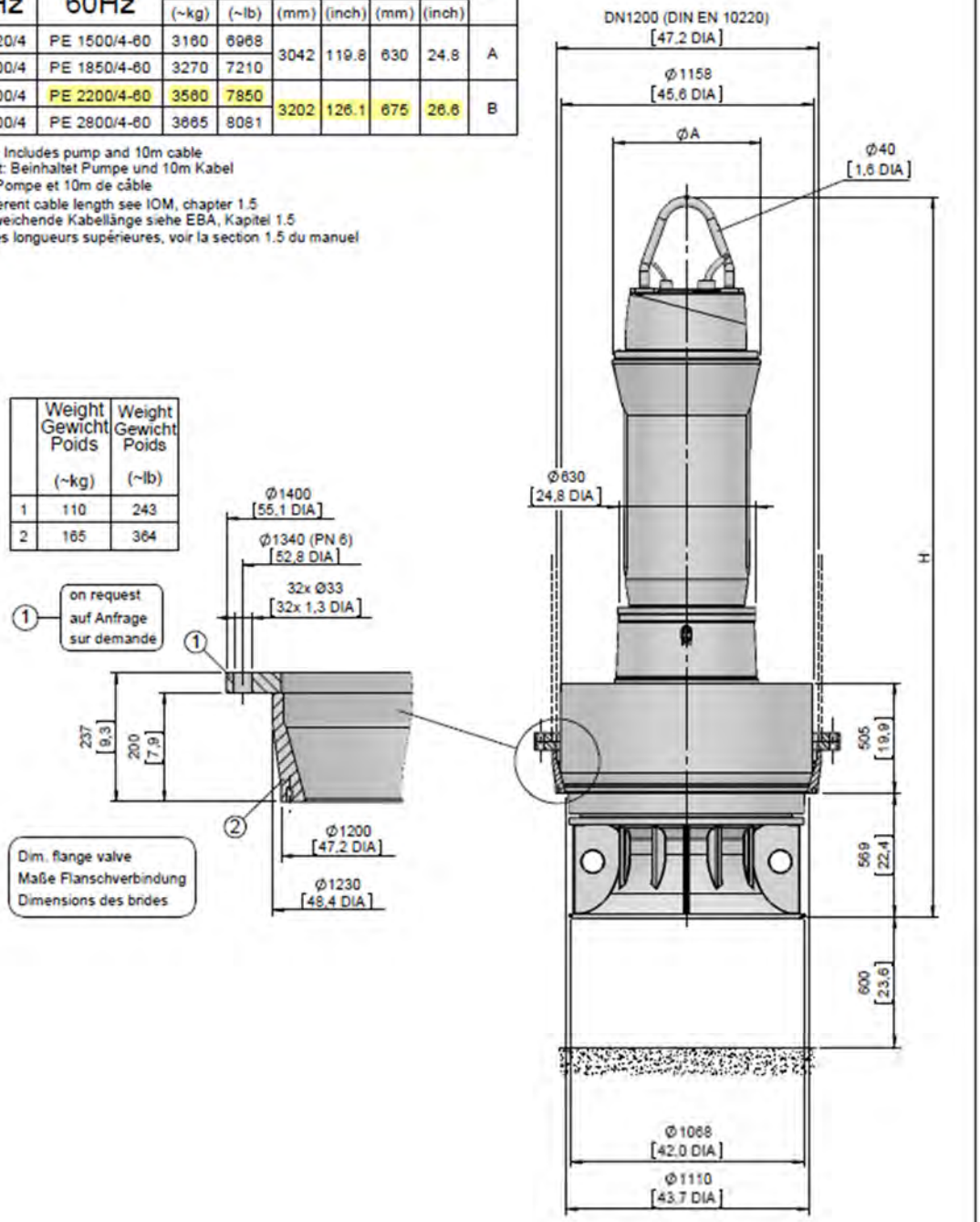
No: M-10.2147 - 05	2	AFLX 1207 G3
Dat/Nam.: 07.06.2016 / K. Srb		Dimension sheet PE6
Cad Code: M_102147		Maßblatt PE6
Technical changes reserved Änderungen vorbehalten Sous réserve de modifications		Plan d'encombrement PE6

SULZER

Type Typ Type 50Hz	Type Typ Type 60Hz	Weight Gewicht Poids		H		ØA		Size
		(~kg)	(~lb)	(mm)	(inch)	(mm)	(inch)	
PE 1320/4	PE 1500/4-60	3160	6968	3042	119.8	630	24.8	A
PE 1600/4	PE 1850/4-60	3270	7210					
PE 2000/4	PE 2200/4-60	3560	7850	3202	126.1	675	26.6	B
PE 2500/4	PE 2800/4-60	3665	8081					

Weight: Includes pump and 10m cable
Gewicht: Beinhaltet Pumpe und 10m Kabel
Poids: Pompe et 10m de câble
For different cable length see IOM, chapter 1.5
Für abweichende Kabellänge siehe EBA, Kapitel 1.5
Pour des longueurs supérieures, voir la section 1.5 du manuel

	Weight Gewicht Poids (~kg)	Weight Gewicht Poids (~lb)
1	110	243
2	165	364



[mm [inch]]

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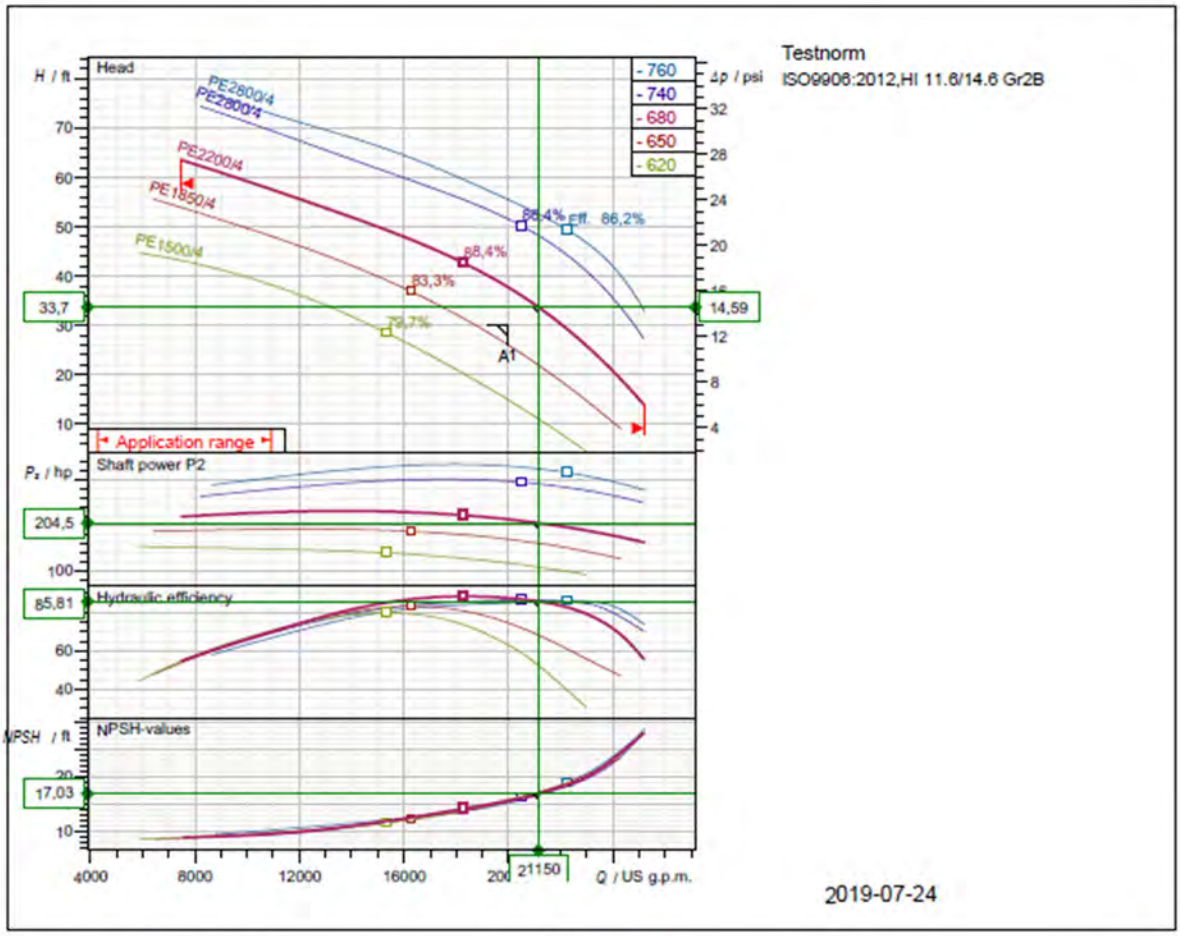
SULZER

AFLX 1207 60 HZ



Operating data specification		Power input	221 hp
Flow	21100 US g.p.m.	Head	33,7 ft
Efficiency	85,8 %	Rated power	205 hp
NPSH	17 ft	Fluid	Water
Temperature	68 °F	Nature of system	Single head pump
No. of pumps	1		
Pump data			
Type	AFLX 1207 60 HZ	Make	SULZER
Series	AFLX	Impeller	Semi-open impeller
N° of vanes	5	Impeller size	26,8 inch
Free passage	6,5 x 3,94 inch	Suction flange	
Discharge flange	DN1200	Type of installation	
Moment of inertia	214 lb ft²		installation with steel riser pipe PE
Motor data			
Rated voltage	480 V	Frequency	60 Hz
Rated power P2	295 hp	Nominal Speed	1790 rpm
Number of poles	4	Efficiency	96,2 %
Power factor	0,878	Rated current	313 A
Starting current	2540 A	Rated torque	865 lbf ft
Starting torque	2510 lbf ft	Degree of protection	IP 68
Insulation class	H(140)	No. starts per hour	10

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Data version Jan 2019

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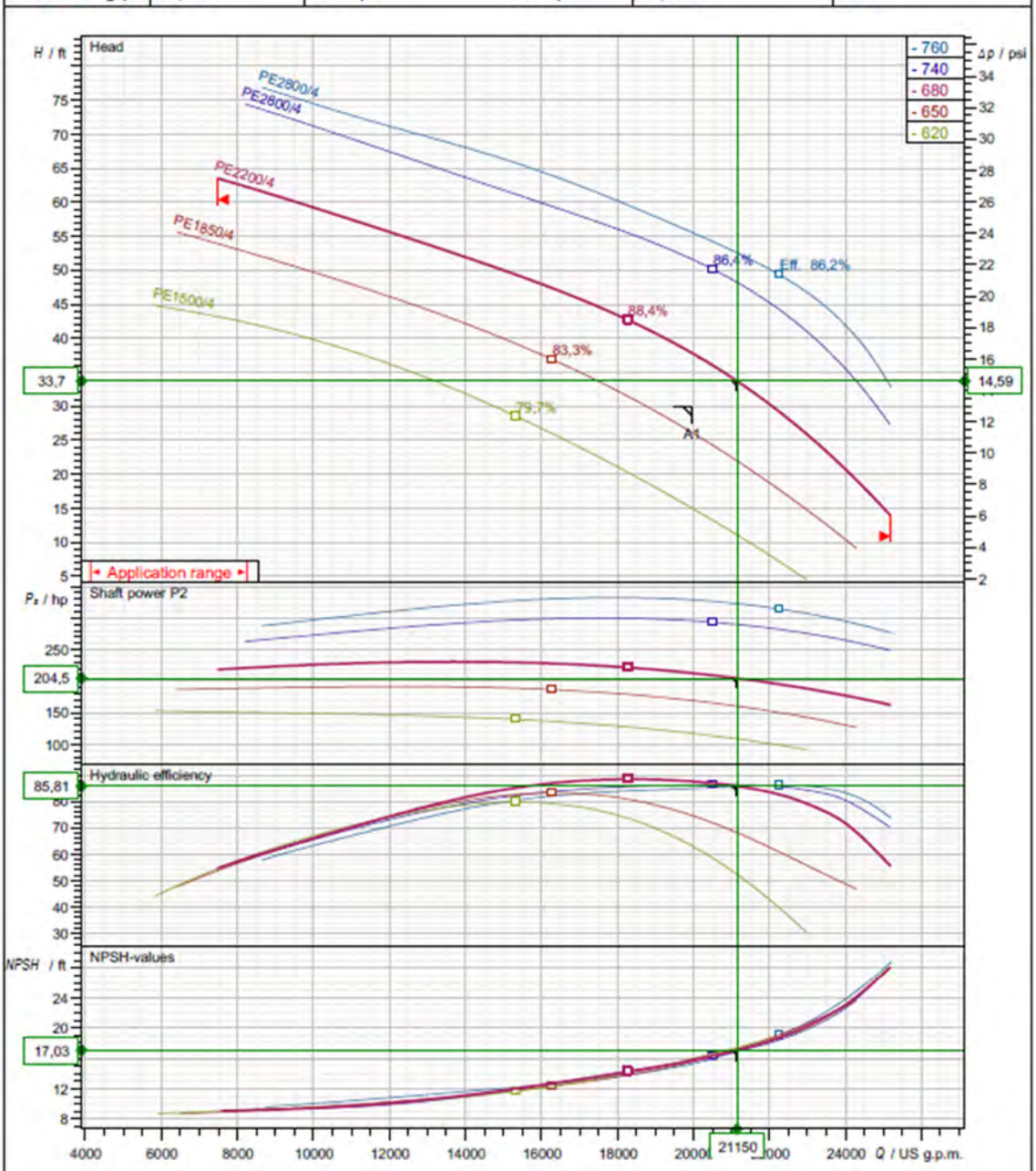
Curve number	Pump performance curves	SULZER
Reference curve AFL 1207 60 HZ	**AFLX 1207 60 HZ**	

				Discharge DN1200	Frequency 60 Hz
Density 62,32 lb/ft³	Viscosity 1,082E-5 ft²/s	Testnorm ISO9906:2012,HI 11.6/14.6 Gr2B		Rated speed 597,8 rpm	Date 2019-07-24
Flow 21100 US g.p.n	Head 33,7 ft	Rated power 205 hp	Power input 221 hp	Hydraulic efficiency 85,8 %	NPSH 17 ft



Impeller size	N° of vanes	Impeller	Solid size	Revision
26,8 inch	5	Semi-open impeller	6,5 x 3,94 inch	

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Data version Jan 2019

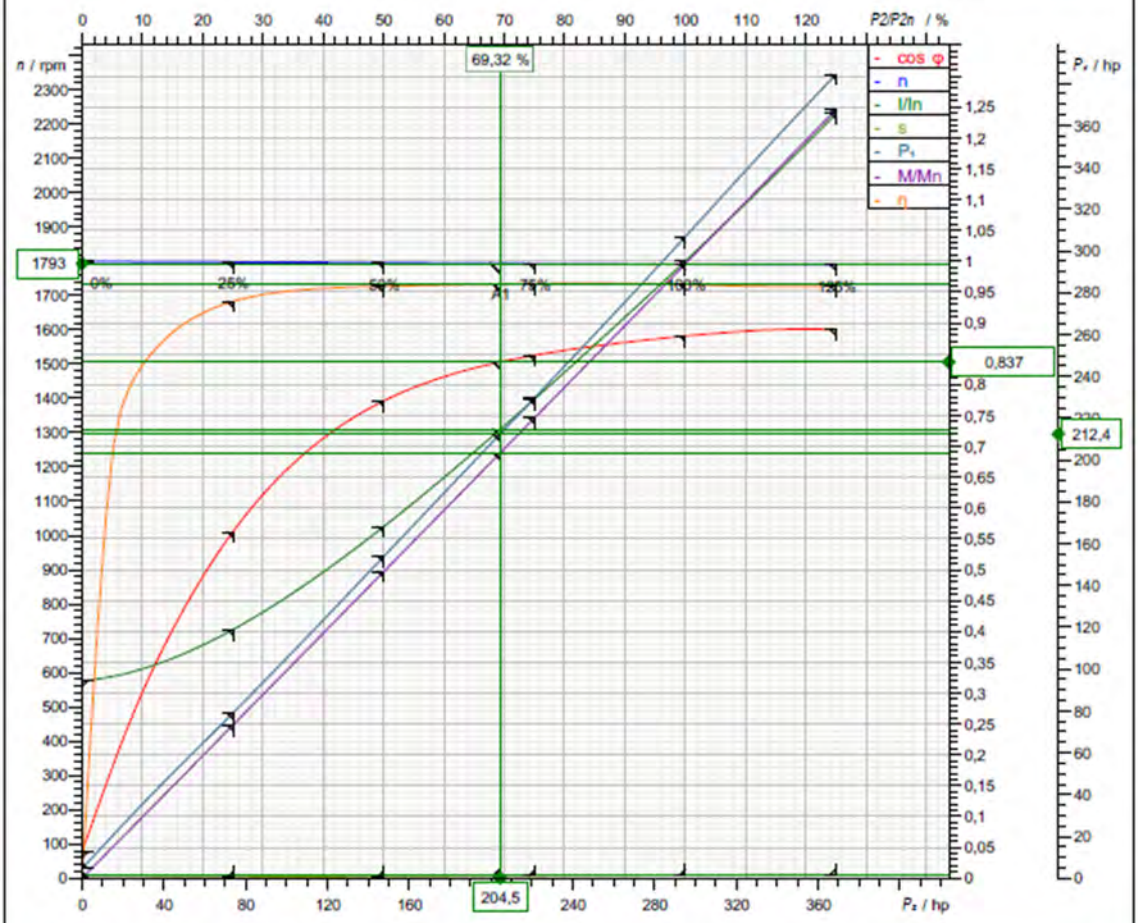
Frequency	PE6
60 Hz	

Motor performance curve

PE2200/4

SULZER

Rated power	Service factor	Nominal Speed	Number of poles	Rated voltage	Date
295 hp	1	1780 rpm	4	480 V	2019-07-24



Symbol	No load	25 %	50 %	75 %	100 %	125 %
P_2 / hp	0	73,76	147,5	221,3	295	368,8
P_1 / hp	4,702	78,9	153,8	229,6	306,7	384,3
η / %	0	93,48	95,93	96,37	96,21	95,95
n / rpm	1799	1797	1795	1793	1791	1789
cos φ	0,04216	0,5613	0,7735	0,8475	0,8787	0,8889
I / A	100,1	126,1	178,3	243	313	387,8
s / %	0,05556	0,1667	0,2778	0,3889	0,5	0,6111
M / lbf ft	0	215,6	431,6	648,2	865,2	1083

Tolerance according to VDE 0530 T1 12.84 for rated power

Starting current	Starting torque	Moment of inertia	No. starts per hour
2540 A	2510 lbf ft	127 lb ft²	10

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Spaix® 4, Version 4.3.11 - 2019/01/16 (Build 240
Data version Jan 2019

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3.17.5. Seventeenth Street Pump Station, Pump 1

SULZER	Massblatt XFP 200G-CB1 Nassinstallation Dimension sheet WET-WELL Installation Dimensioni Installazione sommersa Hoja de dimensiones instalación sumergida Plan d'encombrement Installation noyee	No: AN-M.22.599 - 02 Drawn: 05/08/10 D.Whelan Issue Date: 09/05/2013 Änderungen vorbehalten Technical changes reserved Con riserva di modifiche Con reserva de modificaciones Sous réserve de modification

50 Hz

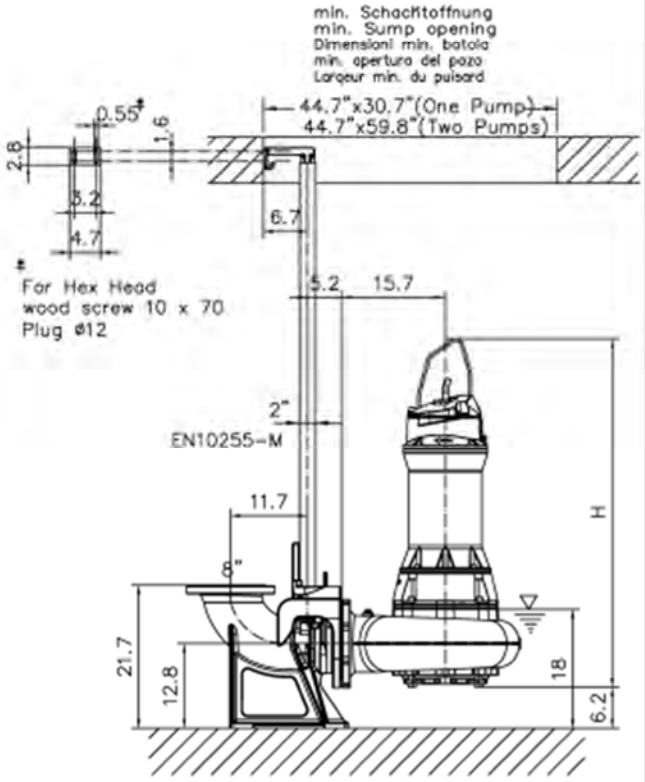
Typ Type Tipo	Gewicht Weight Poids N.C.J. (lbs)	Gewicht Weight Poids W.C.J. (lbs)	Height H (")
PE 90/6	891	1001	53.1
PE 110/4	891	979	53.1
PE 140/4	891	979	53.1
PE 160/4	935	1045	53.1
PE 185/4	935	1045	53.1
PE 220/4	957	1090	54.6

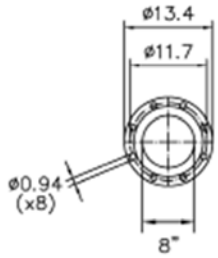
60 Hz

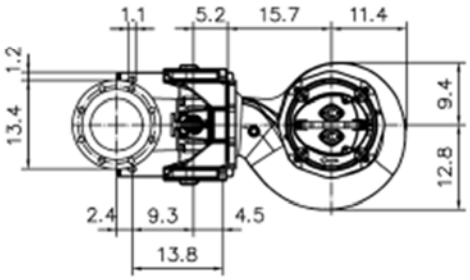
Typ Type Tipo	Gewicht Weight Poids N.C.J. (lbs)	Gewicht Weight Poids W.C.J. (lbs)	Height H (")
PE 90/6	955	1001	53.1
PE 110/6	955	1001	53.1
PE 130/6	955	1001	53.1

N.C.J. = No Cooling Jacket
W.C.J. = With Cooling Jacket

U.S.







Gewicht: Beinhaltet Pumpe,Halterung(Fussstuck) und Kabel (50 Hz = 10 m; 60 Hz = 15 m)	Guss-Allgemeintoleranzen nach DIN1680 – GTB16
Weight: Includes pump, slider bracket and cable (50 Hz = 10 m; 60 Hz = 15 m)	General tolerances for castings in acc. to DIN1680-GTB16
Peso: include pompa, pezzo intermedio a cavo (50 Hz = 10 m; 60 Hz = 15 m)	Tolleranze generali delle fusioni secondo DIN1680-GTB16
Peso: Incluye bomba, soporte deslizante y cable (50 Hz = 10 m; 60 Hz = 15 m)	Tolerancias generales para la fundicion seg. de DIN1680-GTB16
Poids : incluant la pompe, le coulisseau et le cable (50 Hz = 10 m; 60 Hz = 15 m)	Tolérance generale de la fonderie selon DIN1680-GTB16

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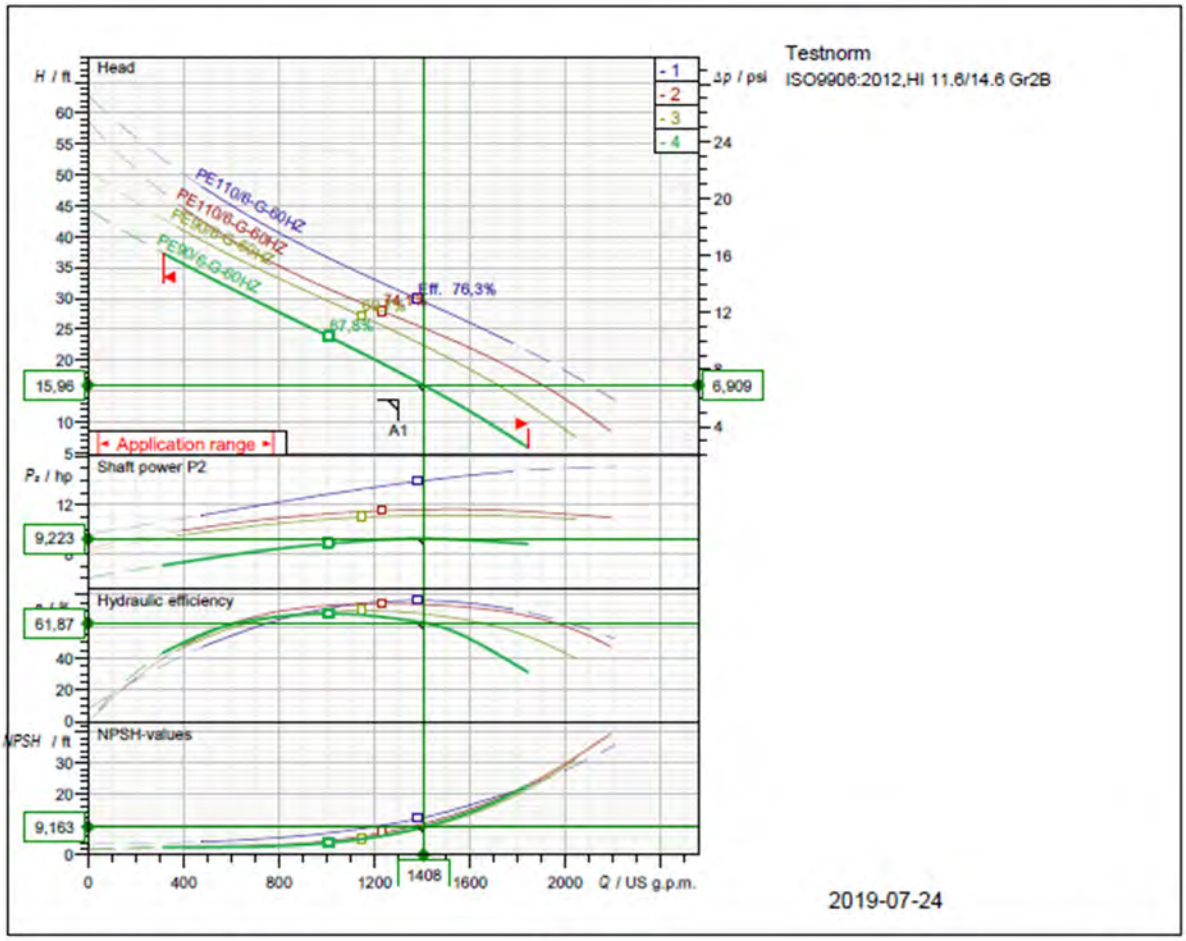
SULZER

XFP200G CB1 60HZ (wet pit/dry pit)



Operating data specification			
Flow	1410 US g.p.m.	Power input	10,3 hp
Efficiency	61,9 %	Head	16 ft
NPSH	9,16 ft	Rated power	9,22 hp
Temperature	68 °F	Fluid	Water
No. of pumps	1	Nature of system	Single head pump
Pump data			
Type	XFP200G CB1 60HZ (wet pit/dry pit)	Make	SULZER
Series	XFP PE1-PE3	Impeller	Contrablock Plus impeller, 1 vane
N° of vanes	1	Impeller size	10,1 inch
Free passage	3,94 inch	Suction flange	DN200
Discharge flange	DN200	Type of installation	
Moment of inertia	2,06 lb ft²	Wet Well installation with pedestal (without cooling jacket)	
Motor data			
Rated voltage	460 V	Frequency	60 Hz
Rated power P2	12,1 hp	Nominal Speed	1180 rpm
Number of poles	6	Efficiency	91 %
Power factor	0,66	Rated current	18,8 A
Starting current	166 A	Rated torque	53,5 lbf ft
Starting torque	227 lbf ft	Degree of protection	IP 68
Insulation class	H	No. starts per hour	15

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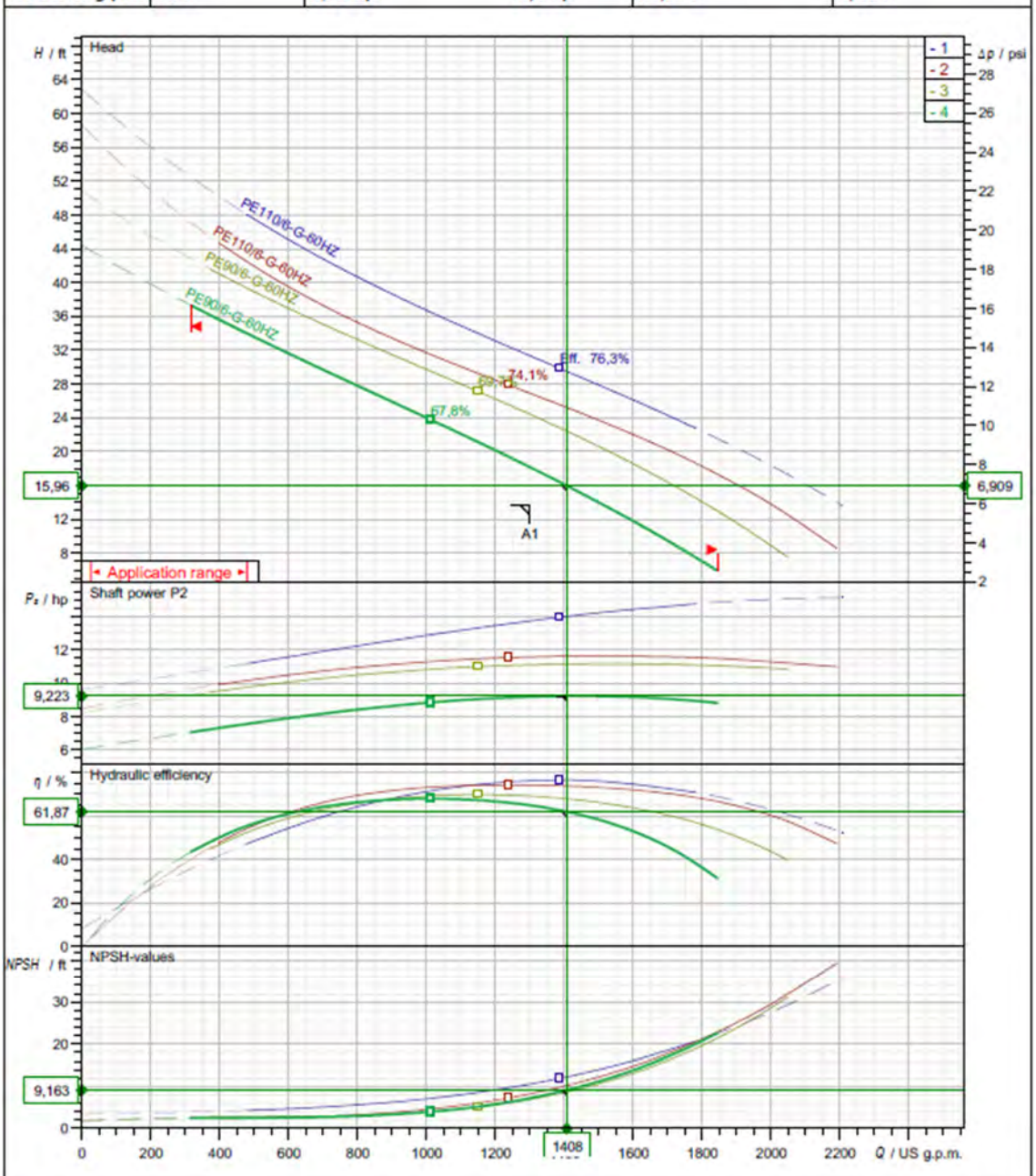
Curve number	Pump performance curves	SULZER
Reference curve XFP200G CB1 60HZ	**XFP200G CB1 60HZ (wet pit/dry pit)**	

				Discharge DN200	Frequency 60 Hz
Density 62,32 lb/ft³	Viscosity 1,082E-5 ft²/s	Testnorm ISO9906:2012,HI 11.6/14.6 Gr2B		Rated speed 1189 rpm	Date 2019-07-24
Flow 1410 US g.p.m.	Head 16 ft	Rated power 9,22 hp	Power input 10,3 hp	Hydraulic efficiency 61,9 %	NPSH 9,16 ft



Impeller size	N° of vanes	Impeller	Solid size	Revision
10,1 inch	1	Contrablock Plus impeller, 1 vane	3,94 inch	

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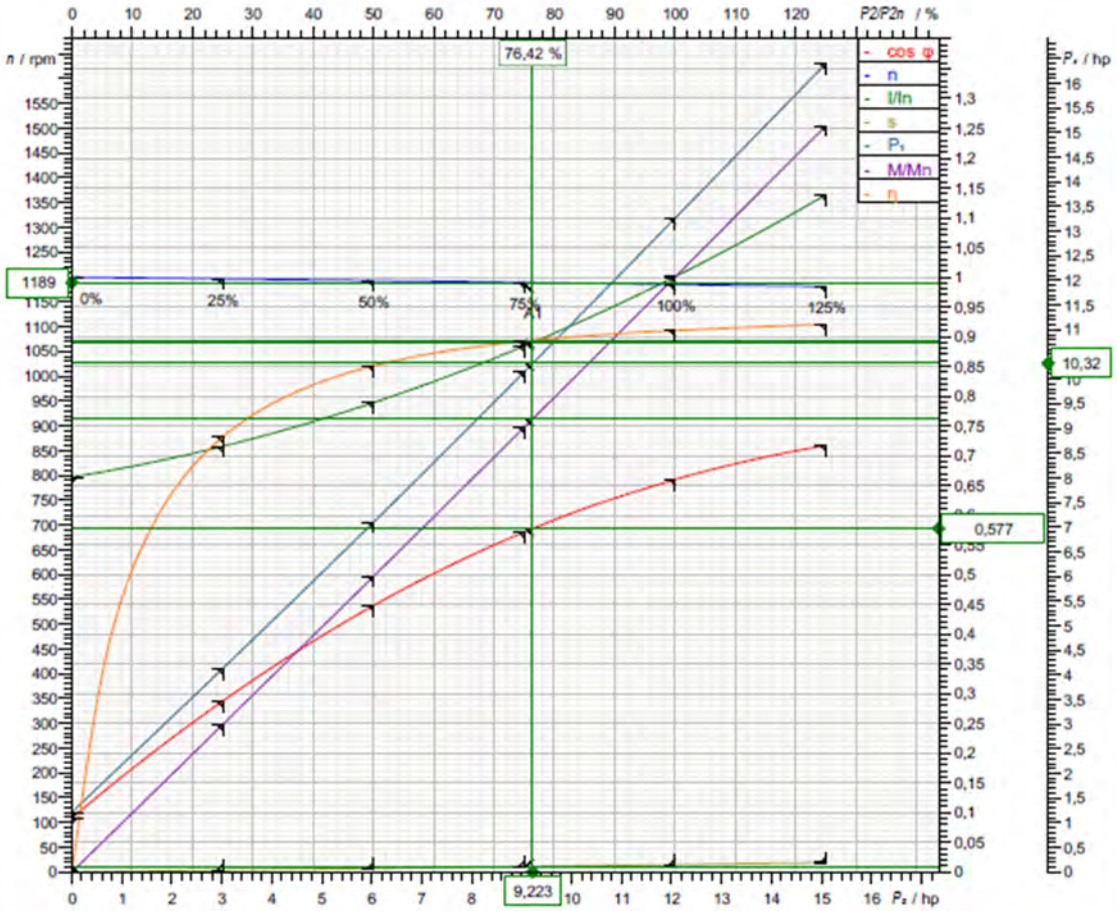
Frequency 60 Hz	PE3	Motor performance curve PE90/6-G-60HZ	SULZER

Rated power	Service factor	Nominal Speed	Number of poles	Rated voltage	Date
12,1 hp	1,3	1180 rpm	6	460 V	2019-07-24



Symbol	No load	25 %	50 %	75 %	100 %	125 %
P_2 / hp	0	3,017	6,035	9,052	12,07	15,09
P_1 / hp	1,213	4,127	7,093	10,15	13,26	16,39
η / %	0	73,11	85,07	89,22	91,01	92,02
n / rpm	1200	1196	1193	1189	1185	1181
cos φ	0,09096	0,2872	0,4476	0,5714	0,6598	0,717
I / A	12,48	13,45	14,83	16,62	18,81	21,4
s / %	0,001323	0,3267	0,5966	0,9034	1,257	1,582
M / lbf ft	0	13,25	26,57	39,98	53,5	67,09

Tolerance according to VDE 0530 T1 12.84 for rated power

Starting current	Starting torque	Moment of inertia	No. starts per hour
166 A	227 lbf ft	5,41 lb ft²	15

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Data version Jan 2019

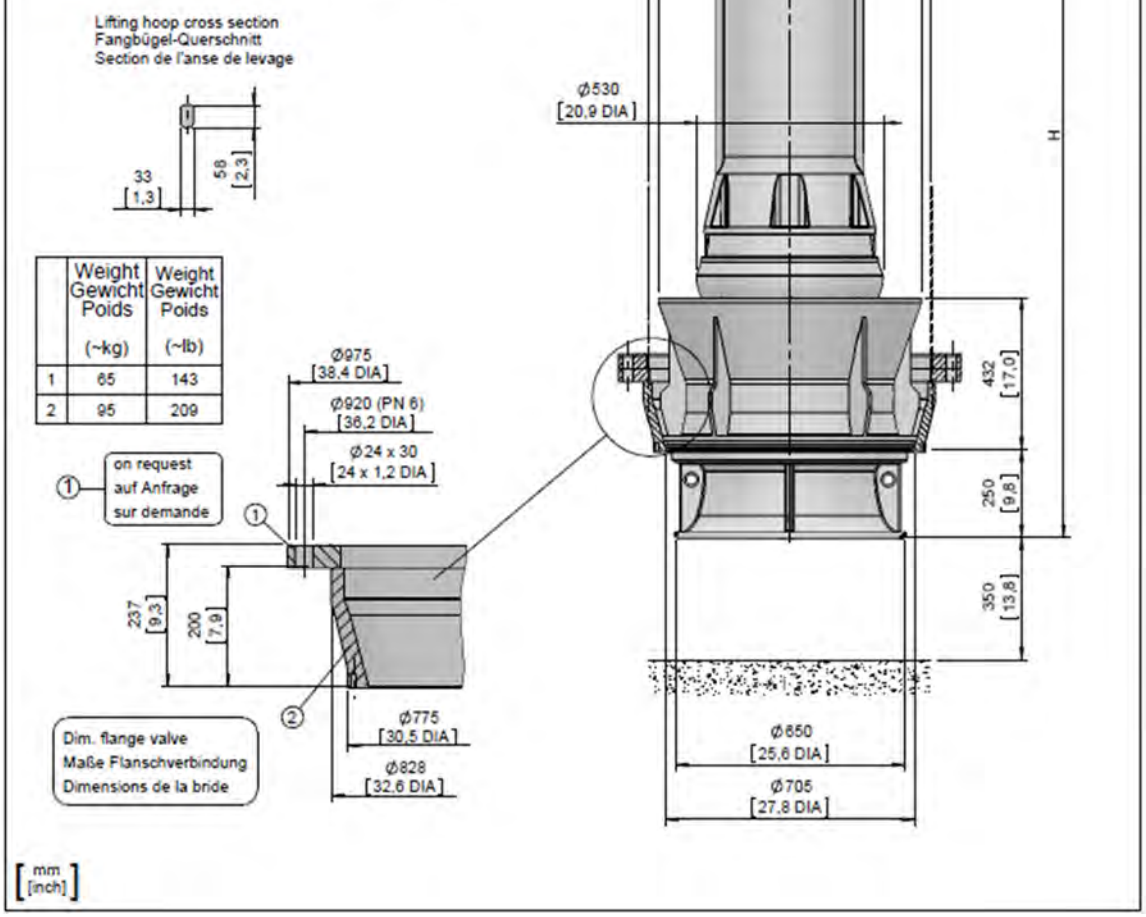
3.17.6. Seventeenth Street Pump Station, Pumps 2-4

No: M-10.2112 - 06	2	VUPX 0601/2
Dat/Nam.: 26.09.2016 / K. Srb		Dimension sheet PE5
Cad Code: M_102112		Maßblatt PE5
Technical changes reserved Änderungen vorbehalten Sous réserve de modifications		Plan d'encombrement PE5

SULZER

Type Typ Type 50Hz	Type Typ Type 60Hz	Weight Gewicht Poids		H		Size
		(~kg)	(~lb)	(mm)	(inch)	
PE 450/6		1245	2745	2168	85.4	A
PE 550/6		1335	2944	2288	90.1	B
PE 750/6		1425	3142			
PE 900/6		1470	3241			
PE 1090/6		1470	3241			
PE 370/8	PE 430/8-60	1270	2800	2168	85.4	A
PE 450/8	PE 520/8-60	1370	3021	2288	90.1	B
PE 550/8	PE 630/8-60	1415	3120			
PE 750/8	PE 860/8-60	1460	3219			
PE 300/10	PE 350/10-60	1395	3076			
PE 370/10	PE 430/10-60	1440	3175			
	PE 520/10-60	1485	3274			
	PE 630/10-60	1485	3274			

Weight: Includes pump and 10m cable
Gewicht: Beinhaltet Pumpe und 10m Kabel
Poids: Pompe et 10m de câble
For different cable length see IOM, chapter 1.5
Für abweichende Kabellänge siehe EBA, Kapitel 1.5
Pour des longueurs supérieures, voir la section 1.5 du manuel



	Weight Gewicht Poids (~kg)	Weight Gewicht Poids (~lb)
1	65	143
2	95	209

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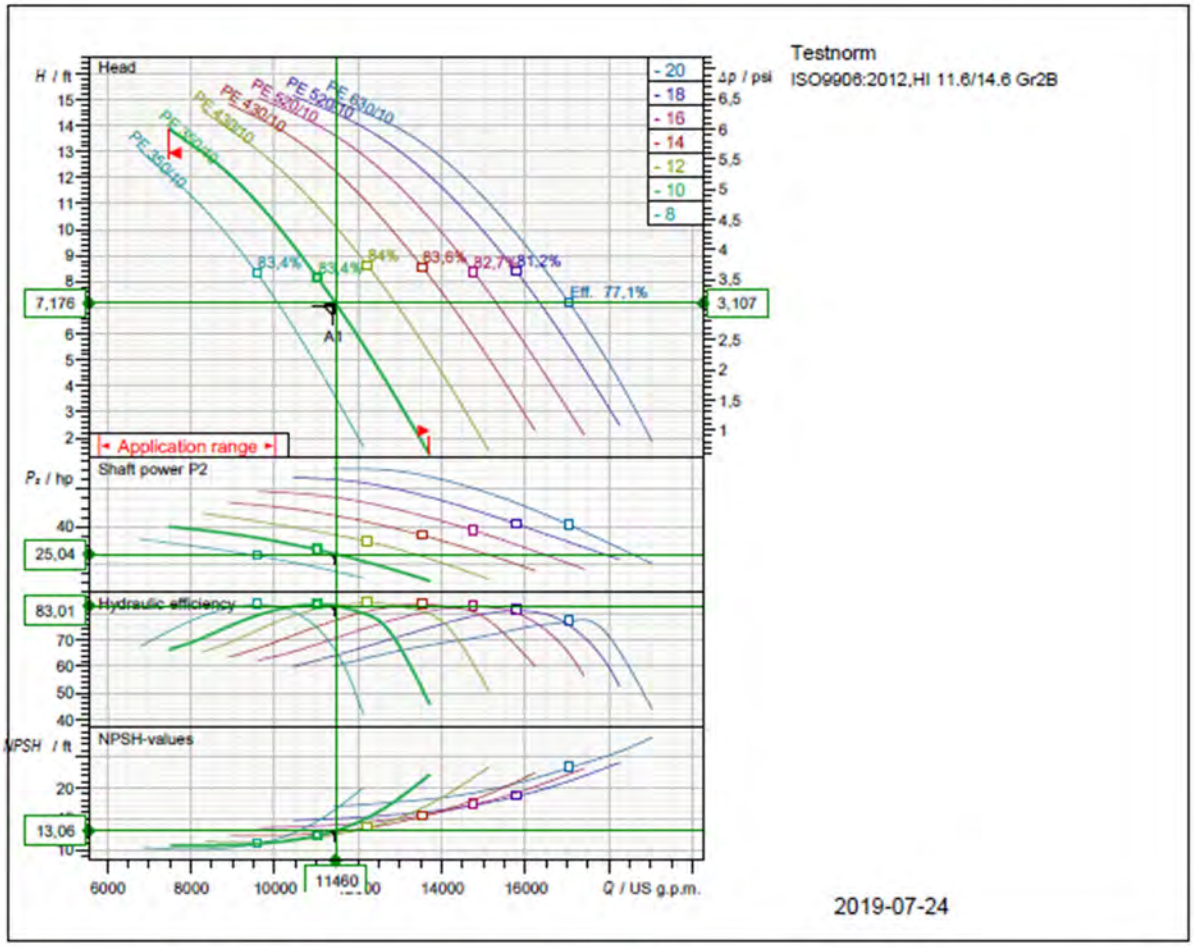
SULZER

VUPX 0601 60 HZ



Operating data specification			
Flow	11500 US g.p.m.	Power input	27 hp
Efficiency	83 %	Head	7,18 ft
NPSH	13,1 ft	Rated power	25 hp
Temperature	68 °F	Fluid	Water
No. of pumps	1	Nature of system	Single head pump
Pump data			
Type	VUPX 0601 60 HZ	Make	SULZER
Series	VUPX	Impeller	Propeller
N° of vanes	3	Impeller size	21,3 inch
Free passage	6,57 inch	Suction flange	
Discharge flange	DN800	Type of installation	
Moment of inertia	14,9 lb ft²		installation with steel riser pipe PE
Motor data			
Rated voltage	480 V	Frequency	60 Hz
Rated power P2	46,9 hp	Nominal Speed	708 rpm
Number of poles	10	Efficiency	93,2 %
Power factor	0,766	Rated current	59 A
Starting current	407 A	Rated torque	348 lbf ft
Starting torque	592 lbf ft	Degree of protection	IP 68
Insulation class	H(140)	No. starts per hour	10

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Data version Jan 2019

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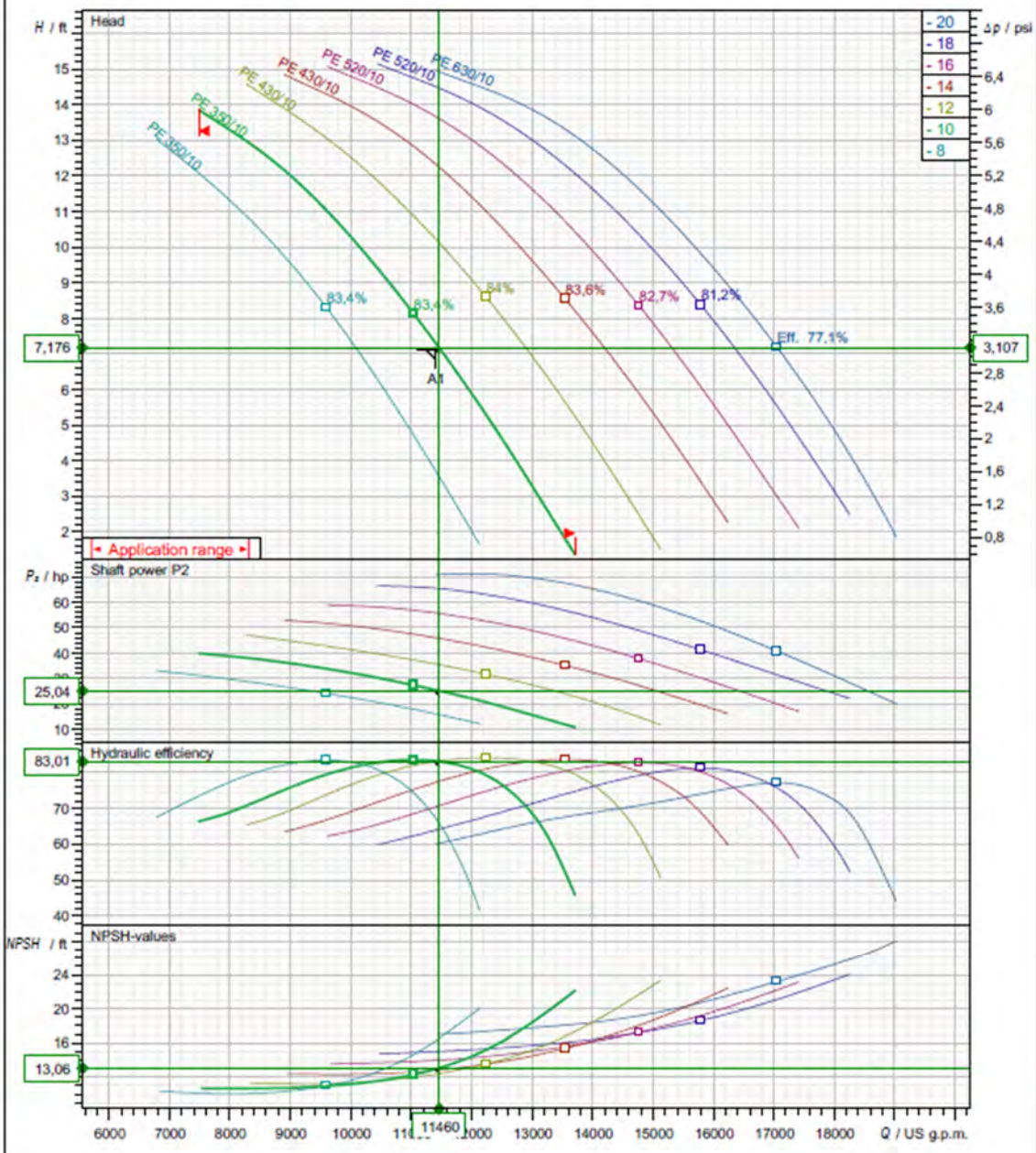
Curve number	Pump performance curves	SULZER
Reference curve VUP 0601 60 HZ	VUPX 0601 60 HZ	

				Discharge DN800	Frequency 60 Hz
Density 62,32 lb/ft³	Viscosity 1,082E-5 ft²/s	Testnorm ISO9906:2012,HI 11.6/14.6 Gr2B		Rated speed 713,5 rpm	Date 2019-07-24
Flow 11500 US g.p.m	Head 7,18 ft	Rated power 25 hp	Power input 27 hp	Hydraulic efficiency 83 %	NPSH 13,1 ft



Impeller size	N° of vanes	Impeller	Solid size	Revision
21,3 inch	3	Propeller	6,57 inch	

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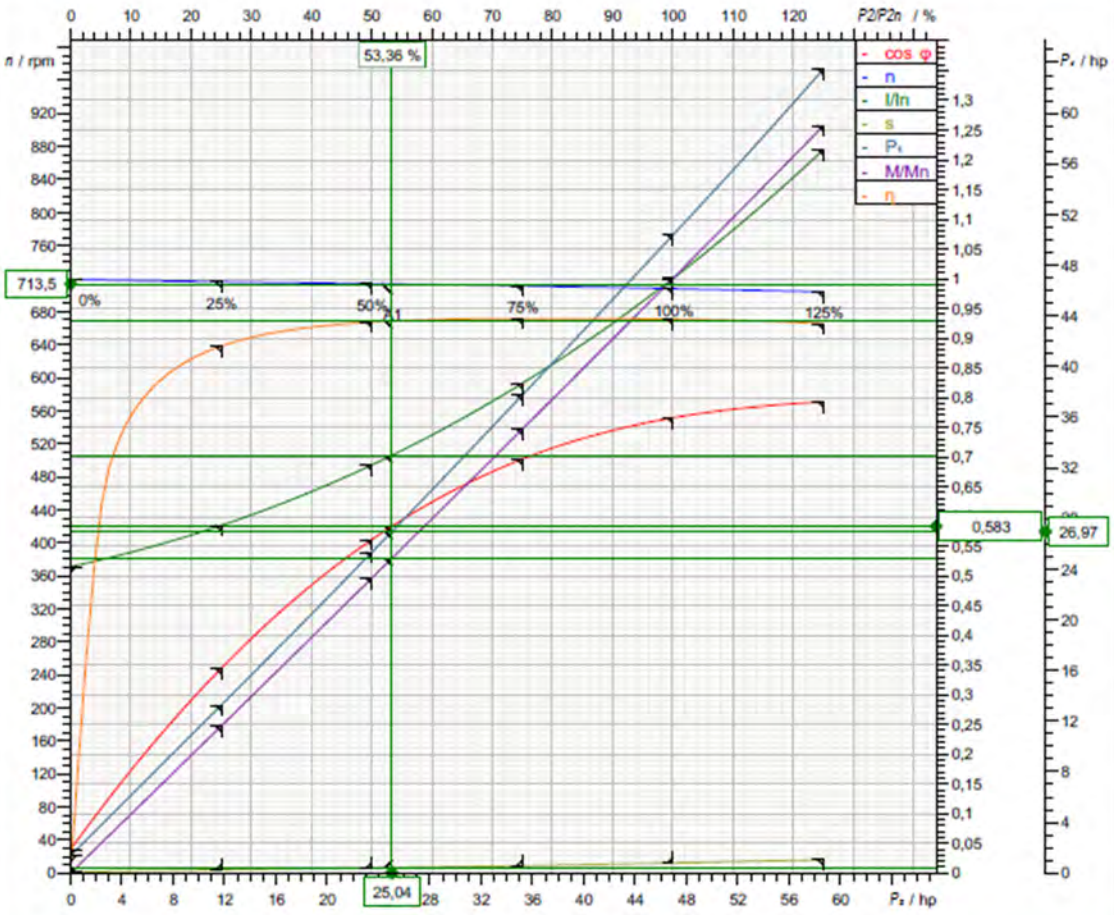
Frequency 60 Hz	PE5	Motor performance curve PE 350/10	SULZER

Rated power	Service factor	Nominal Speed	Number of poles	Rated voltage	Date
46,9 hp	1,3	708 rpm	10	480 V	2019-07-24



Symbol	No load	25 %	50 %	75 %	100 %	125 %
P_2 / hp	0	11,73	23,47	35,2	46,94	58,67
P_1 / hp	1,355	13,24	25,32	37,73	50,38	63,48
η / %	0	88,64	92,7	93,3	93,17	92,42
n / rpm	719	716,1	713,8	711,2	707,9	704
cos φ	0,03997	0,3441	0,5607	0,6963	0,7659	0,793
I / A	30,4	34,5	40,5	48,6	59	71,8
s / %	0,1416	0,5418	0,8609	1,222	1,68	2,219
M / lbf ft	0	86,06	172,7	260	348,2	437,7

Tolerance according to VDE 0530 T1 12.84 for rated power

Starting current	Starting torque	Moment of inertia	No. starts per hour
407 A	592 lbf ft	48,4 lb ft²	10

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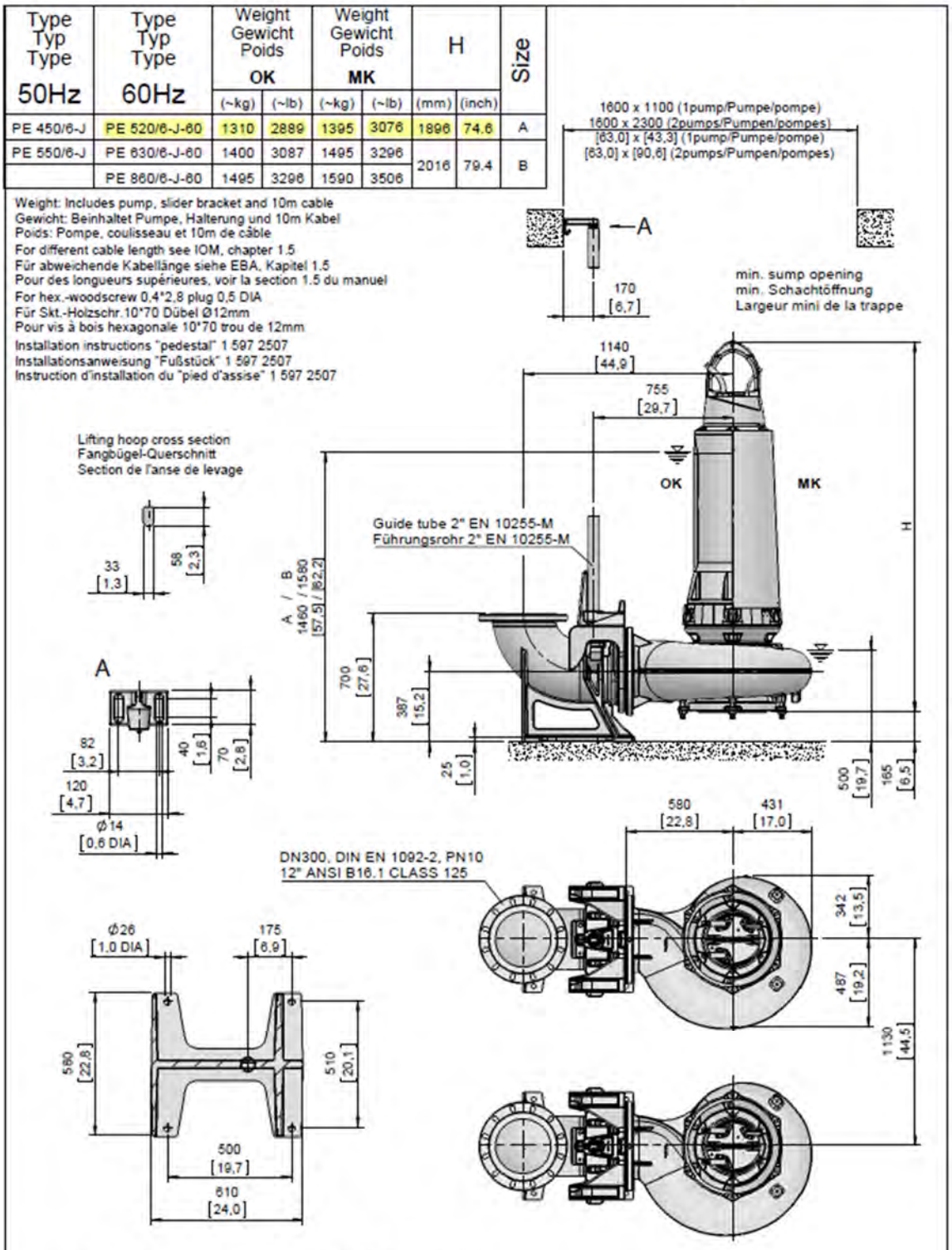
3.17.7. Twenty-Seventh Street Pump Station, Pump 1

No: M-02.2881 - 01	2	XFP 305J-CB2
Dat/Nam.: 11.05.2016 / K. Srb		Dimension sheet PE5 WET WELL Installation
Cad Code: M_022881		Maßblatt PE5 Nassinstallation
Technical changes reserved Änderungen vorbehalten Sous réserve de modifications		Plan d'encombrement PE5 installation submersible

SULZER

Type Typ Type 50Hz	Type Typ Type 60Hz	Weight Gewicht Poids OK		Weight Gewicht Poids MK		H		Size
		(~kg)	(~lb)	(~kg)	(~lb)	(mm)	(inch)	
PE 450/6-J	PE 520/6-J-60	1310	2889	1395	3076	1896	74.6	A
PE 550/6-J	PE 630/6-J-60	1400	3087	1495	3296	2016	79.4	B
	PE 860/6-J-60	1495	3296	1590	3506			

Weight: Includes pump, slider bracket and 10m cable
Gewicht: Beinhaltet Pumpe, Halterung und 10m Kabel
Poids: Pompe, coulisseau et 10m de câble
For different cable length see IOM, chapter 1.5
Für abweichende Kabellänge siehe EBA, Kapitel 1.5
Pour des longueurs supérieures, voir la section 1.5 du manuel
For hex.-woodscrew 0,4*2,8 plug 0,5 DIA
Für Skt.-Holzschr.10*70 Dübel Ø12mm
Pour vis à bois hexagonale 10*70 trou de 12mm
Installation instructions "pedestal" 1 597 2507
Installationsanweisung "Fußstück" 1 597 2507
Instruction d'installation du "pied d'assise" 1 597 2507



[mm / [inch]]

OK = Ohne Kühlmantel
Without cooling jacket
Sans enveloppe de refroidissement

MK = Mit Kühlmantel
With cooling jacket
Avec enveloppe de refroidissement

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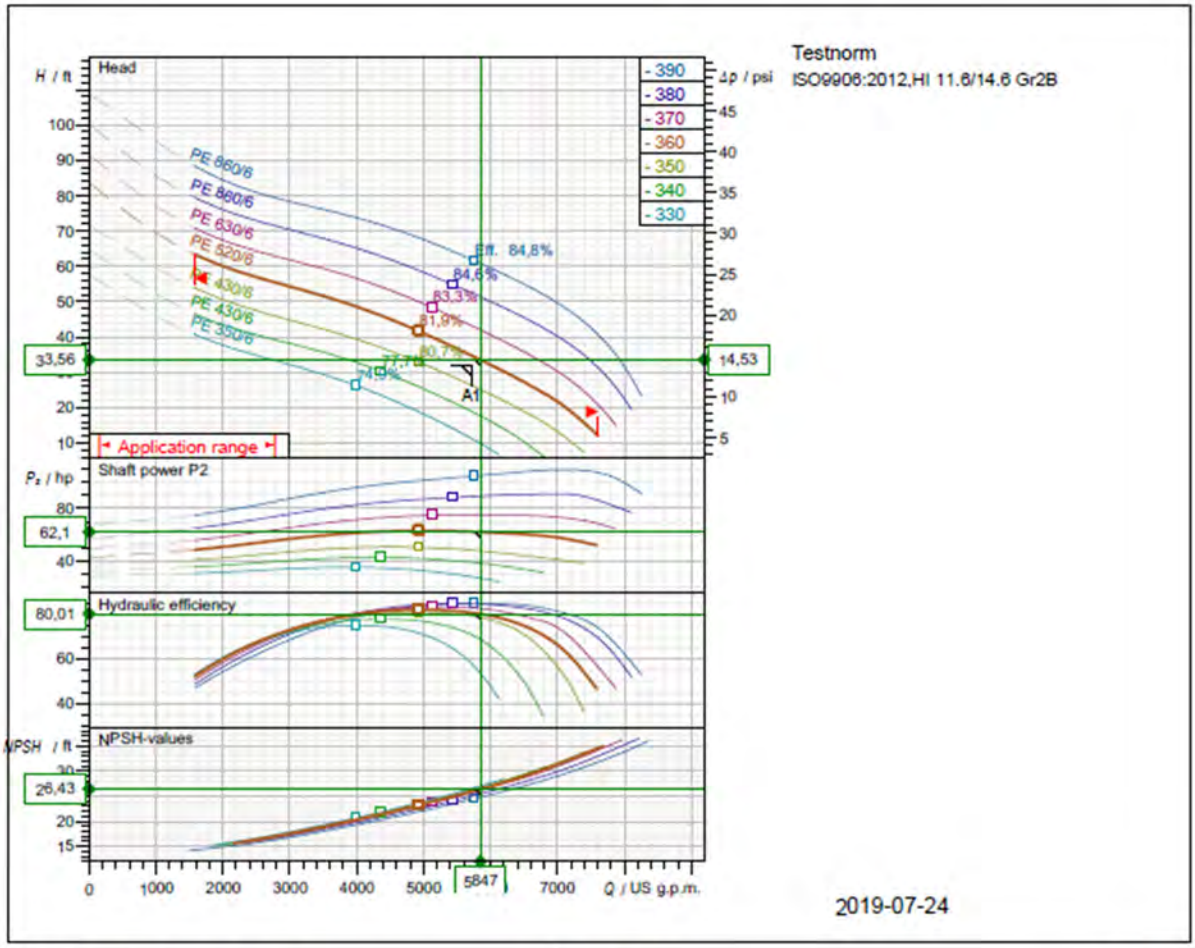
SULZER

XFP 305J-CB2 60 HZ



Operating data specification			
Flow	5850 US g.p.m.	Power input	65,8 hp
Efficiency	80 %	Head	33,6 ft
NPSH	26,4 ft	Rated power	62,1 hp
Temperature	68 °F	Fluid	Water
No. of pumps	1	Nature of system	Single head pump
Pump data			
Type	XFP 305J-CB2 60 HZ	Make	SULZER
Series	XFP PE4-PE7	Impeller	Contrablock Plus impeller
N° of vanes	2	Impeller size	14,2 inch
Free passage	4,72 x 6,3 inch	Suction flange	DN300
Discharge flange	DN300	Type of installation	wet well vertical installation 2"
Moment of inertia			
Motor data			
Rated voltage	480 V	Frequency	60 Hz
Rated power P2	69,7 hp	Nominal Speed	1190 rpm
Number of poles	6	Efficiency	94,5 %
Power factor	0,805	Rated current	82,7 A
Starting current	819 A	Rated torque	308 lbf ft
Starting torque	1140 lbf ft	Degree of protection	IP 68
Insulation class	H(140)	No. starts per hour	10

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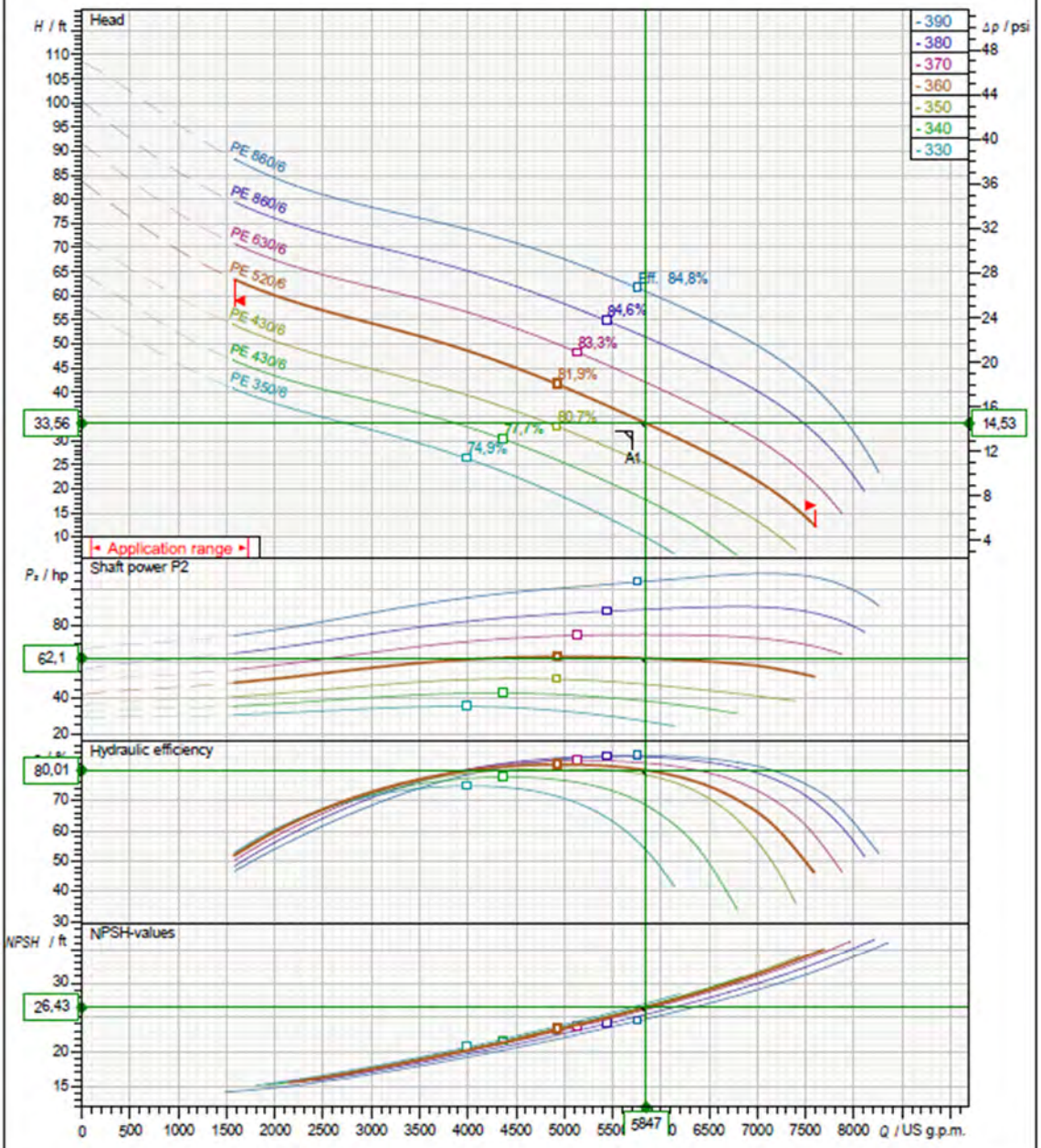
Data version Jan 2019

Curve number	Pump performance curves	SULZER
Reference curve XFP 305J-CB2 60 HZ	**XFP 305J-CB2 60 HZ**	

				Discharge DN300	Frequency 60 Hz
Density 62,32 lb/ft³	Viscosity 1,082E-5 ft²/s	Testnorm ISO9906:2012,HI 11.6/14.6 Gr2B		Rated speed 1191 rpm	Date 2019-07-24
Flow 5850 US g.p.m.	Head 33,6 ft	Rated power 62,1 hp	Power input 65,8 hp	Hydraulic efficiency 80 %	NPSH 26,4 ft



Impeller size	N° of vanes	Impeller	Solid size	Revision
14,2 inch	2	Contrablock Plus impeller	4,72 x 6,3 inch	

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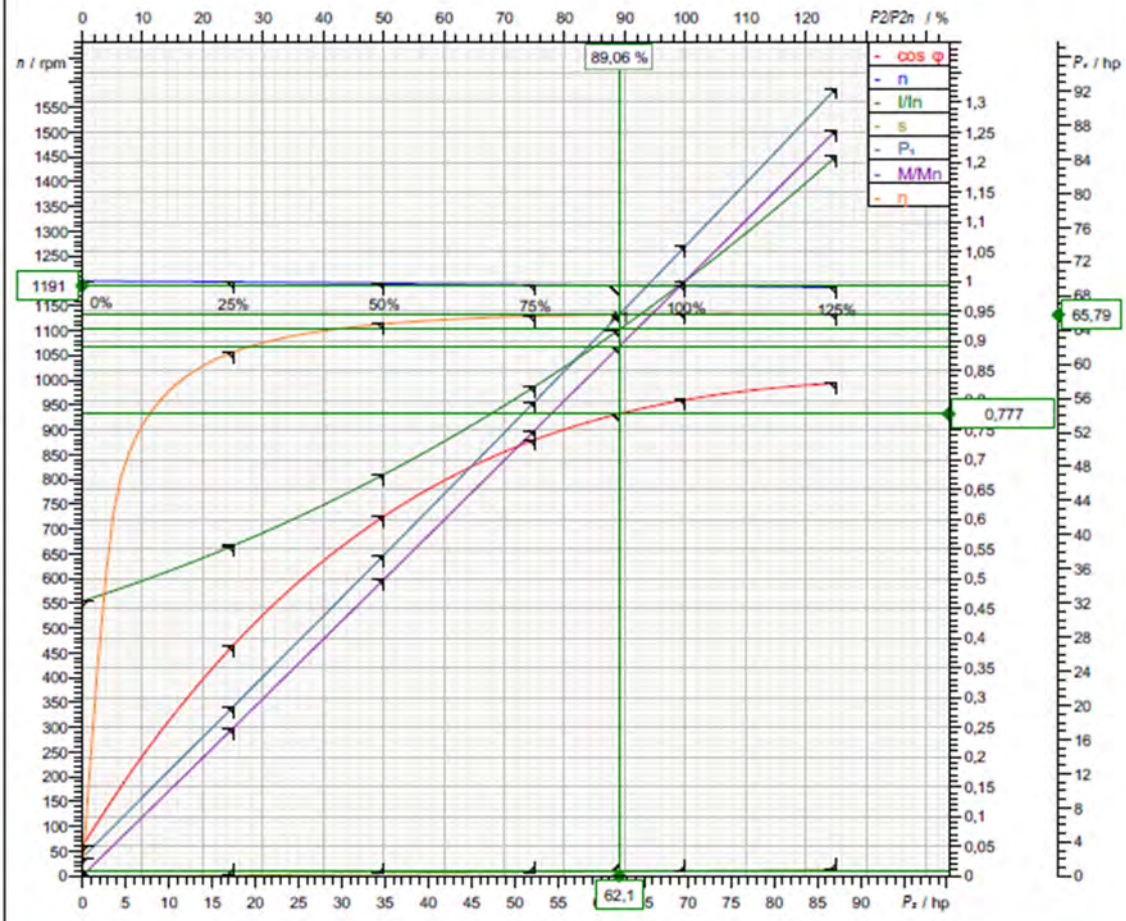
Frequency	PE5
60 Hz	

Motor performance curve

PE 520/6

SULZER

Rated power	Service factor	Nominal Speed	Number of poles	Rated voltage	Date
69,7 hp	1,3	1190 rpm	6	480 V	2019-07-24



Symbol	No load	25 %	50 %	75 %	100 %	125 %
P_2 / hp	0	17,43	34,87	52,3	69,73	87,17
P_1 / hp	2,13	19,8	37,57	55,57	73,79	92,31
η / %	0	88,03	92,79	94,11	94,5	94,42
n / rpm	1200	1198	1195	1192	1190	1187
cos φ	0,05001	0,387	0,6041	0,7329	0,8003	0,828
I / A	38,2	45,9	55,79	68,01	82,7	100
s / %	0,0009921	0,1617	0,4266	0,6567	0,8383	1,082
M / lbf ft	0	76,43	153,3	230,4	307,8	385,7

Tolerance according to VDE 0530 T1 12.84 for rated power

Starting current	Starting torque	Moment of inertia	No. starts per hour
819 A	1140 lbf ft	37 lb ft²	10

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3.17.8. Twenty-Seventh Street Pump Station, Pumps 2-5

No: M-10.2161 - 03 Dat/Nam.: 16.04.2018 / K. Srb Cad Code: M_102161	AFLX 1203 G3
Technical changes reserved Änderungen vorbehalten Sous réserve de modifications	Dimension sheet PE7 Maßblatt PE7 Plan d'encombrement PE7

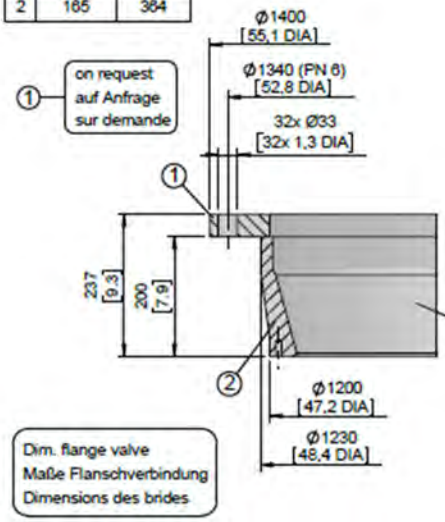
SULZER

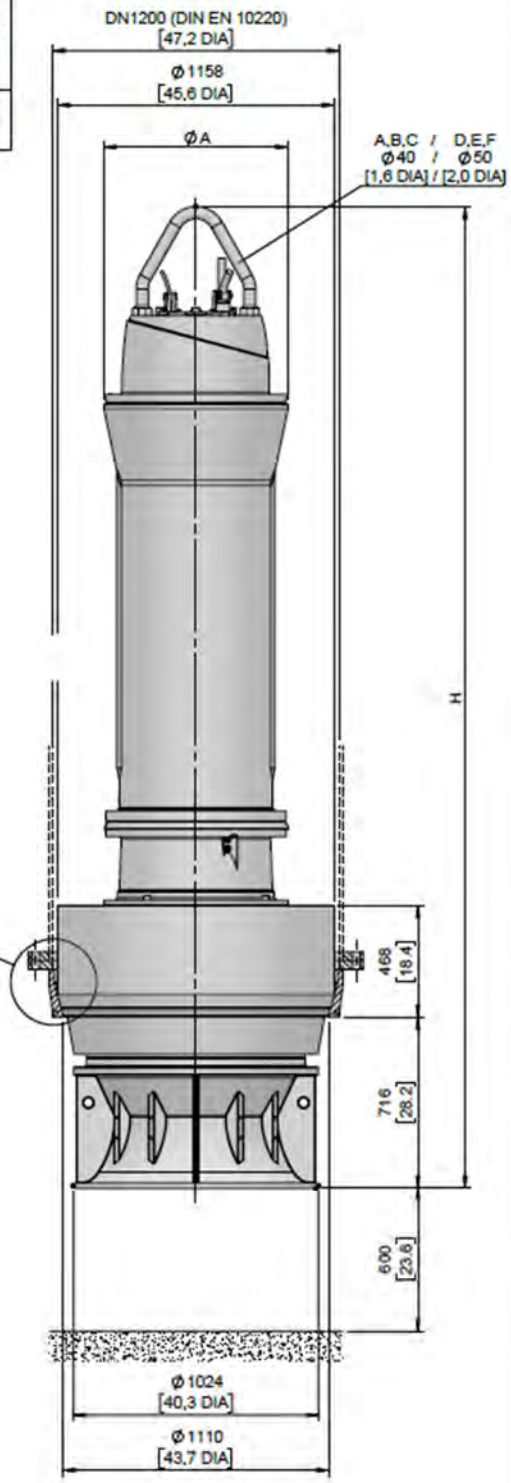
Type Typ Type 50Hz	Type Typ Type 60Hz	Weight Gewicht Poids		H		ØA		Size
		(~kg)	(~lb)	(mm)	(inch)	(mm)	(inch)	
PE 3500/4	PE 4000/4-60	4100	9041	3422	134.7	675	26.6	B
PE 4000/4	PE 4680/4-60	4130	9107					

Weight: Includes pump and 10m cable
Gewicht: Beinhaltet Pumpe und 10m Kabel
Poids: Pompe et 10m de câble

For different cable length see IOM, chapter 1.5
Für abweichende Kabellänge siehe EBA, Kapitel 1.5
Pour des longueurs supérieures, voir la section 1.5 du manuel

	Weight Gewicht Poids (~kg)	Weight Gewicht Poids (~lb)
1	110	243
2	165	364





[mm / [inch]]

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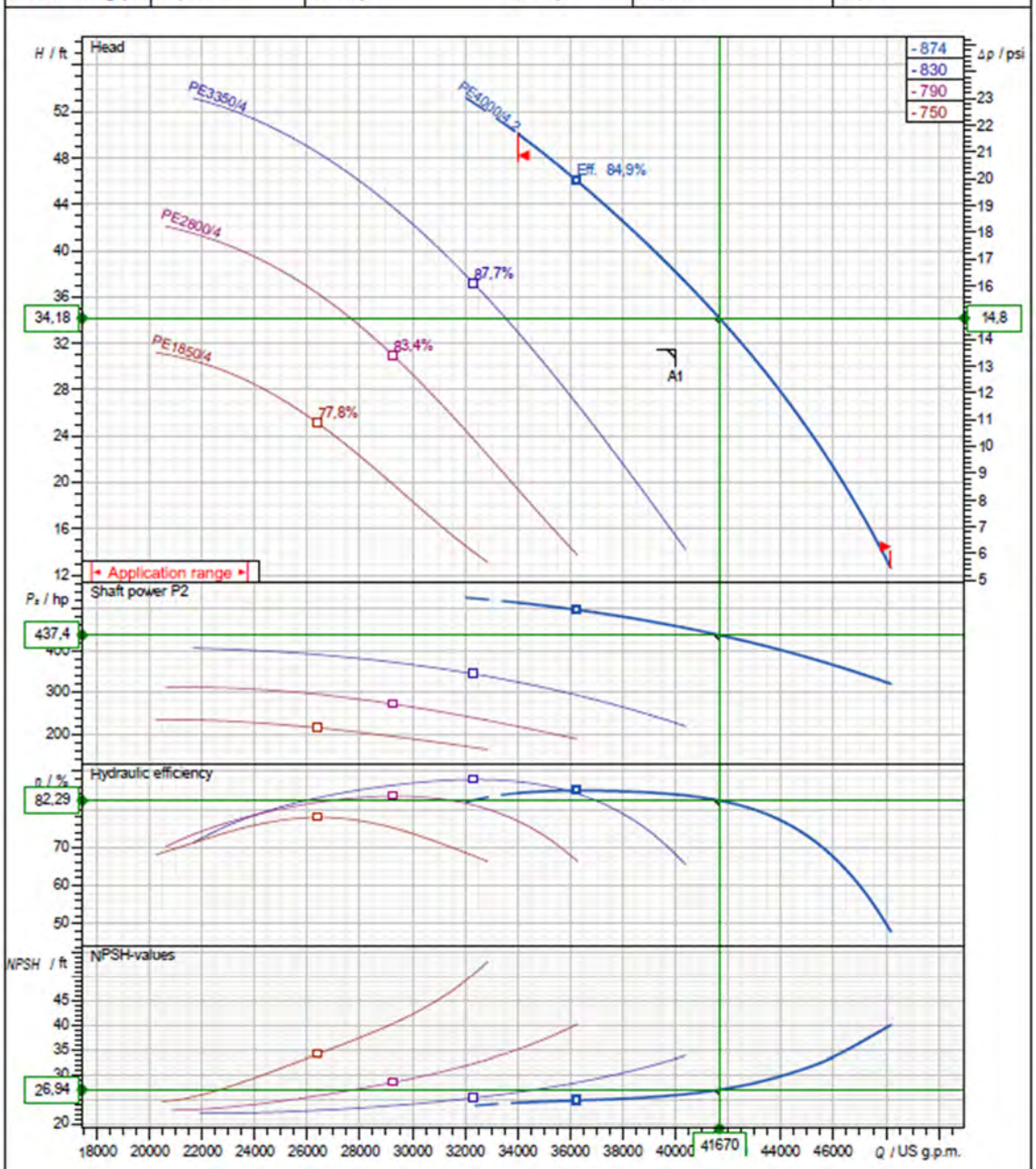
Curve number	Pump performance curves	SULZER
Reference curve AFL 1203 60 HZ	**AFLX 1203 60 HZ**	

				Discharge DN1200	Frequency 60 Hz
Density 62,32 lb/ft³	Viscosity 1,082E-5 ft²/s	Testnorm ISO9906:2012,HI 11.6/14.6 Gr2B		Rated speed 597 rpm	Date 2019-07-24
Flow 41700 US g.p.m	Head 34,2 ft	Rated power 437 hp	Power input 472 hp	Hydraulic efficiency 82,3 %	NPSH 26,9 ft



Impeller size	N° of vanes	Impeller	Solid size	Revision
34,4 inch	5	Semi-open impeller	10 x 4,13 inch	

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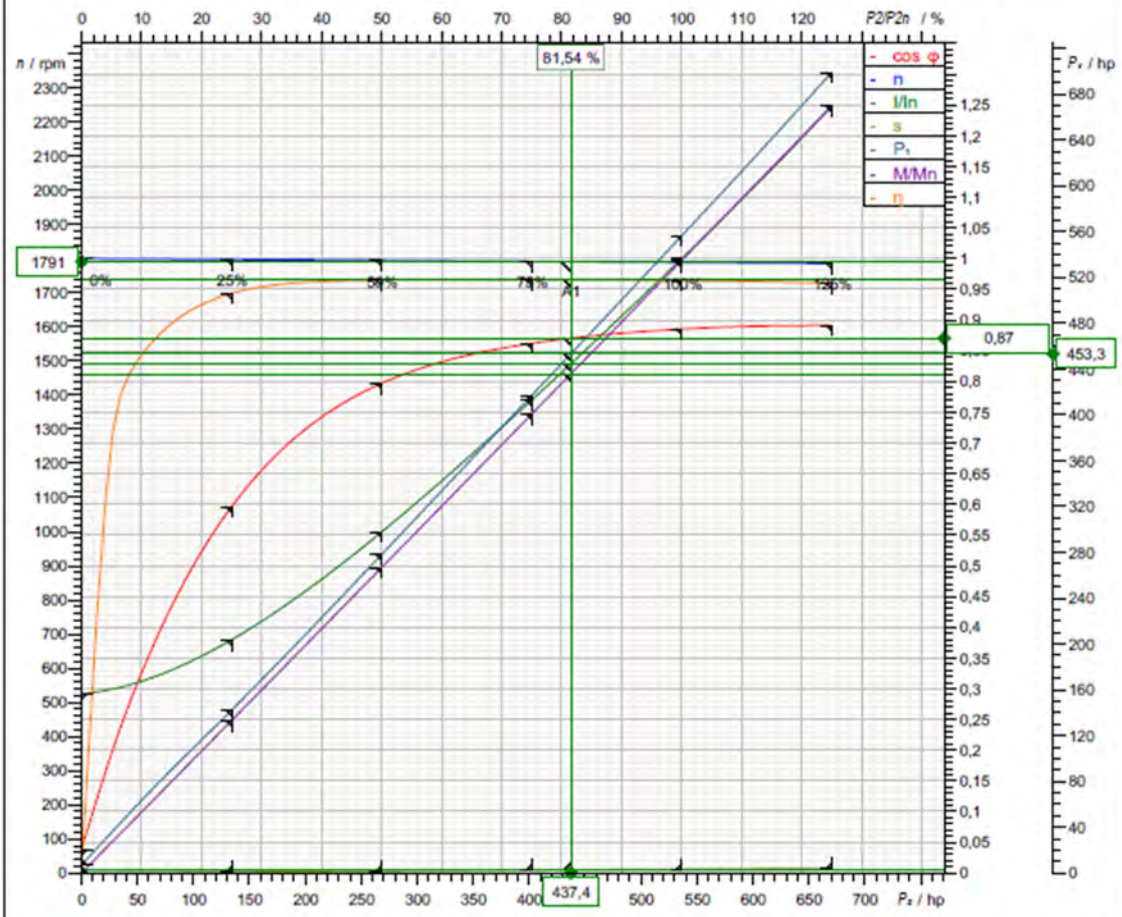
Data version Jan 2019

Frequency 60 Hz	PE7	Motor performance curve PE4000/4.2	SULZER

Rated power	Service factor	Nominal Speed	Number of poles	Rated voltage	Date
536 hp	1	1780 rpm	4	480 V	2019-07-24



Symbol	No load	25 %	50 %	75 %	100 %	125 %
P_2 / hp	0	134,1	268,2	402,3	536,4	670,5
P_1 / hp	6,962	142,2	278	416,9	556,3	698,9
η / %	0	94,33	96,49	96,51	96,43	95,94
n / rpm	1800	1797	1794	1792	1789	1786
cos φ	0,038	0,596	0,797	0,862	0,8852	0,891
I / A	164,3	213,9	312,8	433,8	563,7	703,6
s / %	0	0,1551	0,3064	0,4602	0,6171	0,7721
M / lbf ft	0	391,9	785	1179	1575	1972

Tolerance according to VDE 0530 T1 12.84 for rated power

Starting current	Starting torque	Moment of inertia	No. starts per hour
4680 A	4410 lbf ft	180 lb ft²	10

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Data version Jan 2019

3.17.9. Thirty-Fourth Street Pump Station, Pumps 3-6

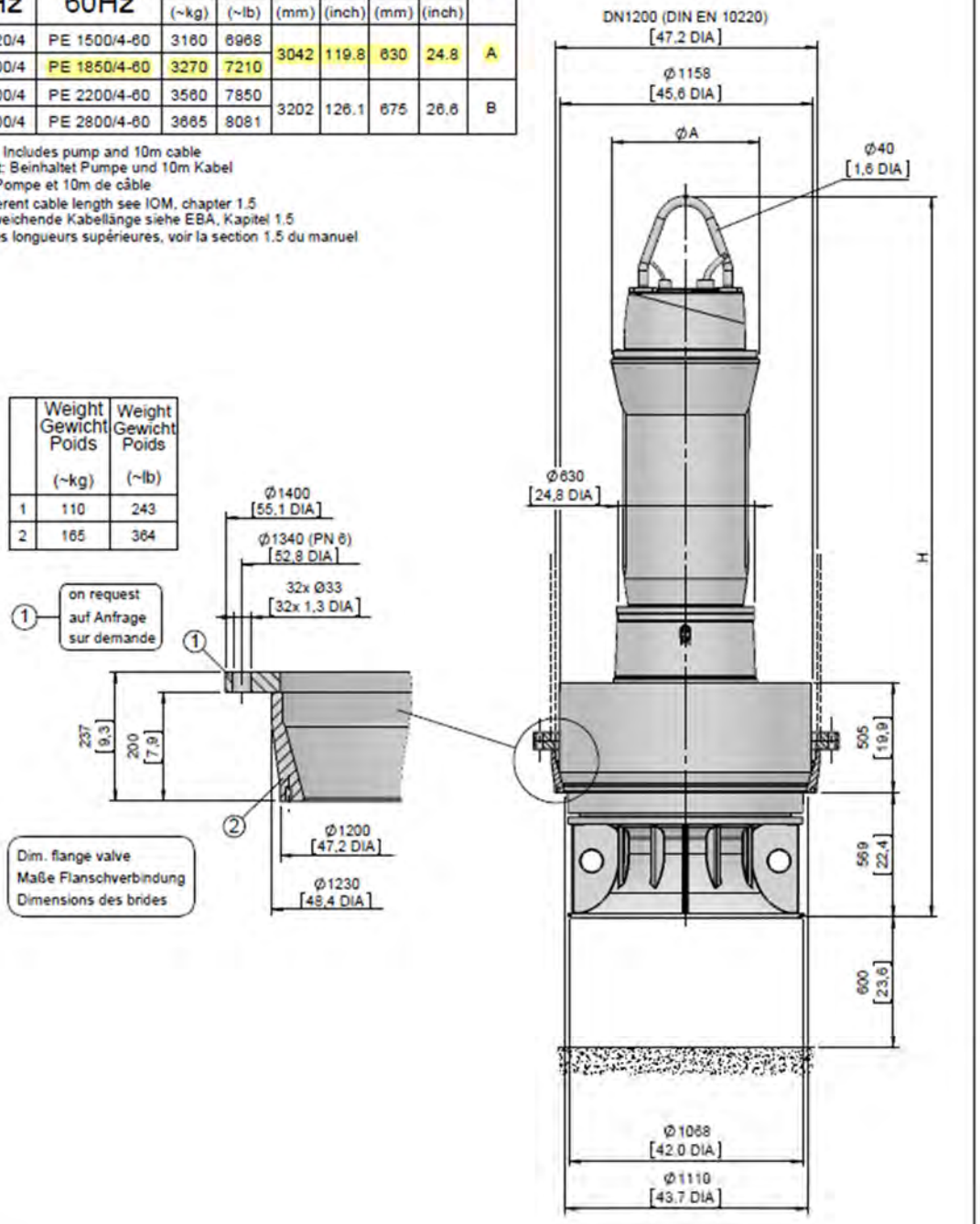
No: M-10.2147 - 05	2	AFLX 1207 G3
Dat/Nam.: 07.06.2016 / K. Srb		Dimension sheet PE6
Cad Code: M_102147		Maßblatt PE6
Technical changes reserved Änderungen vorbehalten Sous réserve de modifications		Plan d'encombrement PE6

SULZER

Type Typ Type 50Hz	Type Typ Type 60Hz	Weight Gewicht Poids		H		ØA		Size
		(~kg)	(~lb)	(mm)	(inch)	(mm)	(inch)	
PE 1320/4	PE 1500/4-60	3160	6968	3042	119.8	630	24.8	A
PE 1600/4	PE 1850/4-60	3270	7210					
PE 2000/4	PE 2200/4-60	3560	7850	3202	126.1	675	26.6	B
PE 2500/4	PE 2800/4-60	3665	8081					

Weight: Includes pump and 10m cable
Gewicht: Beinhaltet Pumpe und 10m Kabel
Poids: Pompe et 10m de câble
For different cable length see IOM, chapter 1.5
Für abweichende Kabellänge siehe EBA, Kapitel 1.5
Pour des longueurs supérieures, voir la section 1.5 du manuel

	Weight Gewicht Poids (~kg)	Weight Gewicht Poids (~lb)
1	110	243
2	165	364



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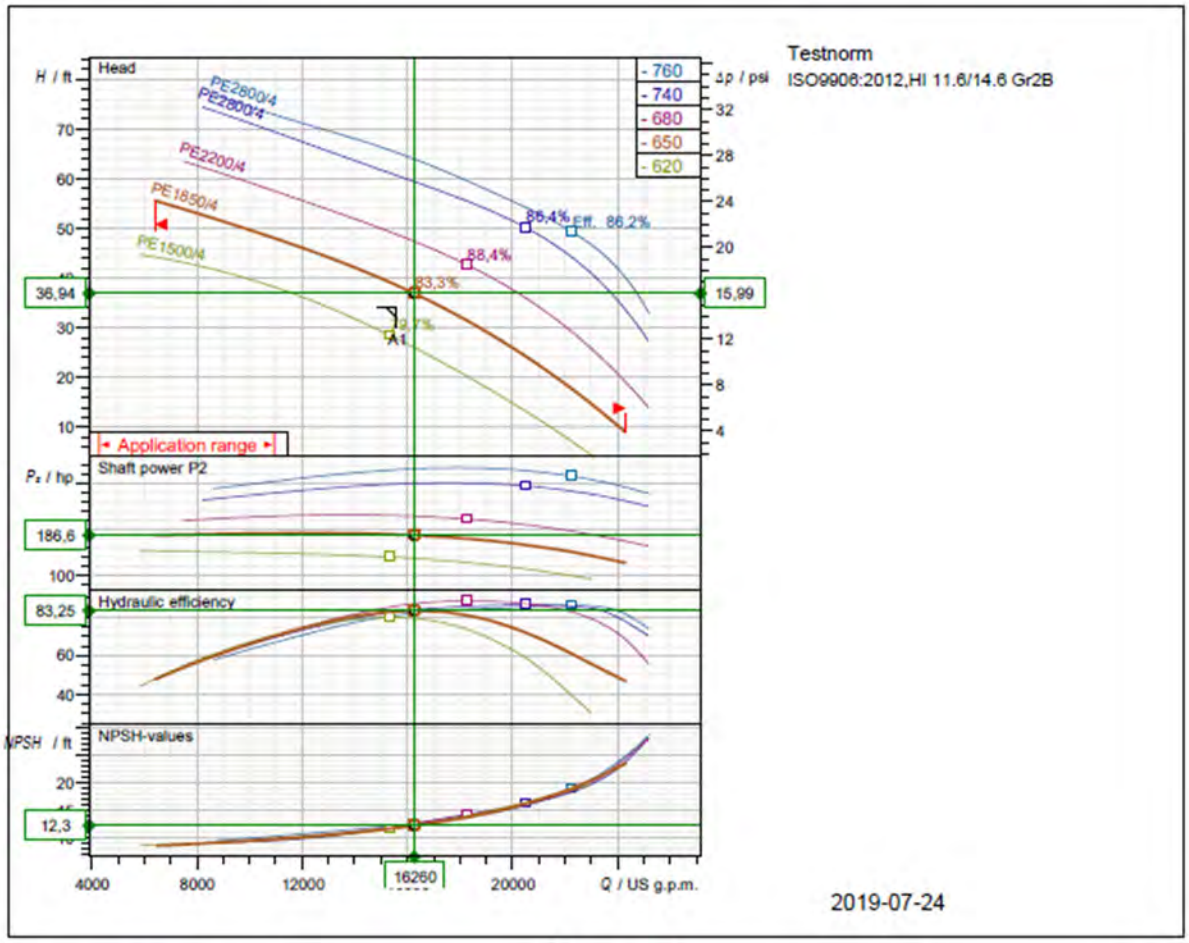
SULZER

AFLX 1207 60 HZ



Operating data specification			
Flow	16300 US g.p.m.	Power input	202 hp
Efficiency	83,2 %	Head	36,9 ft
NPSH	12,3 ft	Rated power	187 hp
Temperature	68 °F	Fluid	Water
No. of pumps	1	Nature of system	Single head pump
Pump data			
Type	AFLX 1207 60 HZ	Make	SULZER
Series	AFLX	Impeller	Semi-open impeller
N° of vanes	5	Impeller size	25,6 inch
Free passage	6,5 x 3,94 inch	Suction flange	
Discharge flange	DN1200	Type of installation	
Moment of inertia	214 lb ft²		installation with steel riser pipe PE
Motor data			
Rated voltage	480 V	Frequency	60 Hz
Rated power P2	248 hp	Nominal Speed	1790 rpm
Number of poles	4	Efficiency	95,9 %
Power factor	0,873	Rated current	266 A
Starting current	2120 A	Rated torque	728 lbf ft
Starting torque	1970 lbf ft	Degree of protection	IP 68
Insulation class	H(140)	No. starts per hour	10

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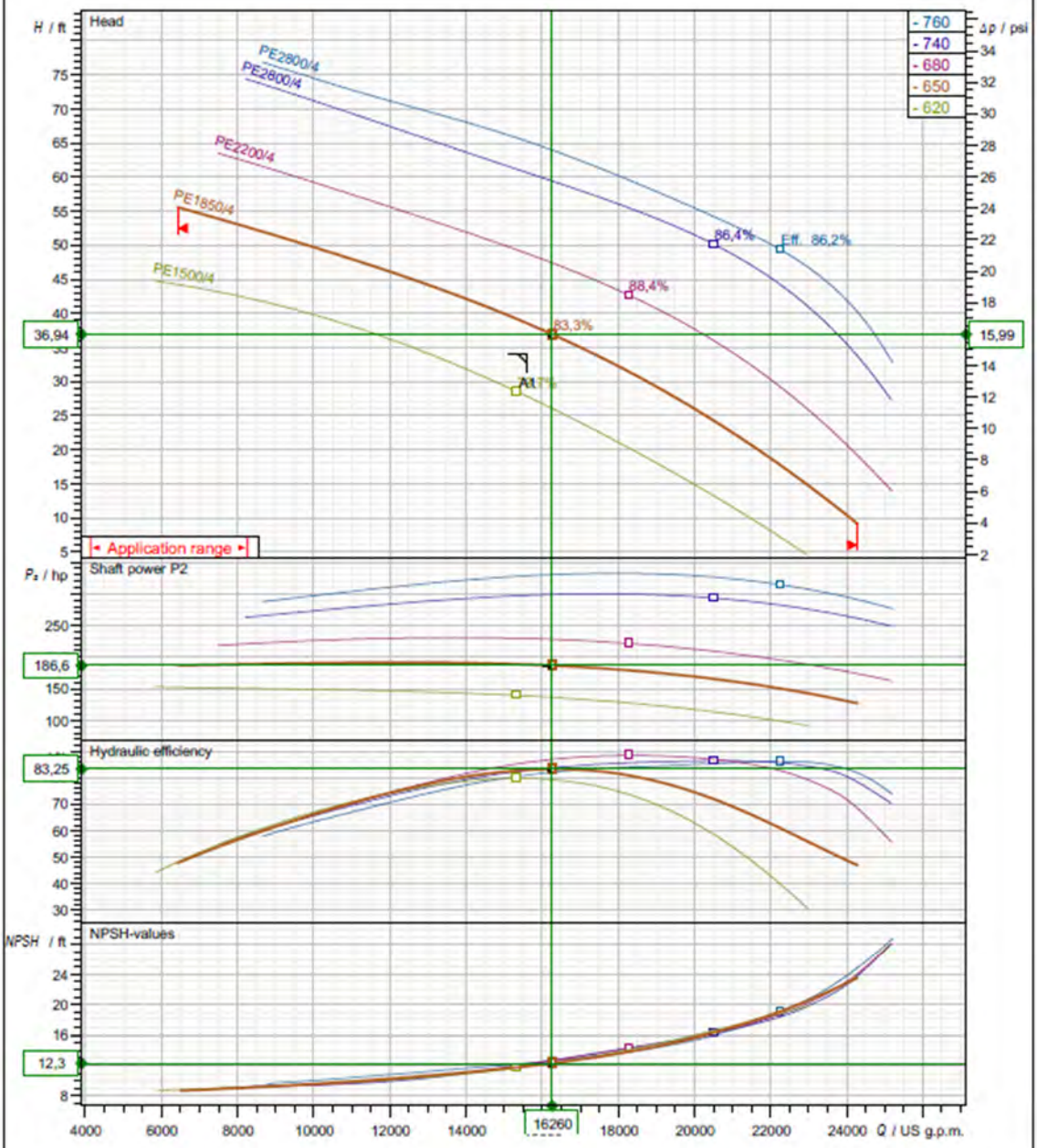
Curve number	Pump performance curves	SULZER
Reference curve AFL 1207 60 HZ	**AFLX 1207 60 HZ**	

				Discharge DN1200	Frequency 60 Hz
Density 62,32 lb/ft³	Viscosity 1,082E-5 ft²/s	Testnorm ISO9906:2012,HI 11.6/14.6 Gr2B		Rated speed 597,5 rpm	Date 2019-07-24
Flow 16300 US g.p.m	Head 36,9 ft	Rated power 187 hp	Power input 202 hp	Hydraulic efficiency 83,2 %	NPSH 12,3 ft



Impeller size	N° of vanes	Impeller	Solid size	Revision
25,6 inch	5	Semi-open impeller	6,5 x 3,94 inch	

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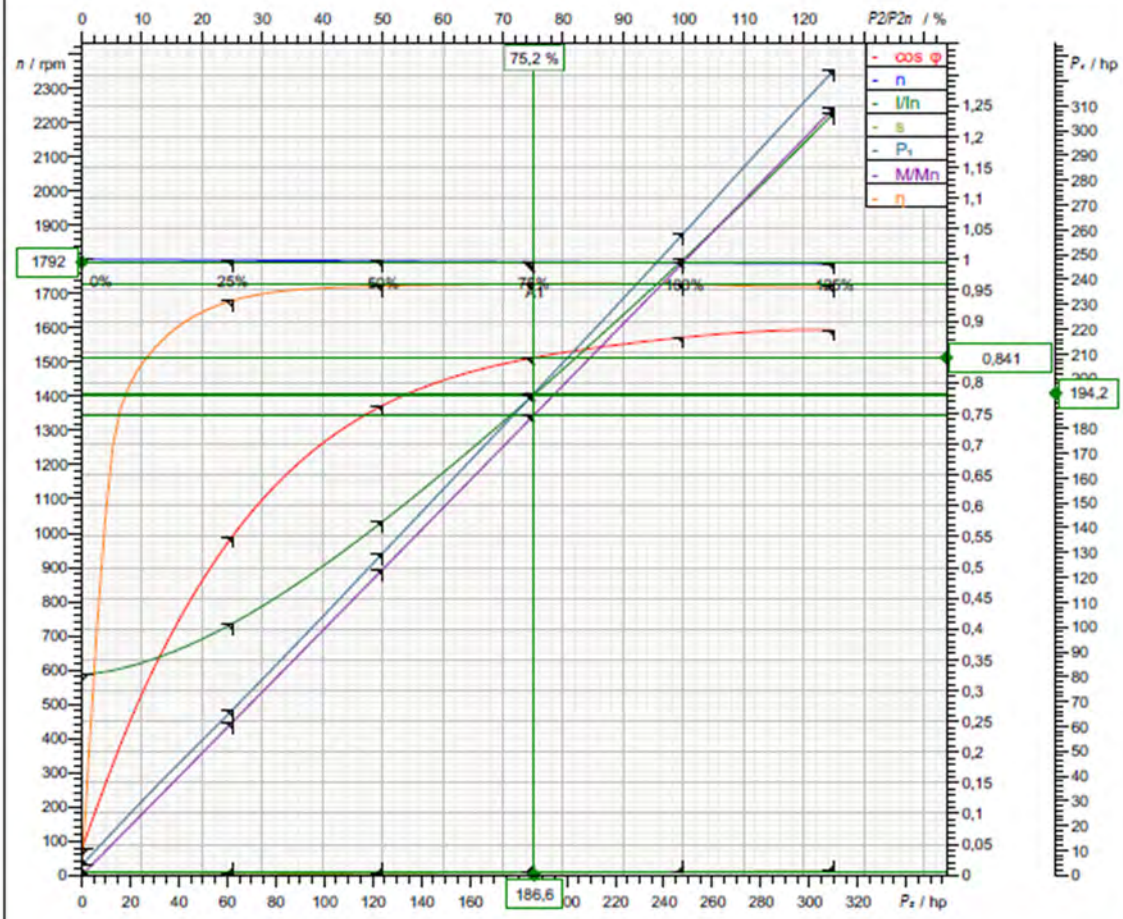
Data version Jan 2019

Frequency 60 Hz	PE6	Motor performance curve PE1850/4	SULZER

Rated power	Service factor	Nominal Speed	Number of poles	Rated voltage	Date
248 hp	1	1780 rpm	4	480 V	2019-07-24



Symbol	No load	25 %	50 %	75 %	100 %	125 %
P_2 / hp	0	62,02	124	186,1	248,1	310,1
P_1 / hp	4,047	66,47	129,6	193,7	258,5	324,3
η / %	0	93,31	95,68	96,07	95,95	95,62
n / rpm	1800	1798	1795	1792	1790	1788
cos φ	0,04207	0,5496	0,7627	0,8403	0,8734	0,8849
I / A	86,29	108,5	152,5	206,7	265,5	328,7
s / %	0	0,1389	0,2778	0,4167	0,5556	0,6944
M / lbf ft	0	181,2	363	545,2	728	911,2

Tolerance according to VDE 0530 T1 12.84 for rated power

Starting current	Starting torque	Moment of inertia	No. starts per hour
2120 A	1970 lbf ft	90,4 lb ft²	10

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Data version Jan 2019

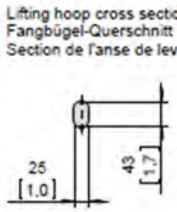
3.17.10. Shawnee Park Pump Station, Pump 1

No: M-10.2149 - 05	2	VUPX 0501/2
Dat/Nam.: 29.04.2016 / K. Srb		Dimension sheet PE4
Cad Code: M_102149		Maßblatt PE4
Technical changes reserved Änderungen vorbehalten Sous réserve de modifications		Plan d'encombrement PE4

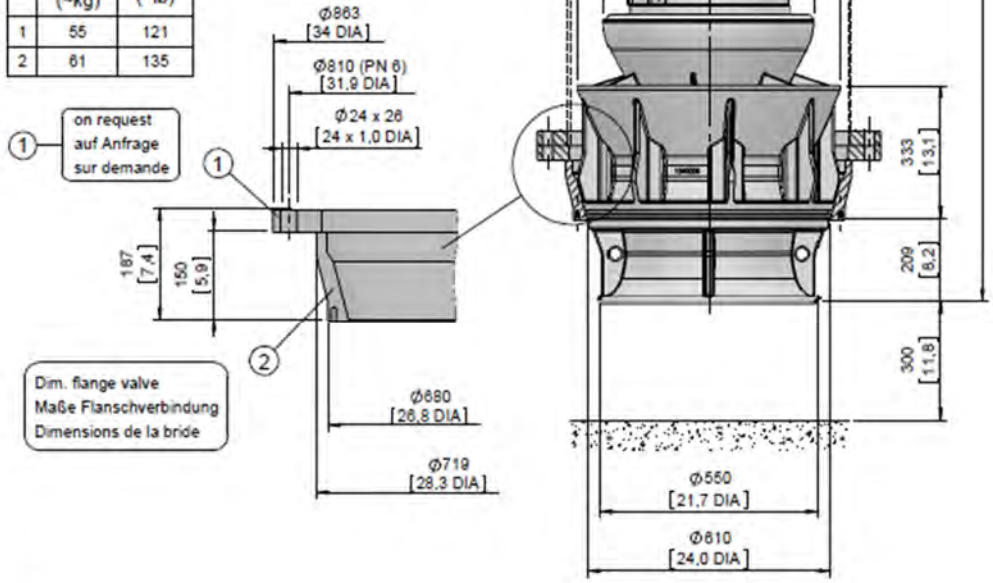
SULZER

Type Typ Type 50Hz	Type Typ Type 60Hz	Weight Gewicht Poids		H		Size
		(~kg)	(~lb)	(mm)	(inch)	
PE 300/6		835	1841	1941	76.4	B
PE 370/6		850	1874			
PE 150/8		760	1676	1861	73.3	A
PE 185/8	PE 210/8-60	805	1775	1941	76.4	B
PE 220/8	PE 250/8-60	835	1841			
PE 300/8	PE 350/8-60	850	1874			

Weight: Includes pump and 10m cable
Gewicht: Beinhaltet Pumpe und 10m Kabel
Poids: Pompe et 10m de câble
For different cable length see IOM, chapter 1.5
Für abweichende Kabellänge siehe EBA, Kapitel 1.5
Pour des longueurs supérieures, voir la section 1.5 du manuel



	Weight Gewicht Poids (~kg)	Weight Gewicht Poids (~lb)
1	55	121
2	61	135



[mm / [inch]]

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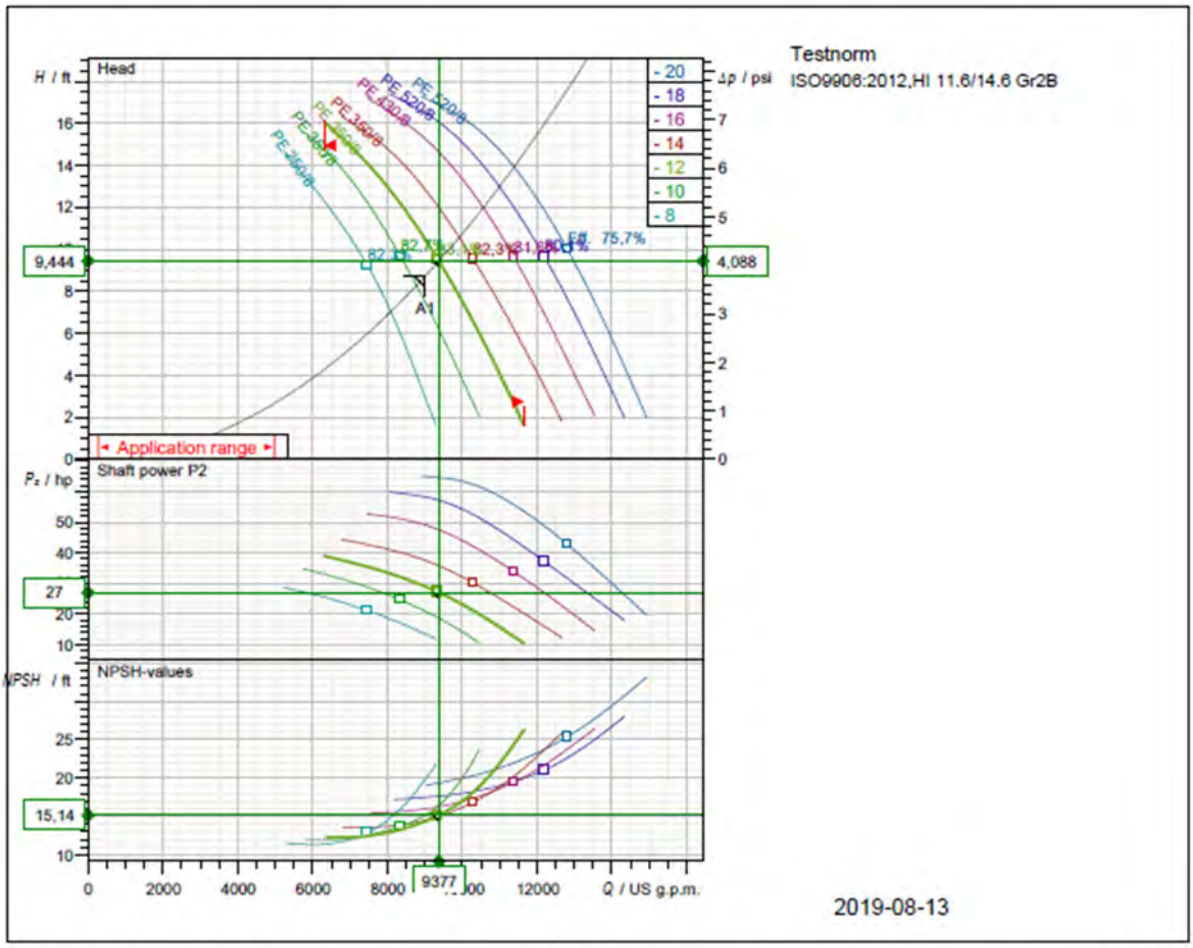
SULZER

VUPX 0501 60 HZ



Operating data specification			
Flow	9380 US g.p.m.	Power input	29,8 hp
Efficiency	83,1 %	Head	9,44 ft
NPSH	15,1 ft	Rated power	27 hp
Temperature	68 °F	Fluid	Water
No. of pumps	1	Nature of system	Single head pump
Pump data			
Type	VUPX 0501 60 HZ	Make	SULZER
Series	VUPX	Impeller	Propeller
N° of vanes	3	Impeller size	18,1 inch
Free passage	3,35 inch	Suction flange	
Discharge flange	DN700	Type of installation	
Moment of inertia	7,12 lb ft²		installation with steel riser pipe PE
Motor data			
Rated voltage	480 V	Frequency	60 Hz
Rated power P2	46,9 hp	Nominal Speed	878 rpm
Number of poles	8	Efficiency	91,4 %
Power factor	0,75	Rated current	61,4 A
Starting current	295 A	Rated torque	281 lbf ft
Starting torque	477 lbf ft	Degree of protection	IP 68
Insulation class	H(140)	No. starts per hour	10

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Data version Jan 2019

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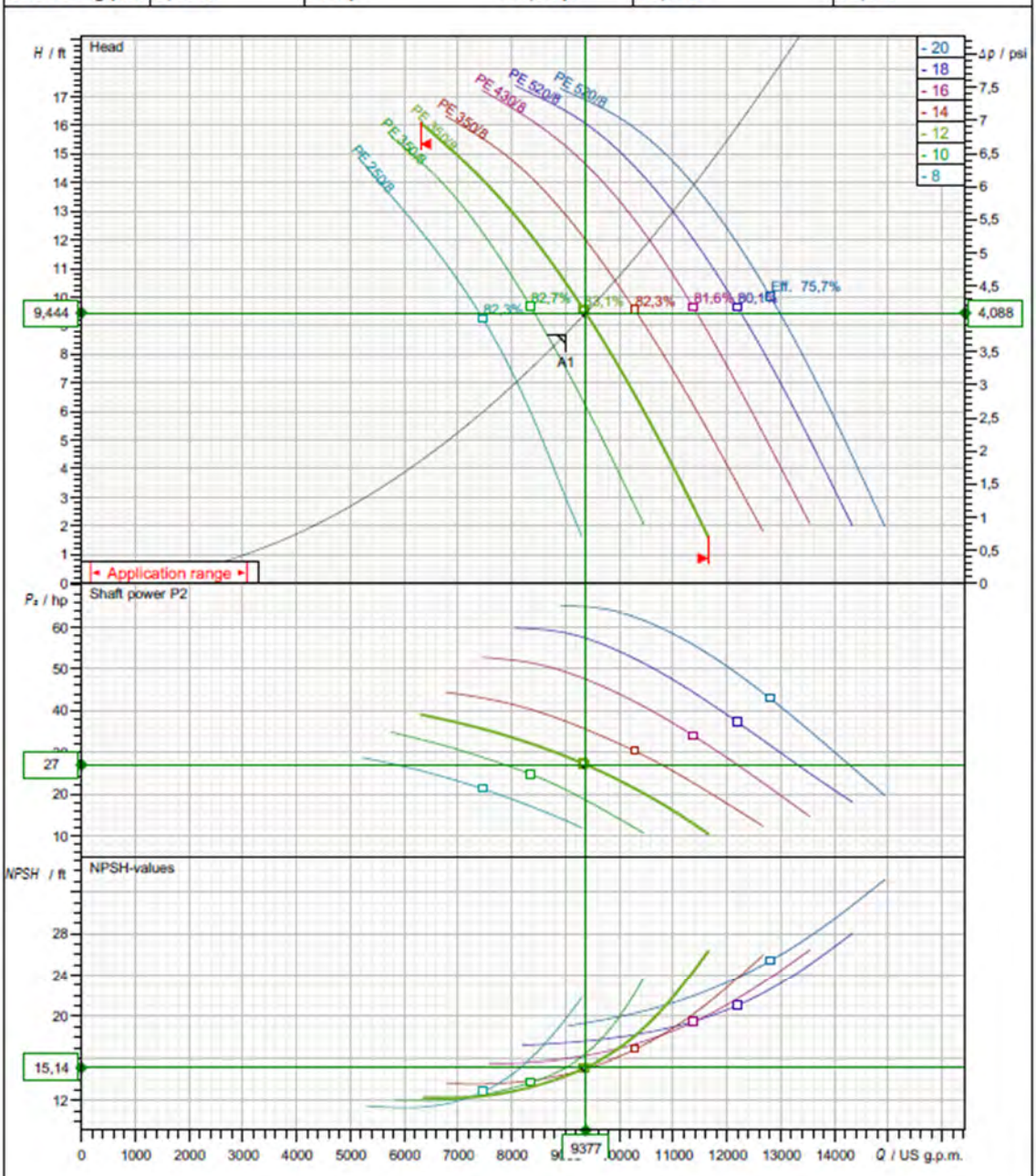
Curve number	Pump performance curves	SULZER
Reference curve VUP 0501 60 HZ	VUPX 0501 60 HZ	

				Discharge DN700	Frequency 60 Hz
Density 62,32 lb/ft³	Viscosity 1,082E-5 ft²/s	Testnorm ISO9906:2012,HI 11.6/14.6 Gr2B		Rated speed 888,2 rpm	Date 2019-08-13
Flow 9380 US g.p.m.	Head 9,44 ft	Rated power 27 hp	Power input 29,8 hp	Hydraulic efficiency 83,1 %	NPSH 15,1 ft



Impeller size	N° of vanes	Impeller	Solid size	Revision
18,1 inch	3	Propeller	3,35 inch	

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Data version Jan 2019

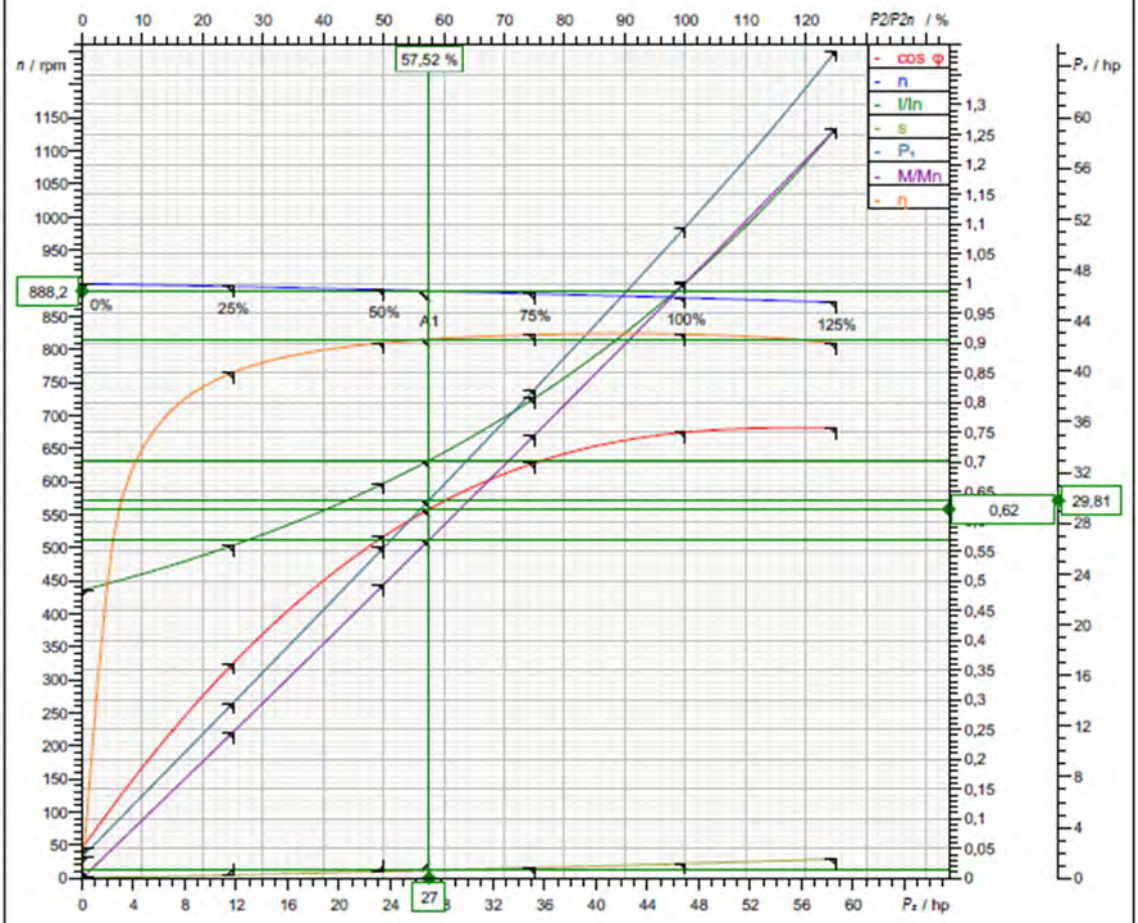
Frequency	PE4
60 Hz	

Motor performance curve

PE 350/8

SULZER

Rated power	Service factor	Nominal Speed	Number of poles	Rated voltage	Date
46,9 hp	1,3	878 rpm	8	480 V	2019-08-13



Symbol	No load	25 %	50 %	75 %	100 %	125 %
P_2 / hp	0	11,73	23,47	35,2	46,94	58,67
P_1 / hp	1,667	13,81	26,08	38,54	51,34	65,26
η / %	0	85	89,98	91,33	91,42	89,9
n / rpm	899	895,1	889,9	884,1	877,9	871
cos φ	0,05031	0,3605	0,5741	0,6979	0,7495	0,7567
I / A	29,72	34,35	40,75	49,53	61,44	77,36
s / %	0,1124	0,5489	1,124	1,765	2,451	3,221
M / lbf ft	0	68,86	138,5	209,1	280,8	353,8

Tolerance according to VDE 0530 T1 12.84 for rated power

Starting current	Starting torque	Moment of inertia	No. starts per hour
295 A	477 lbf ft	14,5 lb ft²	10

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Data version Jan 2019

3.17.11. Shawnee Park Pump Station, Pump 7

No: M-02.3008 - 02	2	XFP 155J-CB2
Dat/Nam.: 07.04.2016 / K. Srb		Dimension sheet PE4 WET WELL Installation
Cad Code: M_023008		Maßblatt PE4 Nassinstallation
Technical changes reserved Änderungen vorbehalten Sous réserve de modifications		Plan d'encombrement PE4 installation submersible

SULZER

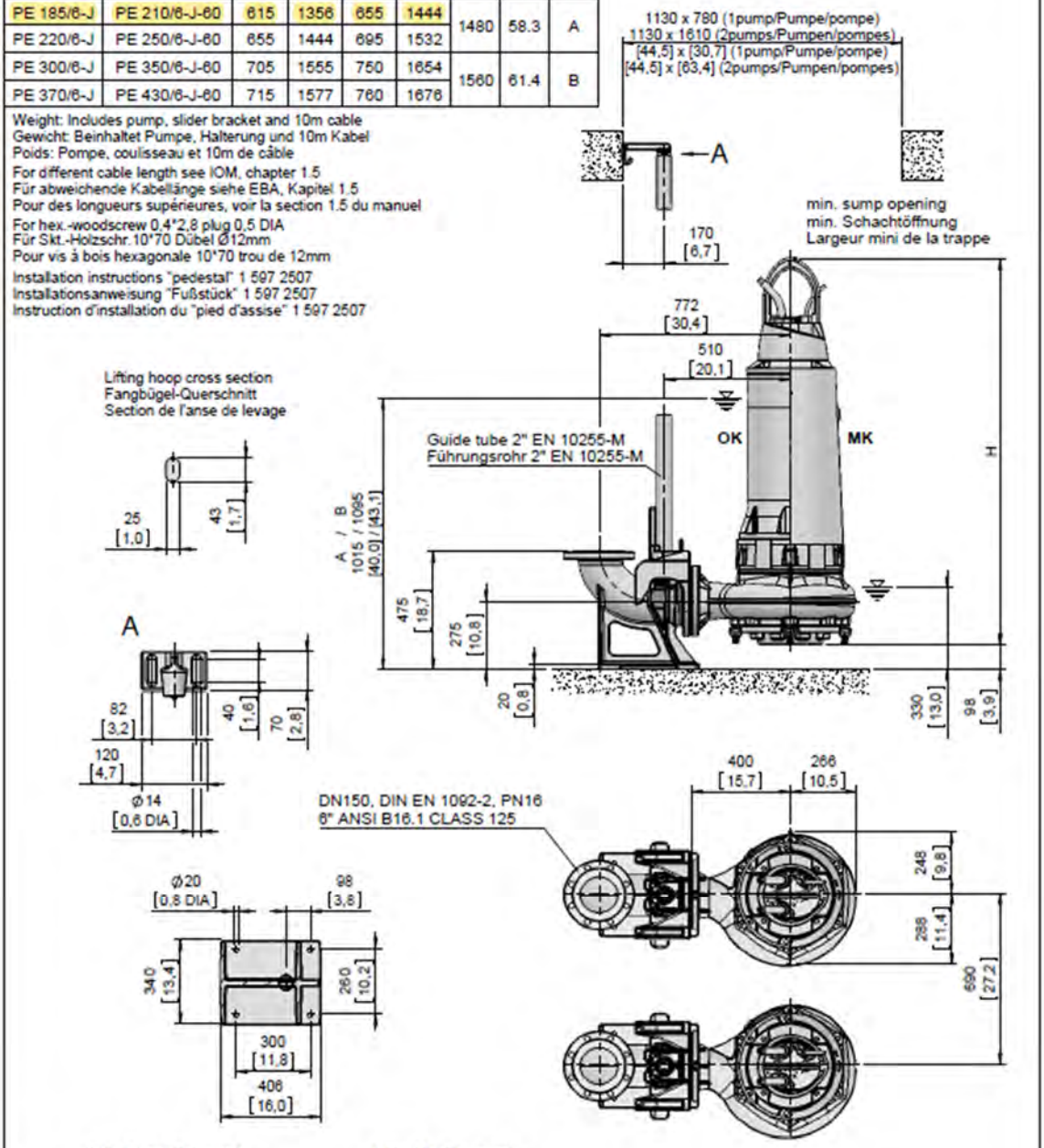
Type Typ Type 50Hz	Type Typ Type 60Hz	Weight Gewicht Poids OK		Weight Gewicht Poids MK		H		Size
		(~kg)	(~lb)	(~kg)	(~lb)	(mm)	(inch)	
PE 220/4-J	PE 250/4-J-60	610	1345	650	1433	1480	58.3	A
PE 300/4-J	PE 350/4-J-60	645	1422	685	1510			
PE 370/4-J	PE 430/4-J-60	680	1499	725	1599	1560	61.4	B
PE 450/4-J	PE 520/4-J-60	710	1566	755	1665			
PE 185/6-J	PE 210/6-J-60	615	1356	655	1444	1480	58.3	A
PE 220/6-J	PE 250/6-J-60	655	1444	695	1532			
PE 300/6-J	PE 350/6-J-60	705	1555	750	1654	1560	61.4	B
PE 370/6-J	PE 430/6-J-60	715	1577	760	1676			

Weight: Includes pump, slider bracket and 10m cable
Gewicht: Beinhaltet Pumpe, Halterung und 10m Kabel
Poids: Pompe, coulisseau et 10m de câble

For different cable length see IOM, chapter 1.5
Für abweichende Kabellänge siehe EBA, Kapitel 1.5
Pour des longueurs supérieures, voir la section 1.5 du manuel

For hex.-woodscrew 0,4*2,8 plug 0,5 DIA
Für Skt.-Holzschr.10*70 Dübel Ø12mm
Pour vis à bois hexagonale 10*70 trou de 12mm

Installation instructions "pedestal" 1 597 2507
Installationsanweisung "Fußstück" 1 597 2507
Instruction d'installation du "pied d'assise" 1 597 2507



[mm / [inch]]

OK = Ohne Kühlmantel
Without cooling jacket
Sans enveloppe de refroidissement

MK = Mit Kühlmantel
With cooling jacket
Avec enveloppe de refroidissement

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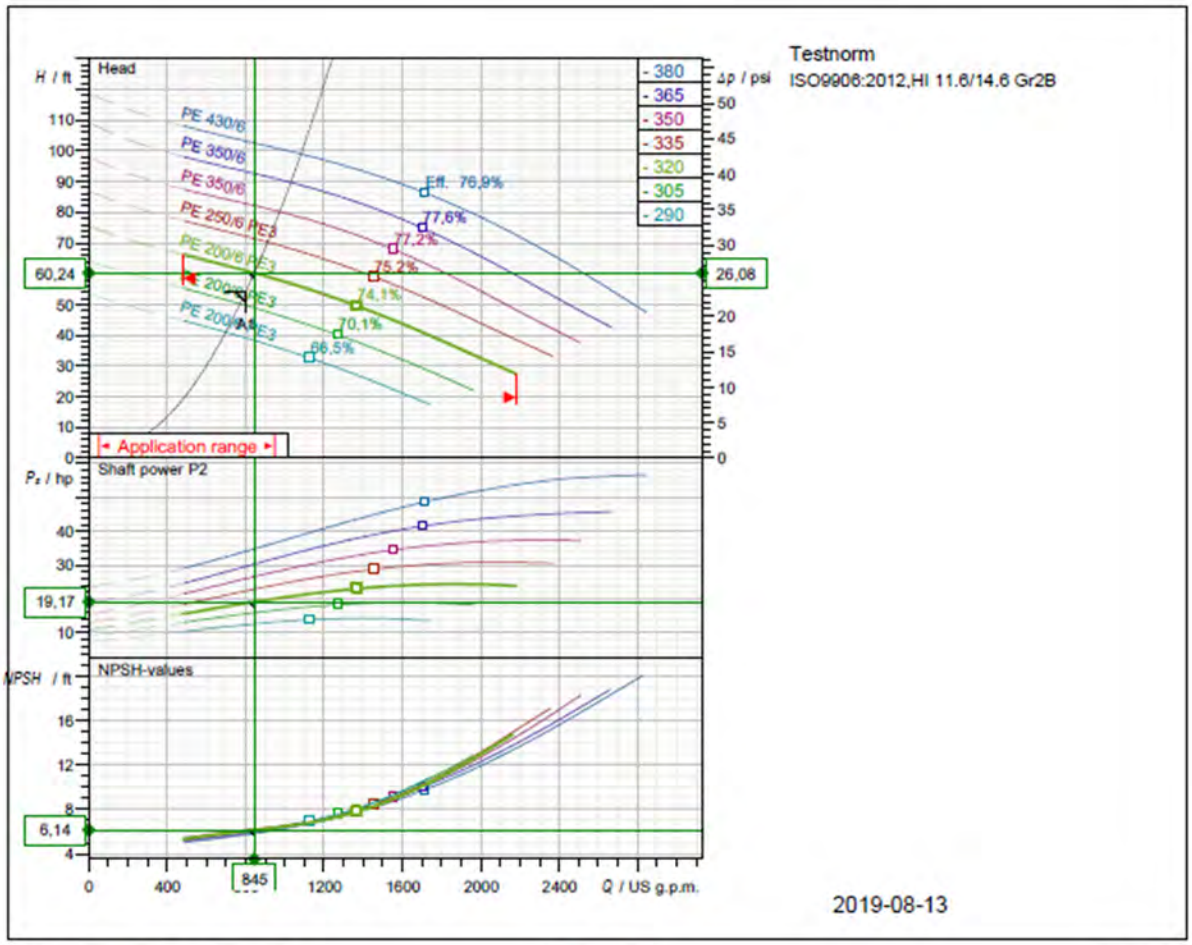
SULZER

XFP 155J-CB2 60 HZ



Operating data specification			
Flow	845 US g.p.m.	Power input	20,6 hp
Efficiency	67,3 %	Head	60,2 ft
NPSH	6,14 ft	Rated power	19,2 hp
Temperature	68 °F	Fluid	Water
No. of pumps	1	Nature of system	Single head pump
Pump data			
Type	XFP 155J-CB2 60 HZ	Make	SULZER
Series	XFP PE4-PE7	Impeller	Contrablock Plus impeller
N° of vanes	2	Impeller size	12,6 inch
Free passage	2,95 x 3,94 inch	Suction flange	DN200
Discharge flange	DN150	Type of installation	
Moment of inertia	14 lb ft²		wet well vertical installation 2"
Motor data			
Rated voltage	460 V	Frequency	60 Hz
Rated power P2	26,8 hp	Nominal Speed	1180 rpm
Number of poles	6	Efficiency	93 %
Power factor	0,826	Rated current	32,7 A
Starting current	233 A	Rated torque	120 lbf ft
Starting torque	312 lbf ft	Degree of protection	IP 68
Insulation class	H	No. starts per hour	15

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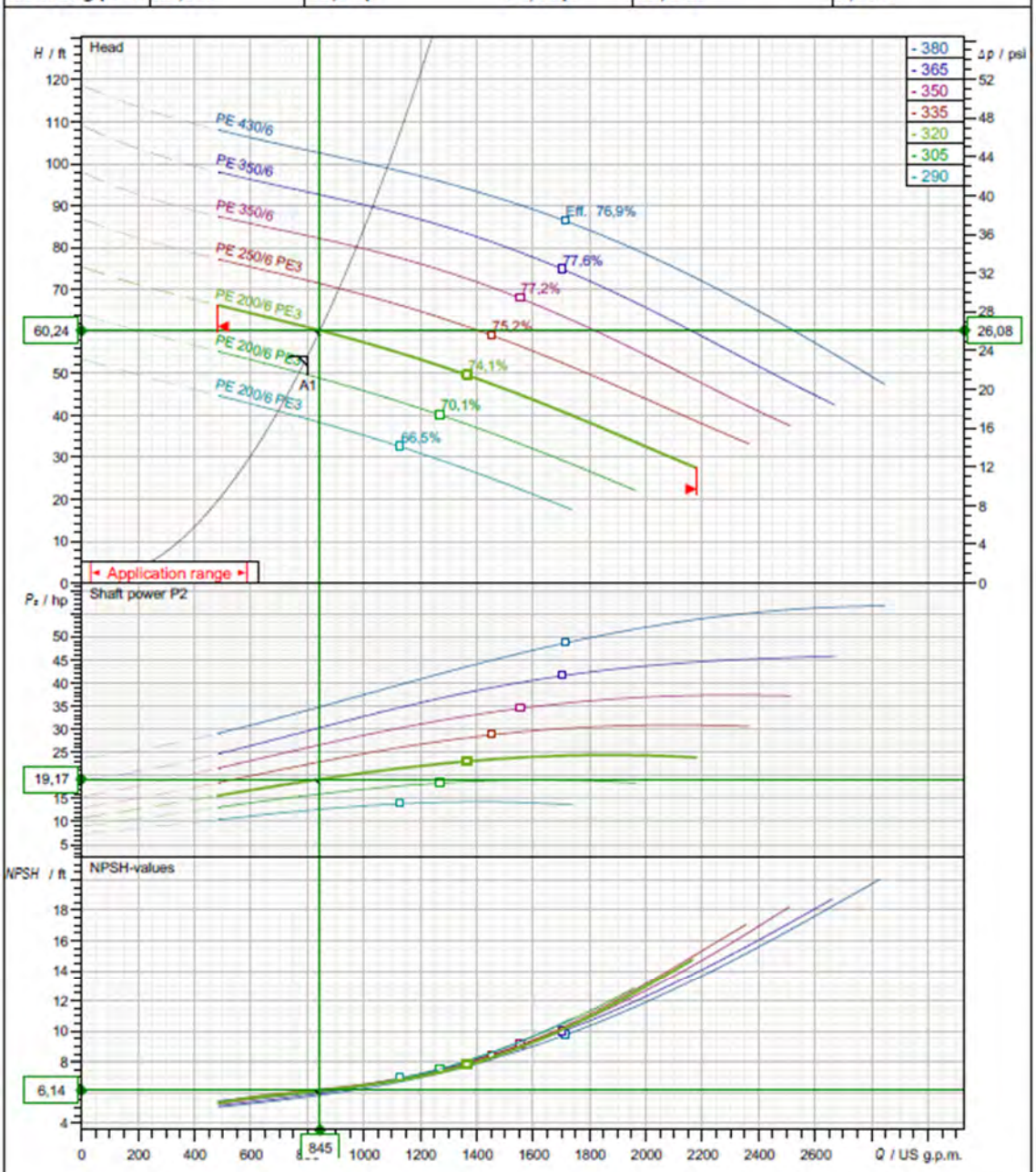
Curve number	Pump performance curves	SULZER
Reference curve XFP 155J-CB2 60Hz	**XFP 155J-CB2 60 HZ**	

				Discharge DN150	Frequency 60 Hz
Density 62,32 lb/ft³	Viscosity 1,082E-5 ft²/s	Testnorm ISO9906:2012,HI 11.6/14.6 Gr2B		Rated speed 1184 rpm	Date 2019-08-13
Flow 845 US g.p.m.	Head 60,2 ft	Rated power 19,2 hp	Power input 20,6 hp	Hydraulic efficiency 67,3 %	NPSH 6,14 ft



Impeller size	N° of vanes	Impeller	Solid size	Revision
12,6 inch	2	Contrablock Plus impeller	2,95 x 3,94 inch	

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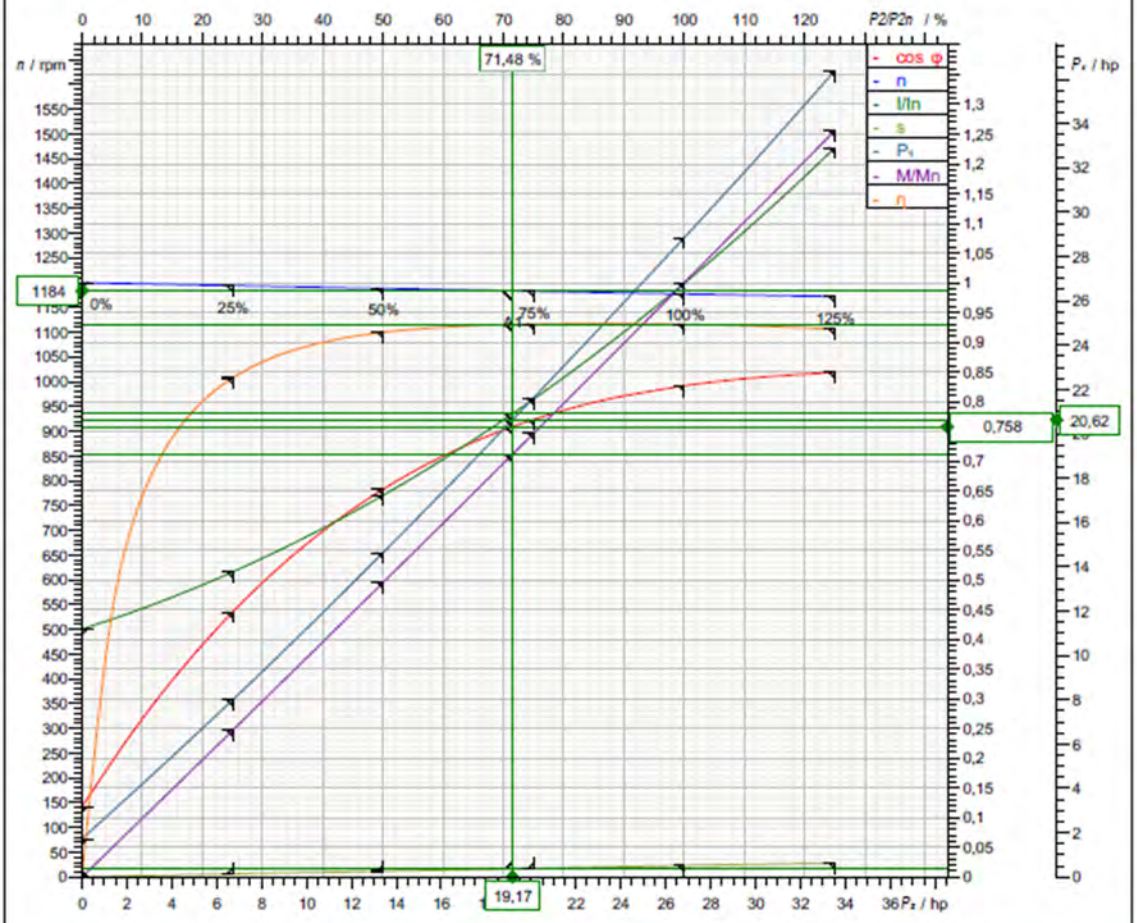
Frequency	PE3
60 Hz	

Motor performance curve

PE 200/6 PE3

SULZER

Rated power	Service factor	Nominal Speed	Number of poles	Rated voltage	Date
26,8 hp	1,3	1180 rpm	6	460 V	2019-08-13



Symbol	No load	25 %	50 %	75 %	100 %	125 %
P_2 / hp	0	6,705	13,41	20,12	26,82	33,53
P_1 / hp	1,721	7,985	14,63	21,62	28,84	36,38
η / %	0	83,97	91,64	93,03	92,98	92,16
n / rpm	1200	1194	1188	1183	1177	1172
cos φ	0,1181	0,4454	0,6522	0,7698	0,8266	0,8489
I / A	13,64	16,78	21	26,29	32,66	40,11
s / %	0	0,5115	0,9769	1,44	1,905	2,336
M / lbf ft	0	29,5	59,28	89,33	119,7	150,2

Tolerance according to VDE 0530 T1 12.84 for rated power

Starting current	Starting torque	Moment of inertia	No. starts per hour
233 A	312 lbf ft	10,4 lb ft²	15

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Data version Jan 2019

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4. Appendix D – Electrical

This appendix lists and describes the current condition of the Louisville levee system and contains recommendations for how to modernize the stations. The Louisville levee system consists of 15 federally funded pump stations: Beargrass Creek pump station (PS), Starkey PS, Fourth Street PS, Fifth Street PS, Tenth Street PS, Seventeenth Street PS, Twenty Seventh Street PS, Thirty Fourth Street PS, Shawnee Park PS, Western PS, Paddy's Run PS, Upper Mill Creek PS, Riverport PS, Lower Mill Creek PS, and Pond Creek PS.

4.1. Louisville Pump Stations

Listed below are the existing conditions of major electrical systems in each pump station, whether these items require replacement, and information on what will be altered with changes to these systems.

4.1.1. Beargrass Creek Pump Station Condition Summary

The Beargrass Creek pump station is dual fed by two 10,000 kVA, 69 kV primary, 4160 VAC secondary, delta/delta configuration transformers owned by the Metropolitan Sewer District (MSD). Each of these feeds are able to supply approximately 62.5 percent of the stations total capacity. Upgrades to the capacity of the dual feeds are not required. The service transformers and associated equipment will be replaced in kind.

The motor control center (MCC) is a General Electric type with a main tie main configuration, 4160 VAC. The MCC is in good condition and will not require to be upgraded.

There are a total of eight synchronous pump motors at this location: A 600 HP, 4160 VAC, 3 phase; a 2500 HP, 4160 VAC, 3 phase; and six 3000 HP, 4160 VAC, 3 phase. Every motor is in good operating condition according to motor winding insulation testing (megger testing). Additional testing will need to be conducted to ensure that upgrades to items such as bearings and the DC component of the motors are not required. The pumps will be rebuilt with this project and this will allow access to the pump motor to see if there are any issues. If any issues are found with the motors the issues will be remedied. With the stations current capacity, Beargrass would be able to run four 3000 HP pumps if one of the service transformers for the station went down.

The Pumps are controlled using an up to date programmable logic controller (PLC) system. Pump status is already monitored on the MSD website using a status control and data acquisition (SCADA) system. The roller gate hoists will be upgraded to increase reliability of the gate. The existing motor for the roller gate will be replaced with a 10 HP motor. Motors will remain manually operated. Plan to integrate monitoring of the station's gate into existing MSD SCADA system. The system will monitor items such as: traveling, open, and closed. New water level transducers will be installed upstream and downstream of the roller gate to monitor whether gate can be raised with existing head pressure conditions. Transducers will be incorporated into PLC system and a display will show water levels on both sides of the gate.

4.1.2. Starkey Pump Station Condition Summary

The Starkey pump station is fed from a 2500 kVA, 13.8 kV primary, 480 VAC secondary, delta/wye (grounded neutral) transformer owned by MSD. The service transformers and associated equipment will be replaced in kind. The Starkey pump station has a secondary mission in that some of the pumps

also are involved in moving sanitary water. Only the pumps that are connected to the sanitary portion of the station are connected to an emergency power generator.

The MCC is a Cutler Hammer type, 480 VAC, with a 5000A main breaker. The MCC is past its useful service life and will be replaced. A modern equivalent will be installed. The MCC main circuit breaker buckets will have power, voltage, amperage, and power factor metering. The MCC motor circuit buckets will have motor running/stop status, voltage, amperage, and power factor metering. A 112.5 kVA dry type transformer will be installed for building support systems including: controls, lighting, 208-120 VAC power, HVAC, etc.

The Starkey pump station has four 500 HP, 480 VAC, 3 phase induction motors. All of these pumps are in good condition and do not require refurbishment according to megger testing. The pumps will be rebuilt with this project and this will allow access to the pump motor to see if there are any issues. If any issues are found with the motors the issues will be remedied. Drive system for each pump uses an 18 pulse transformer and will require new variable frequency drives (VFDs) for control. Power factor adjustment options should be considered for each motor.

Pumps are controlled via VFDs. New VFDs will be installed. Plan to integrate existing PLC monitoring of station into existing MSD SCADA system. The system will monitor items such as: pump status, volts, amps, gate position, etc. The system hardware will be capable of future remote operation of the station.

4.1.3. Fourth Street Pump Station Condition Summary

The Fourth Street pump station is fed from a 1500 kVA, 13.8 kV primary, 2400 VAC secondary, delta/delta transformer owned by MSD. The service transformers and associated equipment have been upgraded and will not require additional work.

The MCC is a Westinghouse type, 2400 VAC. The MCC is in good condition and will not require to be upgraded.

The Fourth Street pump station has three 350 HP, 2400 VAC, 3 phase induction motors. All of these pumps motors have been upgraded recently and will not require additional work. The motor starting equipment at this station is in good condition and will not require alterations. Megger testing results used in Appendix D Attachment 1, Motor Refurbishment, were for the pump motors which have been replaced.

Pumps are controlled using an up to date PLC system which requires no changes

4.1.4. Fifth Street Pump Station Condition Summary

The Fifth Street pump station is fed from a 150 kVA, 4160 VAC primary, 480 VAC secondary, 3 phase pad-mount transformer owned by MSD. The service transformers and associated equipment will be replaced in kind.

The MCC is a General Electric type, 480 VAC, with a 400A main breaker. The MCC is past its useful service life and in need of replacement. A modern equivalent will be installed. The MCC main circuit breaker buckets will have power, voltage, amperage, and power factor metering. The MCC motor circuit buckets will have motor running/stop status, voltage, amperage, and power factor metering. A 112.5 kVA dry type transformer will be installed for building support systems including: controls, lighting, 208-120 VAC power, HVAC, etc.

The Fifth Street pump station has a 25 HP, 440 VAC, 3 phase induction motor and three 50 HP, 440 VAC, 3 phase induction motors. All of these pumps are in poor condition and require refurbishment. If pumps are changed to submersible pumps, pump motor HP values expected to increase and may cause a capacity issue for the station. Additional data will be required to confirm assumption. Reduced voltage starters will be replaced and power factor adjustment options should be considered for each motor.

Pumps are controlled using an out of date PLC system and are activated from within the MCC. New PLC system will be installed. Plan to integrate monitoring of station into existing MSD SCADA system. The system will monitor items such as: pump status, volts, amps, gate position, etc. The system hardware will be capable of future remote operation of the station.

4.1.5. Tenth Street Pump Station Condition Summary

The Tenth Street pump station is fed from a 750 kVA, 13.8 kV primary, 480-277 VAC secondary, 3 phase pad-mount transformer owned by MSD. The service transformers and associated equipment will be replaced in kind.

The MCC is a General Electric type, 480 VAC. The MCC is past its useful service life and in need of replacement. A modern equivalent will be installed. The MCC main circuit breaker buckets will have power, voltage, amperage, and power factor metering. The MCC motor circuit buckets will have motor running/stop status, voltage, amperage, and power factor metering. A 112.5 kVA dry type transformer will be installed for building support systems including: controls, lighting, 208-120 VAC power, HVAC, etc.

The Tenth Street pump station has a 25 HP, 440 VAC, 3 phase induction motor and three 200 HP, 440 VAC, 3 phase induction motors. All of these pumps are in poor condition and require refurbishment. If pumps are changed to submersible pumps, pump motor HP values expected to increase and may cause a capacity issue for the station. Additional data will be required to confirm assumption. Reduced voltage starters will be replaced and power factor adjustment options should be considered for each motor.

Pumps are controlled using an out of date PLC system and are activated from within the MCC. New PLC system will be installed. Plan to integrate monitoring of station into existing MSD SCADA system. The system will monitor items such as: pump status, volts, amps, gate position, etc. The system hardware will be capable of future remote operation of the station.

4.1.6. Seventeenth Street Pump Station Condition Summary

The Seventeenth Street pump station is fed from a 300 kVA, 13.8 kV primary, 480-277 VAC secondary, 3 phase pad-mount transformer owned by MSD. The service transformers and associated equipment will be replaced in kind.

The MCC is a General Electric type, 480 VAC. The MCC is past its useful service life and in need of replacement. A modern equivalent will be installed. The MCC main circuit breaker buckets will have power, voltage, amperage, and power factor metering. The MCC motor circuit buckets will have motor running/stop status, voltage, amperage, and power factor metering. A 112.5 kVA dry type transformer will be installed for building support systems including: controls, lighting, 208-120 VAC power, HVAC, etc.

The Seventeenth Street pump station has a 15 HP, 440 VAC, 3 phase induction motor and three 75 HP, 440VAC, 3 phase induction motors. All of these pumps are in poor condition and require refurbishment. If pumps are changed to submersible pumps, pump motor HP values expected to increase and may cause a capacity issue for the station. Additional data will be required to confirm assumption. Reduced voltage starters will be replaced for these motors and power factor adjustment options should be considered for each motor.

Pumps are controlled using an out of date PLC system and are activated from within the MCC. New PLC system will be installed. Plan to integrate monitoring of station into existing MSD SCADA system. The system will monitor items such as: pump status, volts, amps, gate position, etc. The system hardware will be capable of future remote operation of the station.

4.1.7. Twenty Seventh Street Pump Station Condition Summary

The Twenty Seventh Street pump station is fed from a 2000 kVA, 13.8 kV primary, 2400 VAC secondary, 3 phase pad-mount transformer owned by MSD. The service transformers and associated equipment will be replaced in kind.

The MCC is an Eaton type, 2400 VAC. The MCC is in good condition and will not require to be upgraded but this is dependent on motor sizes not changing.

The Twenty Seventh Street pump station has a 60 HP, 2300 VAC, 3 phase induction motor and four 350 HP, 2300VAC, 3 phase induction motors. All of these pumps are in poor condition and require refurbishment. If pumps are changed to submersible pumps, pump motor HP values expected to increase and may cause a capacity issue for the station. A new MCC would likely be required if this were to happen. Additional data will be required to confirm assumption. Reduced voltage starters will be replaced for these motors and power factor adjustment options should be considered for each motor.

Pumps are controlled using a PLC system and are activated from within the MCC. New PLC system will be installed. Plan to integrate monitoring of station into existing MSD SCADA system. The existing instrumentation will be reused. The system will monitor items such as: pump status, volts, amps, gate position, etc. The system hardware will be capable of future remote operation of the station.

4.1.8. Thirty-Fourth Street Pump Station Condition Summary

The Thirty Fourth Street pump station is fed from a 750 kVA, 13.8 kV primary, 480-277VAC secondary, 3 phase pad-mount transformer owned by MSD. The service transformers and associated equipment will be replaced in kind. The Thirty Fourth Street pump station has a secondary mission in that some of the pumps also are involved in moving sanitary water. Only the pumps that are connected to the sanitary portion of the station are connected to an emergency power generator.

The MCC is a Square D model, 480-277 VAC. The MCC is in good condition and will not require to be upgraded but this is dependent on motor sizes not changing.

The Thirty Fourth Street pump station has two 75 HP, 460 VAC, 3 phase induction motors and four 150 HP, 440VAC, 3 phase induction motors. All of these pumps are in poor condition and require refurbishment. If pumps are changed to submersible pumps, pump motor HP values expected to increase and may cause a capacity issue for the station. A new MCC would likely be required if this were to happen. Additional data will be required to confirm assumption. Reduced voltage starters will

be replaced for these motors and power factor adjustment options should be considered for each motor.

Pumps are controlled using a PLC system and are activated from within the MCC. New PLC system will be installed. Plan to integrate monitoring of station into existing MSD SCADA system. The existing instrumentation will be reused. The system will monitor items such as: pump status, volts, amps, gate position, etc. The system hardware will be capable of future remote operation of the station.

4.1.9. Shawnee Park Pump Station Condition Summary

The Shawnee pump station is fed from a three phase 3750 kVA, 13.8 kV primary, 2400VAC secondary pad mounted transformer owned by MSD. The service transformers and associated equipment will be replaced in kind. The 2400VAC bus-way for the service into the station will be replaced with this in kind replacement. The 13.8 kV, 600A switch on the primary side of the service transformer and the 1200A and 600A switches on the secondary side of the transformer will be replaced with these changes.

The MCC is a General Electric type, 2400 VAC, with a 1200A main breaker. The MCC is past its useful service life and in need of replacement. A modern equivalent will be installed. The MCC main circuit breaker buckets will have power, voltage, amperage, and power factor metering. The MCC motor circuit buckets will have motor running/stop status, voltage, amperage, and power factor metering. Reduced voltage starters will be replaced for these motors and power factor adjustment options should be considered for each motor. A 480V service is present at this location through a 250 kVA, 2400 VAC primary, 480/277 VAC secondary transformer located outdoors in the switchyard which feeds a 480 VAC switchboard inside the station. The 480 VAC switchboard and the 480 VAC transformer will require upgrades. The switchboard will be replaced with a switchboard able to handle the total capacity of the 250 kVA transformer.

The Shawnee Park pump station has a 75 HP, 2400 VAC, 3 phase induction motor and five 800 HP, 2400VAC, 3 phase induction motors. All of these pumps are in poor condition and require refurbishment. Reduced voltage starters will be replaced for these motors and power factor adjustment options should be considered for each motor. The sump pump motor will also be replaced in kind with this upgrade.

Pumps are controlled using an out of date PLC system. New PLC system will be installed. The existing sump instrumentation is in working condition and will be integrated into new PLC system. Plan to integrate monitoring of station into existing MSD SCADA system. The system will monitor items such as: pump status, volts, amps, gate position, etc. The system hardware will be capable of future remote operation of the station.

4.1.10. Western Parkway Pump Station Condition Summary

The Western pump station is dual fed by two 7500 kVA, 13.8 kV primary, 4160 VAC secondary, delta/wye transformers owned by MSD. Each feed is able to provide 70 percent of the total capacity to the station. The service transformers shall be upgraded to provide 100% capacity to the station. The new service transformers will be 12000 kVA and other service equipment such as the secondary wiring of the transformers and switches will also be upgraded to appropriate sizes. Refer to section 4.3.3.1. Emergency Power for additional information.

The MCC is rated for 4160 VAC. The MCC is in new condition and will not require any upgrades. The MCC of the station is capable of handling the entire station load and will not need to be upgraded to accommodate this increase.

The three 450 HP, 4160 VAC, 3 phase, synchronous pump motors and four 1250 HP, 4160 VAC, 3 phase, synchronous pump motors are in good condition at this station and will not require refurbishment. Additional testing will need to be conducted to ensure that upgrades to items such as bearings and the DC component of the motors are not required. New water level transducers will be installed upstream and downstream sides of MSD gate #102 to monitor whether gate can be raised with existing head pressure conditions. Transducers will be incorporated into PLC system and a display will show water levels on both sides of the gate.

Pumps are controlled using an out of date PLC system. New PLC system will be installed. The existing sump instrumentation is in working condition and will be integrated into new PLC system. Plan to integrate monitoring of station into existing MSD SCADA system. The system will monitor items such as: pump status, volts, amps, gate position, etc. The system hardware will be capable of future remote operation of the station.

4.1.11. Paddy's Run Pump Station Condition Summary

The Paddy's Run pump station is fed from a 6000 kVA, 13.8 kV primary, 2400VAC secondary, 3 phase pad-mount transformer owned by MSD. The service transformers and associated equipment will be replaced in kind. The primary 15 kV switch for this transformer is in poor condition and will need to be replaced and a load break fused switch will be installed on the secondary side of the transformer which has been sized for the full load of the transformer.

The MCC is a Westinghouse type, 2400VAC. The MCC is past its useful service life and in need of replacement. A modern equivalent will be installed. The MCC main circuit breaker buckets will have power, voltage, amperage, and power factor metering. The MCC motor circuit buckets will have motor running/stop status, voltage, amperage, and power factor metering. A 400A fused service disconnect switch for a future 480VAC service will be installed along with a 100 kVA dry type transformer, rated 480-208/120 and two 208 VAC three phase panels with 42 poles each for building support systems which include: controls, lighting, HVAC, etc.

Paddy's Run has two 700 HP, 2400VAC, 3 phase synchronous motors and four 1250 HP, 2400VAC, 3 phase synchronous motors. All of these pumps are in poor condition and require refurbishment. Reduced voltage starters will be replaced for these motors.

Pumps are controlled using an out of date PLC system. New PLC system will be installed. A HMI will be installed near the control panel for operator use. Plan to integrate monitoring of station into existing MSD SCADA system. The system will monitor items such as: pump status, volts, amps, gate position, etc. The system hardware will be capable of future remote operation of the station.

The trash rake system at Paddy's Run is non-operational and needs replacement. Refer to Appendix C for additional details.

4.1.12. Riverport Pump Station Condition Summary

The Riverport pump station is fed from three 833 kVA, 69 kV primary, 4160VAC secondary, delta/wye transformers owned by MSD. The service transformers and associated equipment will be replaced in kind.

The MCC is a Westinghouse Ampgard, 4160 VAC, with a 200A main breaker. The MCC is past its useful service life and in need of replacement. A modern equivalent will be installed. The MCC main circuit breaker buckets will have power, voltage, amperage, and power factor metering. The MCC motor circuit buckets will have motor running/stop status, voltage, amperage, and power factor metering. A 112.5 kVA dry type transformer will be installed for building support systems including: controls, lighting, 208/120 VAC power, HVAC, etc.

Three 450 HP, 4160 VAC, 3 phase, induction pump motors are in good condition at this station and will not require refurbishment. Reduced voltage starters will be replaced for these motors and power factor adjustment options should be considered for each motor.

Pumps are controlled using a PLC system and are activated from within the MCC. New PLC system will be installed. Plan to integrate monitoring of station into existing MSD SCADA system. The system will monitor items such as: pump status, volts, amps, gate position, etc. The system hardware will be capable of future remote operation of the station.

4.1.13. Lower Mill Creek Pump Station Condition Summary

The Lower Mill Creek pump station is fed from three 1250 kVA, 69 kV primary, 4160VAC secondary, delta/wye transformers owned by MSD. The service transformers and associated equipment will be replaced in kind.

The MCC is a Westinghouse Ampgard, 4160 VAC, with a 200A main breaker. The MCC is past its useful service life and in need of replacement. A modern equivalent will be installed. The MCC main circuit breaker buckets will have power, voltage, amperage, and power factor metering. The MCC motor circuit buckets will have motor running/stop status, voltage, amperage, and power factor metering. A 112.5 kVA dry type transformer will be installed for building support systems including: controls, lighting, 208/120 VAC power, HVAC, etc.

Three 1250 HP, 4160 VAC, 3 phase, synchronous pump motors are in good condition at this station according to megger testing reports and will not require refurbishment. Additional testing will need to be conducted to ensure that upgrades to items such as bearings and the DC component of the motors are not required. The pumps will be rebuilt with this project and this will allow access to the pump motor to see if there are any issues. If any issues are found with the motors the issues will be remedied. Reduced voltage starters will be installed with these motors upon return from being refurbished.

Pumps are controlled using an out of date PLC system and are activated from within the MCC. New PLC system will be installed. Plan to integrate monitoring of station into existing MSD SCADA system. The system will monitor items such as: pump status, volts, amps, gate position, etc. The system hardware will be capable of future remote operation of the station.

4.1.14. Upper Mill Creek Pump Station Condition Summary

The Upper Mill Creek pump station is fed from a 10000 kVA, 69 kV primary, 4160VAC secondary, delta/wye transformers owned by MSD. The service transformers and associated equipment will be replaced in kind.

The MCC is a Westinghouse type, 4160 VAC, with a 1200A main breaker. The MCC is past its useful service life and in need of replacement. A modern equivalent will be installed. The MCC

main circuit breaker buckets will have power, voltage, amperage, and power factor metering. The MCC motor circuit buckets will have motor running/stop status, voltage, amperage, and power factor metering. A 112.5 kVA dry type transformer will be installed for building support systems including: controls, lighting, 208/120 VAC power, HVAC, etc.

There are three 3000 HP, 4160 VAC, 3 phase, synchronous pump motors at this station. Pump motors 1 and 3 have recently undergone refurbishment and will not require additional upgrades. Pump motor number 2 is beyond minimum design life and will require refurbishment. Reduced voltage starters will be replaced for these motors and power factor adjustment options should be considered for each motor.

Pumps are controlled using an out of date PLC system and are activated from within the MCC. New PLC system will be installed. Plan to integrate monitoring of station into existing MSD SCADA system. The system will monitor items such as: pump status, volts, amps, gate position, etc. The system hardware will be capable of future remote operation of the station.

4.1.15. Pond Creek Pump Station Condition Summary

The Pond Creek pump station is dual fed by two 12000 kVA, 69 kV primary, 4160 VAC secondary transformers owned by MSD. Each feed is able to provide 85.5 percent of the total capacity to the station and are in bad condition. The service transformers and associated equipment will be replaced in kind.

The MCC is a main tie main configuration, 4160 VAC, 2000A mains, 1600A tie. The MCC is past its useful service life and in need of replacement. The MCC configuration will need to change to 2500A mains with a 2000A tie to handle the load if the dual service feed is upgraded. The MCC main circuit breaker buckets will have power, voltage, amperage, and power factor metering. The MCC motor circuit buckets will have motor running/stop status, voltage, amperage, and power factor metering. A 112.5 kVA dry type transformer will be installed for building support systems including: controls, lighting, 208/120 VAC power, HVAC, etc.

There are four 4700 HP, 4160 VAC, 3 phase, synchronous pump motors at this station. Every motor will need refurbishment to insure smooth operation. Reduced voltage starters will be installed with these motors upon return from being refurbished. With the stations current capacity, Pond Creek would be able to run three 4700 HP pumps if one of the service transformers for the station went down.

Pumps are controlled using an out of date PLC system. New PLC system will be installed. There is currently a Farval automatic greasing system and vibration sensors for each pump motor operated using the existing PLC. This system will be reintegrated into the new PLC system. Plan to integrate monitoring of station into existing MSD SCADA system. The system will monitor items such as: pump status, volts, amps, gate position, etc. The system hardware will be capable of future remote operation of the station.

4.2. Existing Pump Station Controls

The existing Louisville levee system pump stations utilize programmable logic controllers (PLCs) and submersible level transducers for station control. Additionally, a networked supervisory control and data acquisition (SCADA) system allows the majority of stations to have the ability to transmit status of station to a centralized location at MSD.

Replacement and upgrades to the stations on a case by case basis may present integration issues with the existing SCADA system. The majority of stations are controlled using Allen Bradley PLC hardware. Current plans are to integrate existing controls hardware with the existing SCADA system. A sole source justification for Allen Bradley products may be required due to system compatibility, existing spare parts the sponsor currently owns, and maintenance personnel's knowledge of existing hardware.

4.3. Service and Emergency Power Recommendations

This section gives reasoning for the decision to replace or keep the existing service and emergency power at each of the pump stations per the recommendations provided by MSD through their comprehensive plan.

4.3.1. Background

There are two general voltage levels the electrical utility uses to power the Louisville Levee System:

1. Transmission Level - Above 34 kV
   - Stations: Beargrass, Lower Mill Creek, Riverport, Upper Mill Creek, and Pond Creek
2. Distribution Level - Below 34 kV
   - Stations: Starkey, Fourth Street, Fifth Street, Tenth Street, Seventeenth Street, Twenty Seventh Street, Thirty Fourth Street, Shawnee, Western, and Paddy's Run

4.3.1.1. Transmission Level Systems

Stations that are on the transmission side of the system have limited interference from the general populace. These systems will go down primarily due to major storm events and when utility substation transformers have gone down. These types of systems are extremely reliable and the likelihood of an event occurring are small.

4.3.1.2. Distribution Level Systems

Stations that are on the distribution side are more likely to go down due to factors outside of the electrical utilities control (customer caused, lightning strikes, a vehicle strikes a pole, failed transformer, failed insulator, etc.). The higher probability events are ones that involve the public according to conversations with the electrical utility.

4.3.2. Service Upgrades

Transformers and other service gear at all pump stations except the Fourth Street pump station are in need of replacement and are recommended to be upgraded to modern day equivalents. Refer to Sections 4.3.4. and 4.3.5. for additional information.

4.3.3. Emergency Power

There are two methods for providing emergency power to the Louisville Levee System.

1. A dual feed system
   a. This is where two services are provided to supply power to the pump station substation and are ideally not coming out of the same utility substation (At the very least, not the same transformer in the same utility substation). Each feed will supply power to one service transformer at the pump station. Each transformer would feed half of the pump station's MCC during normal pumping

operations. Only when one of the pump station service transformers was down would the entire station be ran off of one service transformer, thus one utility feed.

2. Emergency generators

4.3.3.1. Existing Dual Feeds and Emergency Generation

The pump stations that currently have a dual feed system are Western, Beargrass and Pond Creek. The feeds at these stations are unable to run the full capacity of the station off of one transformer. If one transformer goes down at each of these locations, the second transformer at these stations would be able to support 70.8%, 62.5% and 85.5% of the total station capacity respectively. A theoretical load was calculated for each motor at these stations using motor nameplate data and historical data that had been recorded by MSD. The total load calculated for the motors were multiplied by a value of 1.1 to account for smaller loads in the station such as lighting and other miscellaneous loads. The total load of each station was then compared against the service transformer for the station with a service factor of 1.15 to determine these percentages.

The Thirty Fourth Street and Starkey pump stations have an emergency power generator powering the sanitary portion of the station. No other station has emergency generators.

4.3.3.2. MSD Recommendations

In MSD's comprehensive facility plan, it was looked into whether dual feeds or adding generators was viable at each of their pump stations. Their recommendations were to upgrade the emergency power at the following stations:

1. Dual feed system – Upper Mill Creek, Fourth Street, Shawnee and Paddy's Run.
2. Emergency generators – Starkey, Riverport, Lower Mill, Fifth Street, Tenth Street, Seventeenth Street, Twenty Seventh Street and Thirty Fourth Street.

4.3.4. Recommendations

4.3.4.1. Dual Feeds

Western's dual feed service transformers will be upgraded to provide 100% capacity for the pump station. The utility feed of the station is on the distribution level and thus carries a higher risk of dropping due to outside interferences unlike the transmission level services. The service transformer capacities will need to be upgraded from 7500 kVA to 12000 kVA to provide 100% capacity to the station.

The likelihood of power loss at Beargrass pump station was looked into extensively in the 2019 SQRA. Since the station's feeds are on the transmission system, they are considered extremely reliable. Data obtained on one of the feeds indicated it has experienced an outage for approximately 10.5 hours over the past 5 years. This equates to approximately 0.02% of the time. The likelihood of the river being high, a power outage, and a significant rainfall event all occurring simultaneously was considered remote. Refer to section 4.3.6. for a representation of the power loss event tree. Beargrass will have its dual feed service equipment upgraded in kind with modern equipment due to the age of the service equipment and likelihood that the existing switchgear will not last until the next major upgrade to the station.

Pond Creek's service feeds can handle 85.5% of the total capacity of the station on one of its service transformers. This implies that 3 of 4 pumps would be able to operate if one of the utility

transformers were to go down while the station was needed for operation. The existing service equipment will be replaced in kind with modern equipment to reduce the risk of the station for similar reasons as the Beargrass pump station.

Paddy's Run is currently fed from the Paddy's Run Substation which is located directly adjacent to the pump station. This feed is considered extremely reliable due to its close proximity to the substation. There is currently only one feed for this pump station but the feed can be switched between multiple transformers in the substation. The existing service equipment should be replaced in kind with modern equipment.

Upper Mill is close to a power plant and two neighborhoods. The estimated cost to increase the station to have redundant power would be 6.7 million dollars (2016 figures). Recommendation would be for the existing service equipment to be upgraded in kind due to the reliability of the transmission line system.

The Shawnee pump station is in close proximity to the Del Park Substation. If a dual feed were to be added, a second feed would go to the same station but be on a different transformer. An issue arises here due to the Del Park Substation only having 1 transformer during the time of the meeting between the Corps and the electrical utility. In this meeting, the current down time of the pump station due to a transformer issue at the Del Park Substation would be between 4 to 48 hours. Recommendation would be for the existing service equipment be upgraded in kind.

The Fourth Street pump station should not require a dual feed system. This is due to the pump station being in the electrical utilities most reliable area. Outages in this area last on an order of magnitude of minutes. A secondary feed is possible to be added but unneeded.

4.3.4.2. Generators

Generators high maintenance costs plus the low usage potential are reasons for not including them in the base upgrade for the Louisville feasibility project. A risk analysis was performed to identify the joint likelihood of a catastrophic failure occurring due to the pump station power going down at the same time that the river was also high, and a significant (10 year) rain event occurred. The pump stations on the system are typically only in flood mode approximately 1% to 3% of the time. A ten year rain event with an annual probability of 10% coinciding with a power outage, which is significantly less than 1% of the time annually, produces a return interval of the joint likelihood of once every 100,000 to 33,333 years. Switching to a 1 year rainfall event would reduce the return interval to once every 10,000 to 3,333 years. These probabilities are so low that backup power is unable to be justified incrementally for the project. Refer to section 4.3.6. for a representation of the power loss event tree. It is recommended that Starkey, Riverport, Lower Mill, Fifth Street, Tenth Street, Seventeenth Street, Twenty Seventh Street and Thirty Fourth Street pump stations have no additional generators added and that only the service transformers and associated equipment at these locations be upgraded.

4.3.5. Additional Remarks

The existing conditions of the majority of service transformers and the pump station service equipment have been identified as in need of replacement. However, the 2019 periodic inspection of the Louisville levee system shows all of the service transformers and equipment as being "Acceptable." This was not broken out to show the status of these items on a pump station level. MSD has provided additional data to verify which transformers need replacement and which are in good working condition. The Fourth Street and Western pump stations have been identified as the

only stations that have had recent upgrades to their service transformer and equipment and will not require upgrades with this project.

4.3.6. Pump Station Power Loss Event Tree

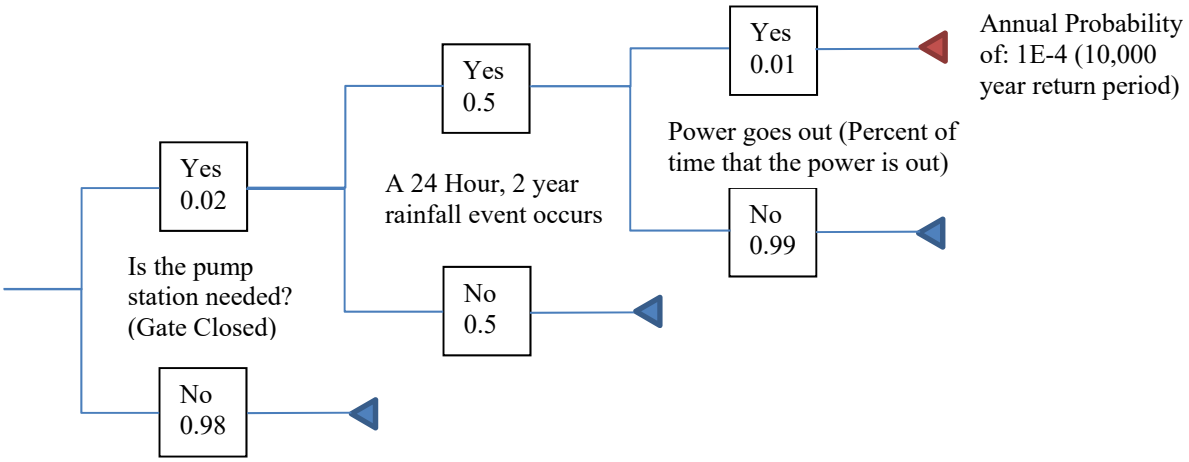

Figure 4-1: Pump Station Power Loss Event Tree

4.4. MSD Pump Station Equipment Matrix

The electrical design team developed an equipment matrix associated with the Louisville MSD Levee system pump stations. The matrix's intent was to capture all aspects of the pump stations equipment including sizes, current state, and future plans.

The design team sent the matrix out to electrical manufacturers and product representatives to get budgetary pricing on replacement equipment. The pricing returned has also been inputted into the matrix. The matrix has been provided as an attachment to this Appendix. Below is a description of each section.

4.4.1. Transformer Replacement

Transformer sizing for each station has been provided, as well as budgetary pricing for replacement transformers.

4.4.2. Replacement Power Distribution Equipment Costs

The feasibility team utilized MSD's 20 Year Comprehensive Facility Plan, LRL's site visit notes from the 2014 LSE, and electrical inspection reports submitted by MSD to determining the present state of each stations power distribution equipment. This data was sent to electrical equipment manufacturers to determine a rough order of magnitude quote for replacement.

4.4.3. Controls Costs

Currently, controls differ from station to station. Some of the stations have capabilities to allow MSD personnel to remotely view pump status, sump status, and gate status. MSD expressed the capability to remotely operate stations from central station in future. Feasibility team extrapolated prices provided to us by MSD from the Beargrass reconstruction project in 2017 to come up with an estimate for control replacement for other stations. Additionally, MSD provided a technical memo by

HDR which included an estimate to provide controls to three pump stations: Fifth St, Tenth St, and Thirty Fourth St.

4.4.4. Motor Refurbishment Costs

Motors were analyzed utilizing the 2014 LSE field notes, along with 2017 and 2018 megger testing results provided by MSD. Bad and borderline motors were selected for re-winding/refurbishment. Motor data was sent to Jasper Electric Motors to have them provide an estimate for refurbishment. Additional pricing has been added in the cost estimate for motor inspection, replacement of all bearing, and DC portions of synchronous motors to be refurbished, at the request of MSD.

Appendix D – Electrical

Attachment 1 – Pump Station Equipment Matrix

- Transformer Data
- Power Distribution Equipment
- Controls
- Motor Refurbishment

Louisville MSD Floodpump Stations

Transformer Data				
Prepared by Jeff Timbas				
Pump Station	**Service Size**	**Service Transformer Particulars**	**System Voltage (XFMR secondary)**	**Replacement Costs (2019 dollars)**
Starkey	2500 kVA	Single 3 phase transformer. Delta/Wye (grounded neutral) connection, 13.8/480V, OA/FA	480 VAC	$35,997.00
Western	2X7500 kVA (main tie main)		4160 VAC	$240,000.00
Upper Mill	10000 kVA	Single 3 phase transformer. Delta/Wye connection, 69 kV/4160 VAC	4160 VAC	$320,000.00
Riverport	Tr	Three single phase 833 kVA transformer, wired delta/wye. 69kV/4160VAC	4160 VAC	$75,000.00
Lower Mill	3750 kVA	Three single phase 1250 kVA transformer, wired delta/wye. 69kV/4160VAC	4160 VAC	$85,000.00
Pond Creek	2X12000 kVA (main tie main)	Two transformers here - Delta/Wye connection, 69kV/4160VAC. Looking to upsize both services an additional 33% to provide 100% rudundant capacity for each service. As of now each service can only run 75% of the station.	4160 VAC	$360,000.00
Beargrass	2X10000 kVA (main tie main)	Two transformers here - Delta/Delta connection, 69kV/4160VAC. No upsizing at this location, just a replace in kind.	4160 VAC	$320000 FOR REPLACEMENT $50,000 FOR OIL REPLACEMENT TO A NON-FLAMMABLE TYPE
Fourth Street	1500 kVA	Padmount 3 phase, 1500kVA, 13.8kV/2400VAC delta/delta.	2400 VAC	$30,292.00
Fifth Street	150 kVA	Three single phase, 50 kVA transformers, 4160VAC/480VAC	480 VAC	$12,894.00
Tenth Street	750 kVA	Padmount 3 phase, 750 kVA, 13.8kV/480-277VAC	480 VAC	$15,741.00
Seventeenth Street	300 kVA	Padmount 3 phase, 300kVA, 13.8kV/480-277VAC	480 VAC	$9,965.00
Twenty Seventh Street	2000 kVA	Padmount 3 phase, 2000kVA, 13.8kV/2400VAC	2400 VAC	$31,491.00
Thirty Fourth Street	750 kVA	Padmount 3 phase, 750kVA, 13.8kV/480-277VAC	480 VAC	$15,741.00
Shawnee Park	3750 kVA	Padmount 3 phase, 3750kVA, 4160VAC/2400VAC	2400 VAC	$120,000.00
Paddy's Run	6000 kVA	Padmount 3 phase, 6000kVA, 13.8kV/2400VAC	2400 VAC	$170,000.00

Louisville MSD Floodpump Stations

Replacement Power Distribution Costs

Prepared by Jeff Timbas

Pump Station	Service Transformer Size	Primary Voltage	Secondary (Station) System Voltage	MCC Main CB size	Decription	Additional Considerations	Have drawings?	Costs	Notes
Starkey		13.8 kV	480 VAC	5000 A	4X500 submersible pumps (induction type), VFD driven. Drive system for each pump utilizes an 18 pulse transformer, old VFD for DC generator, new VFD for pump drive. Client wants same configuration due to space restrictions. Drawings for Station (Starkey PS) provided. Station has two MCCs (one for larger equipment (this is located outside in the switchyard), one for support equipment (Indoors, fed from larger equipment MCC). 112.5 kVA dry type transfomer for building support systems (controls, lighting, 208/120 VAC power, HVAC, etc) System may also need an additional backup generator (currently has a 1750 which is good for half of the station, may need an additional 1750, plus paralleling gear and an upgraded ATS)	Would like system capable of being integrated into a SCADA system. Status on breaker position, motor running/stop status, with possible future remote controls capabilities. Also would like a mains power meter, and volt/amp metering for every motor circuit bucket. Secondary consideration: power factor correction capacitors. Also need to replace switchyard equipment (outdoor rated) - 15 kV fused primary switch for primary protection of the 2500 kVA transformer - i believe this is rated 175A)	Yes	$570,000	Estimate includes new 15kV primary, transformer, LV SWGR, new MCC, light panels and transformers, misc disconnects, EESS start-up, study, and customer training
Western	2X7500 kVA (main tie main)	13.8 kV	4160 VAC				N/A	No Changes to MCC (New)	
Upper Mill	10000 kVA	69 kV	4160 VAC	1200 A	3X3000 HP synchronous motors. Reduced voltage starters, power factor adjustment options at each starter bucket. 112.5 kVA dry type transfomer for building support systems (controls, lighting, 208/120 VAC power, HVAC, etc) Also considering a 100% redundant service, would like the MCC to be main tie main, and include 2X5kV, 1200 A service entrance rated switches to serve as disconnects for each service.	Would like system capable of being integrated into a SCADA system. Status on breaker position, motor running/stop status, with possible future remote controls capabilities. Also would like a mains power meter, and volt/amp/power factor metering for every motor circuit bucket.	Yes	$1,330,000	Price does not include transformer or 69kV station electrical equipment. Estimate includes synchronus RVSS line up, MV Capacitors, EESS training, msic lighting panels transformers
Riverport	2500 kVA	69 kV	4160 VAC	200 A	3X450 HP induction motors. Reduced voltage starters, power factor adjustment options at each starter bucket. 112.5 kVA dry type transfomer for building support systems (controls, lighting, 208/120 VAC power, HVAC, etc) Also considering 1500 kW generator and associated ATS.	Would like system capable of being integrated into a SCADA system. Status on breaker position, motor running/stop status, with possible future remote controls capabilities. Also would like a mains power meter, and volt/amp/power factor metering for every motor circuit bucket. Secondary consideration: power factor correction capacitors.	Yes	$200,700	Includes 4160v Ampgard lineup, MV Capacitors, EESS startup and training. 112.5 kva transformer
Lower Mill	3750 kVA	69 kV	4160 VAC	200 A	3X1250 HP synchronous motors. Reduced voltage starters, power factor adjustment options at each starter bucket. 112.5 kVA dry type transfomer for building support systems (controls, lighting, 208/120 VAC power, HVAC, etc) Also considering 2X2500 kW generators, paralleling gear, and associated ATS.	Would like system capable of being integrated into a SCADA system. Status on breaker position, motor running/stop status, with possible future remote controls capabilities. Also would like a mains power meter, and volt/amp/power factor metering for every motor circuit bucket.	Yes	$244,200	Includes 4160v Ampgard lineup, MV Capacitors, EESS startup and training. 112.5 kva transformer
Pond Creek	2X12000 kVA (main tie main)	138 kV	4160 VAC	2X2000A	4X4800 HP synchronous motors. Reduced voltage starters, power factor adjustment options at each starter bucket. MCC is a main-tie-main configuration - 2000A mains, 1600A tie. Configuration needs to increase to 2500A mains, 2000A tie to provide 100% redundant service. As of now only 3 out of the 4 pumps can be run on a single service. 112.5 kVA dry type transfomer for building support systems (controls, lighting, 208/120 VAC power, HVAC, etc)	Would like system capable of being integrated into a SCADA system. Status on breaker position, motor running/stop status, with possible future remote controls capabilities. Also would like a mains power meter, and volt/amp/power factor metering for every motor circuit bucket.	Yes	$956,100	Includes 4160v Ampgard lineup, MV Capacitors, EESS startup and training. 112.5 kva transformer
Beargrass	2X10000 kVA (main tie main)	69 kV	4160 VAC				N/A	No Changes to MCC (New)	
Fourth Street	1500 kVA	13.8 kV	4160 and 480				N/A	No Changes to MCC (New)	
Fifth Street	150 kVA		480 VAC	400 A	3X50 HP induction motors. Reduced voltage starters, power factor adjustment options at each starter bucket. 112.5 kVA dry type transfomer for building support systems (controls, lighting, 208/120 VAC power, HVAC, etc) Also considering a hookup and associated equipment for a portable 250 kW generator	Would like system capable of being integrated into a SCADA system. Status on breaker position, motor running/stop status, with possible future remote controls capabilities. Also would like a mains power meter, and volt/amp/power factor metering for every motor circuit bucket. Secondary consideration: power factor correction capacitors.	Yes	$90,000	Includes 480v MCC, Capacitors, and EESS startup and training.

Matrix Cont.

Tenth Street	750 kVA	13.8 kV	480 VAC		1X25 HP induction motor, 3X200 HP induction motors. Reduced voltage starters, power factor adjustment options at each starter bucket. 112.5 kVA dry type transfomer for building support systems (controls, lighting, 208/120 VAC power, HVAC, etc) Also considering 800 kW generator and associated ATS.	Would like system capable of being integrated into a SCADA system. Status on breaker position, motor running/stop status, with possible future remote controls capabilities. Also would like a mains power meter, and volt/amp/power factor metering for every motor circuit bucket. Secondary consideration: power factor correction capacitors.	Yes	$78,750	Includes 480v MCC, Capacitors, Transformer and EESS startup and training.
Seventeenth Street	300 kVA	13.8 kV	480 VAC		1 X 15 HP, 3 X 75 HP induction type motors. Reduced voltage starters, power factor adjustment options at each starter bucket. 112.5 kVA dry type transfomer for building support systems (controls, lighting, 208/120 VAC power, HVAC, etc) Also considering 600 kW generator and associated ATS.	Would like system capable of being integrated into a SCADA system. Status on breaker position, motor running/stop status, with possible future remote controls capabilities. Also would like a mains power meter, and volt/amp/power factor metering for every motor circuit bucket. Secondary consideration: power factor correction capacitors.	Yes	$78,750	Includes 480v MCC, Capacitors, Transformer and EESS startup and training.
Twenty Seventh Street	2000 kVA	13.8 kV	2400 VAC		Considering a 2000 kW generator and associated ATS	No Changes to MCC (New)	N/A	No Changes to MCC (New)	
Thirty Fourth Street	750 kVA	13.8 kV	480 VAC		Considering a 800 kW generator and associated ATS	No Changes to MCC (New)	N/A	No Changes to MCC (New)	
Shawnee Park	3750 kVA	13.8 kV	2400 VAC	1200 A (2400 VAC MCC)	Station has 2 voltages - 2400 (main transformer) and 480 (generated in switchyard by an outdoor 250 kVA, 2400-480/277V transformer. MCC is 2400 VAC, additional 480 VAC switchboard - both need replacing. 2400 V Pumps - 1X75 HP, 5X800 HP , 1X15 HP @ 480 VAC - All motors induction type. Replacement starters to be reduced voltage. Power factor correction included as well. Busway for 2400 VAC service into station needs replacement. The 480 VAC powers a switchboard in the basement of the station. Replacement of the switchboard (large enough to handle 250 kVA capacity of the outdoor transformer) is desired as well.	Would like system capable of being integrated into a SCADA system. Status on breaker position, motor running/stop status, with possible future remote controls capabilities. Also would like a mains power meter, and volt/amp/power factor metering for every motor circuit bucket. Secondary consideration: power factor correction capacitors. Also need to replace switchyard equipment (outdoor rated). 13.8 kV, 600 A switch, 2400V, 1200A switch, and a 2400, 600A switch.	Yes	$395,900	Includes 2400v Ampgard Lineup,MV Capacitors 480v Switcboard, and EESS Startup and Training
Paddy's Run	6000 kVA	13.8 kV	2400 VAC		2X700 HP, 4X1250 HP Synchronous motors, Replacement starters to be reduced voltage. Power factor correction included as well. I would also request a 400A fused service disconnect to serve a future 480 VAC service, along with a 100 kVA dry type transformer rated 480-208/120, plus two 208 VAC three phase panels with 42 poles each.	Would like system capable of being integrated into a SCADA system. Status on breaker position, motor running/stop status, with possible future remote controls capabilities. Also would like a mains power meter, and volt/amp/power factor metering for every motor circuit bucket. Update switchyard equipment. Need updated 15 kV switch on primary. Also need a load break fused switch for station secondary (pad mount) sized for full load of the tranformer.		$390,000	Includes 2400v Ampgard Lineup, MV Capacitors, 400a Disconnect, Transformer, 2 - Panelboards, EESS Startup and Training
Power distribution equipment has recently been upgraded - No changes required									
Power distribution equipment needs upgrading									

Louisville MSD Floodpump Stations

Controls Costs

Prepared by Jeff Timbas

Pump Station	Added Controls	Costs (2017) - HDR Tech Memo 11/16/2017 (2017 Dollars)	Costs (Scaled from Beargrass FPS Cost Breakdown)
Starkey	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.		No changes required, controls are up to date.
Western	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.		Instrumentation/Controls - $300,000 Note: Station controls were upgraded in 2011, but MSD expressed interest in upgrading control with this project.
Upper Mill	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.		Instrumentation/Controls - $150,000
Riverport	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.		Instrumentation/Controls - $150,000
Lower Mill	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.		Instrumentation/Controls - $100,000
Pond Creek	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.		Instrumentation/Controls - $100,000
Beargrass	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.		Has been upgraded already. Breakdown indicated following: Instrumentation/Controls - $300,000 Gate and Valve Actuator Modifications - $250,000
	Roller Gate Controls Upgrade		ROM for replacement - $50,000
Fourth Street	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.		No changes required, controls are up to date.
Fifth Street	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.	$40,000	
Tenth Street	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.	$84,000	
Seventeenth Street	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.		Instrumentation/Controls - $100,000
Twenty Seventh Street	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.		Instrumentation/Controls - $100,000
Thirty Fourth Street	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.	$85,000	
Shawnee Park	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.		Instrumentation/Controls - $200,000
Paddy's Run	PLC control system, integrated into MSD's SCADA website. Initally for monitoring (pump status, volts, amps, gate position, etc.,) with capabilities for remote operation.		Instrumentation/Controls - $100,000

Estimate basis for orange cells

No changes necessary

Estimate from HRD Tech Memo (11/16/17)

Estimated from logical extraoplation of Beargrass controls costs

Louisville MSD Floodpump Stations
Motor Refurbishment Costs
Prepared by Jeff Timbas

Pump Station	Motor Status	Pump Number	MFR	Motor	HP	Volts	Phase	Type	RPM	Poles	Amps	Ins Arm/FLD (synchronous)	Excitation Volts	SF	PF	Ambient (Deg C)	Insulation	Code	Frame	Form	Serial #	Torque (LB-FT^2)	Motor Wt	Rotor Wt	Refurbishment Costs 2019	Feasibility Design Direction
Starkey	All ok																									Motors to remain
Western	All ok																									Motors to remain
Upper Mill	Borderline Megger Results	1	Yakasawa	Synchronous	3000	4000	3	SBDV	257		332	B/B	150 (180A)	1	1.0	40		C			807442301	95000	58400	20700	$356,000.00	Motor to remain
	Borderline Megger Results	2	Yakasawa	Synchronous	3000	4000	3	SBDV	257		332	B/B	150 (180A)	1	1.0	40		C			8074423A02	95000	58400	20700	$356,000.00	Motor to remain
	Borderline Megger Results	3	Yakasawa	Synchronous	3000	4000	3	SBDV	257		332	B/B	150 (180A)	1	1.0	40		C			807442301	95000	58400	20700	$356,000.00	Motor to remain
Riverport	All ok																									Motors to remain
Lower Mill	All ok																									Motors to remain
Pond Creek	Needs refurbishment	1	Toshiba	Synchronous	4700	4160	3	TAKL	171.4	42	509	390 (field amps)	140		1.0	40	F(stator and rotor)	C		VCAT	8513253				$480,000	Motor to remain
	Needs refurbishment	2	Toshiba	Synchronous	4700	4160	3	TAKL	171.4	42	509	390 (field amps)	140		1.0	40	F(stator and rotor)	C		VCAT					$480,000.00	Motor to remain
	Needs refurbishment	3	Toshiba	Synchronous	4700	4160	3	TAKL	171.4	42	509	390 (field amps)	140		1.0	40	F(stator and rotor)	C		VCAT					$480,000.00	Motor to remain
	Needs refurbishment	4	Toshiba	Synchronous	4700	4160	3	TAKL	171.4	42	509	390 (field amps)	140		1.0	40	F(stator and rotor)	C		VCAT					$480,000.00	Motor to remain
Beargrass	All ok																									Motors to remain
Fourth Street	Needs refurbishment	1	Fairbanks-Morse	Induction	350	2300	3	QZV	587		83			1.15		40		E	11117.5		597662				$27,639.00	Motor to remain
	Needs refurbishment	2	Fairbanks-Morse	Induction	350	2300	3	QZV	587		83			1.15		40		E	11117.5		597661				$27,639.00	Motor to remain
	Needs refurbishment	3	Fairbanks-Morse	Induction	350	2300	3	QZV	587		83			1.15		40		E	11117.5		597660				$27,639.00	Motor to remain
Fifth Street	Borderline Megger Results	1	Westinghouse	Induction	50	440	3		705		60			1.15		40		F			9B8818				$10,972.00	Replace with subersible pump
	Borderline Megger Results	2	Westinghouse	Induction	50	440	3		705		60			1.15		40		F							10,972.00	Replace with subersible pump
	Borderline Megger Results	3	Westinghouse	Induction	50	440	3		705		60			1.15		40		F							$10,972.00	Replace with subersible pump
	Borderline Megger Results	4	Westinghouse	Induction	25	440	3																			Replace with subersible pump
Tenth Street	Borderline Megger Results	1	Westinghouse	Induction	25	440	3																			Replace with subersible pump
Seventeenth Street	Borderline Megger Results	1	Westinghouse	Induction	15	440	3		1161		19.7								364 P		1-9B8822				$1,363.00	Replace with subersible pump
	Borderline Megger Results	2	Westinghouse	Induction	75	440	3		705		101							F	581PH		289G8823				$12,304.00	Replace with subersible pump
	Borderline Megger Results	3	Westinghouse	Induction	75	440	3		705		101							F	581PH		289G8823				$12,304.00	Replace with subersible pump
	Borderline Megger Results	4	Westinghouse	Induction	75	440	3		705		101							F	581PH		289G8823				$12,304.00	Replace with subersible pump
Twenty Seventh Street	Borderline Megger Results	1	Ideal Electric	Induction	60	2300	3	A	1170		15.2			1.15							174655				$3,214.00	Replace with subersible pump
	Borderline Megger Results	2	Ideal Electric	Induction	350	2300	3	AT	500		84			1.15				V-4			174621				$31,109.00	Replace with subersible pump
	Borderline Megger Results	3	Ideal Electric	Induction	350	2300	3	AT	500		84			1.15				V-4			174622				$31,109.00	Replace with subersible pump
	Borderline Megger Results	4	Ideal Electric	Induction	350	2300	3	AT	500		84			1.15				V-4			174623				$31,109.00	Replace with subersible pump
	Borderline Megger Results	5	Ideal Electric	Induction	350	2300	3	AT	500		84			1.15				V-4			174624				$31,109.00	Replace with subersible pump
Thirty Fourth Street	Borderline Megger Results	1	ITT Fligt	Induction	75	460	3		1170		91										420044				$3,768.00	Replace with subersible pump
	Borderline Megger Results	2	ITT Fligt	Induction	75	460	3		1170		91										430045				$3,768.00	Replace with subersible pump
	Borderline Megger Results	3	Ideal Electric	Induction	150	440	3		875		183										174656				$14,608.00	Replace with subersible pump
	Borderline Megger Results	4	Ideal Electric	Induction	150	440	3		875		183										174657				$14,608.00	Replace with subersible pump
	Borderline Megger Results	5	Ideal Electric	Induction	150	440	3		875		183										174658				$14,608.00	Replace with subersible pump
	Borderline Megger Results	6	Ideal Electric	Induction	150	440	3		875		183										174659				$14,608.00	Replace with subersible pump
Shawnee Park	Borderline Megger Results	1	EPC	Induction	75	2300	3	L-8450	1160		18.4			1.15							64969					Replace with subersible pump
	Borderline Megger Results	2	EPC	Induction	800	2300	3	L-8465	360		195			1.15							64970				$62,723.00	Motor to remain
	Borderline Megger Results	3	EPC	Induction	800	2300	3	L-8465	360		195			1.15							64974				$62,723.00	Motor to remain
	Borderline Megger Results	4	EPC	Induction	800	2300	3	L-8465	360		195			1.15							64973				$62,723.00	Motor to remain
	Borderline Megger Results	5	EPC	Induction	800	2300	3	L-8465	360		195			1.15							64971				$62,723.00	Motor to remain
	Borderline Megger Results	6	EPC	Induction	800	2300	3	L-8465	360		195			1.15							64972				$62,723.00	Motor to remain
Paddy's Run	Needs refurbishment	1	Fairbanks-Morse	Synchronous	700	2300	3	TZVW	360		139	55	93	1.25							598876				$85,478.00	Motor to remain
	Needs refurbishment	2	Fairbanks-Morse	Synchronous	700	2300	3	TZVW	360		139	55	93	1.25							598877				$85,478.00	Motor to remain
	Needs refurbishment	3	Fairbanks-Morse	Synchronous	1250	2300	3	TZUW	327		245	74	98	1.15							598881				$145,162.00	Motor to remain
	Needs refurbishment	4	Fairbanks-Morse	Synchronous	1250	2300	3	TZUW	327		245	74	98	1.15							598878				$145,162.00	Motor to remain
	Needs refurbishment	5	Fairbanks-Morse	Synchronous	1250	2300	3	TZUW	327		245	74	98	1.15							598880				$145,162.00	Motor to remain
	Needs refurbishment	6	Fairbanks-Morse	Synchronous	1250	2300	3	TZUW	327		245	74	98	1.15							598879				$145,162.00	Motor to remain
Motors are ok																										
Motors had boarderline megger results																										
Motors had bad megger results and need refurbishment																										

APPENDIX E – Civil
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5. APPENDIX E – CIVIL 2

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5. Appendix E – Civil

This appendix lists and describes the proposed locations of various construction and access roads, along with the locations of T-wall and I-wall installations and repairs.

5.1. Required Permits

During the design phase of the project, a SWPPP will be developed by USACE. The contractor will be responsible for attaining all necessary permits.

5.2. Beargrass Creek Pump Station

Beargrass Creek Pump Station has four access points. No utility relocations are expected at this facility in order to perform the scoped work. No traffic control will be required. Temporary work easements are to be provided in the portions of the property not owned by Louisville/ Jefferson County.

5.3. Starkey Pump Station

Starkey Pump Station has two access points. No utility relocations are expected at this facility in order to perform the scoped work. No traffic control will be required. The property is owned by Louisville/ Jefferson County.

5.4. Butchertown I-Wall

Sections of I-wall in Butchertown need to be stabilized at various locations (as shown on sheet CS102). The locations of the I-walls that require work include: STA 85+00 on Branden Klayko Alley and STA 77+00 to 78+20 at the intersection of North Shelby Street and Franklin Street. Work includes the conversion of existing I-wall to a modified T-wall and installation of fill material on the landside of the wall for additional stability. Additional details for the I-wall stabilizations can be found in the structural plans. One or more lanes are necessary to be closed on North Shelby and Franklin Street. Traffic control measures will be performed by the contractor. Temporary work easements will be provided to allow work on the I-Wall along N. Shelby Street.

5.5. 4th Street Pump Station

The 4th Street Pump Station has one access point. No utility relocations are expected at this facility in order to perform the scoped work. No traffic control will be required. The property is owned by Louisville/ Jefferson County.

5.6. 5th Street Pump Station

The 5th Street Pump Station has one access point. No utility relocations are expected at this facility in order to perform the scoped work. Contractor may use area directly south of pump station as staging/ laydown area as shown on Sheet 5-C-101. Contractor will be responsible for traffic control at end of Place Montpellier.

5.7. 10th Street Pump Station and Closure

The 10th Street Pump Station has one access point. No utility relocations are expected at this facility in order to perform the scoped work. Contractor may use area directly east of pump station as staging/ laydown area as illustrated by the contractor work limit on Sheet 10-C-101. The 10th Street closure will be permanently closed. (shown on sheet 10-C-101) The 10th Street closure is placed in service at lower river elevations (when compared to other closures), so it is installed more frequently than other closures. It must be installed with multiple personnel and large equipment. In an effort to increase worker safety (by removing or reducing overhead lifts and large equipment from the installation process), reduce the risk of not getting the closure installed in time, and to simplify the closure plan for the city of Louisville, two options were evaluated: permanently sealing the roadway closure and leaving a man door for access and a double leaf swing gate. Permanently sealing the 10th Street Closure is the more economical and simple alternative. Additional details for this road closure can be found in the structural report.

5.8. 17th Street Pump Station

The 17th Street Pump Station has one access point. No utility relocations are expected at this facility. Laydown/staging area is provided. Traffic control measures are not expected.

5.9. Canal Station

The wall will tie into the existing wall on the west and the existing levee on the east. Currently the abandoned building forms a portion of the flood protection system, and the proposed wall will provide a continuation of the flood protection when the existing building is demolished. Two existing 30” diameter pipes will be plugged by entering the screen house, inserting a bladder to dewater and grouting pipes a minimum of 20 feet. A small storage structure will have to be demolished prior to the alignment being constructed and two utility holes will have undergo inspections to determine condition. Wall details will be shown in the structural plans.

5.10. 27th Street Pump Station/ Closure

The North 27th Street closure will be permanently closed because of the deteriorating condition of the road and structure. A concrete bulkhead will be constructed landside of the railroad bridge and the void filled with controlled low strength material. It is estimated that 830 cubic yards of material will be needed. The walls on the landside will be demolished 18” below grade and topsoil will be placed on the landside embankment. Disturbed area shall be seeded.

5.11. McAlpine Access Road

A proposed access road will be required on North 31st Street to provide a secondary access point to the McAlpine Locks and Dam. The new asphalt road will have an approximate length of 1400 feet and a width of 24 feet, and a new 26 foot swing gate for traffic control will be placed at the end of the road. Utilities are not expected to be relocated; however, it is recommended that surveys are done prior to design.

5.12. 34th Street Pump Station

The 34th Street Pump Station has one access point. There is not site work to be done at this pump station. No utility relocations are expected at this facility. Laydown/staging area is provided. Traffic control measures are not expected.

5.13. Shawnee Park Pump Station

Shawnee Park Pump Station has one access point. No site work will be done at this pump station. No utility relocations are expected at this facility. Traffic control measures are not expected.

5.14. Western Parkway Pump Station

Western Parkway Pump Station has one access point. No site work will be done at this pump station. No utility relocations are expected at this facility. Traffic control measures are not expected.

5.15. Paddy's Run Pump Station

The (4) 72" discharge pipes and (2) 54" discharge pipes from the pump station to the top of the levee are to be removed and replaced. The portions of discharge pipe not being replaced will be epoxy lined. An alternative to replacing the current scope of work was to build a new pump station as shown on sheet PR-C-101. There is one access point and traffic control measures are not expected to be necessary.

5.16. Upper Mill Creek Pump Station

The (3) 72" discharge pipes at this pump station will be epoxy lined from the pump station to the toe of the levee (approximately 50'). There is one access point and traffic control measures are not expected to be necessary.

5.17. Riverport Pump Station

A portion of the (3) 30" discharge pipes will be replaced. The pipes not being replaced will be epoxy lined from the pump station to the toe of the levee. There is one access point and traffic control measures are not expected to be necessary.

5.18. Johnsontown Closure Vault

Existing Closure Vault is to be demolished and replaced with new closure vault. The area surrounding the vault will be graded to ensure water drains away from the vault. Contractor will be responsible for traffic control on adjacent portion of Johnsontown Road.

5.19. Lower Mill Creek Pump Station

The (3) 48" discharge pipes at this pump station will be epoxy lined from the pump station to the toe of the levee. There is one access point and traffic control measures are not expected to be necessary.

5.20. Pond Creek Pump Station

I-wall repairs are required at this location to increase stability (PC-C-101/102). Details for the I-wall repairs can be found in the structural plans. The contractor will be responsible for access to the levee toe to perform repairs on the I-Wall. No utility relocations are expected and traffic control is not required at this site.

5.21. Real Estate

Temporary and permanent easements will have to be acquired as depicted in in the Right of Way Sheets using the naming convention: xx-R-101.
Table 1-1 below states the amount of real estate at each pump station/work feature divided into: Temporary Work Easement, Proposed Permanent Right of Way and Existing Right of Way.

Feature	Temporary Ease. (acres)	Proposed Perm RW (acres)	Existing RW (acres)
Beargrass Creek PS	0	0.6	1.6
Starkey Pump PS	0	0	0.22
Butchertown I-Wall	0.16	0	0.1
4th St PS	0	0	0.22
5th St PS	0	0	0.12
10th St PS	0	0	0.1
17th St PS	0	0	0.3
Canal Station	0.56	0.45	0.3
27th St PS	0.60	0	0
McAlpine Access Rd.	0	0	7.3
34th St PS	0	0	0.3
Shawnee Park PS	0	0	1.1
Western FPS	0.5	0	0
Paddy's Run PS	0	0	0.64
Upper Mill Creek PS	1.4	0	0
Riverport PS	0	0	0.71
Johnsontown Rd Closure	0	0	1.1
Lower Mill Creek PS	0	0	0.65
Pond Creek PS	0	0	2.4

APPENDIX F – Surveying and Mapping Requirements
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6.2. FUTURE SURVEY AND MAPPING 2
6.3. UTILITY RELOCATIONS 2

6. Appendix F – Surveying and Mapping Requirements

This appendix describes the existing survey and mapping as well as plans for future surveys and mapping.

6.1. Existing Survey and Mapping

The Corps of Engineers has obtained survey data from the City of Louisville's online GIS program, LOJIC. The mapping utilized a 2-foot contour interval and referenced the horizontal datum NAD 83 Kentucky State Planes. The mapping provided included data such as: building footprints, storm and sanitary sewer locations and roadway locations.

All utility relocations were determined based upon the available data and assumptions were made based on the uncertainty of the utility information.

6.2. Future Survey and Mapping

During PED Phase, surveys are necessary at the following project areas: McAlpine Access Road, North 27th Street Closure, Canal Street T-Wall alignments, I-Wall stabilization at STA 85+00 and STA 77+00 to 78+20 and for the construction access road at the Pond Creek Pump Station.
The mapping will be horizontally referenced to NAD83 and the coordinate system and projection will be KY North SPCS. The unit of measure will be US Survey Ft. The vertical datum will be NAVD88. The cadd file will be Microstation DGN using the AEC Cadd Standard. The topographic surveys will not include cadastral features as boundary surveys are not part of this work. We will set and reference a 2 point baseline at each site consisting of IPCs.

6.3. Utility Relocations

Based on the available mapping data from the City of Louisville, no relocation of the MSD combined and sanitary sewers in proximity to the project area are expected.

Overhead utility relocations are not expected to be necessary based on feasibility site visits; however, once surveys are completed at remaining sites, further determinations can be made.

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7. Appendix G – Geotechnical

This appendix lists and describes the current condition of the levee with respect to features considered for reconstruction, and the geotechnical considerations that were part of the feasibility study and the formulation of the alternatives. It also includes preliminary design information on floodwall risk reduction. Listed within are specific measures where geotechnical considerations were applied, the information available, analyses performed, the assumptions, future information needed, and the project risk involved with the information and assumptions utilized.

7.1. Levee Embankment Condition Summary

The 2019 Periodic Inspection (PI) results are summarized in Table 7-1 below. The PI Report is included in Volume 3.

Table 7-1: 2019 Periodic Inspection Embankment Results

Item	Rating
Item 1: Unwanted Vegetation Growth	M
Item 2: Sod Cover	A
Item 3: Encroachments	M
Item 4: Closure Structures	A
Item 5: Slope Stability	A
Item 6: Erosion/Bank Caving	M
Item 7: Settlement	A
Item 8: Depressions/Rutting	M
Item 9: Cracking	A
Item 10: Animal Control	M
Item 11: Culverts/Discharge Pipes	M
Item 12: Riprap Revetments and Bank Protection	M
Item 13: Revetments Other than Riprap	M
Item 14: Underseepage Relief Wells/Toe Drainage Systems	M
Item 15: Seepage	M

Generally, the embankment portions of the project are considered in good condition with some maintenance deficiencies existing along portions of the project, but no overall 'Unacceptable' ratings were given. Since the 2005 Reconstruction Guidance restricts the study from correcting maintenance deficiencies, correcting the items dealing with the embankments were generally considered outside the scope of the study.

7.2. Floodwall Foundation Condition Summary

The 2019 Periodic Inspection (PI) results are summarized in Table 7-2 below. The PI Report is included in Volume 3.

Table 7-2: 2019 Periodic Inspection Floodwall Foundation Condition Results

Item	Rating
Item 1: Unwanted Vegetation Growth	M
Item 2: Encroachments	M
Item 3: Closure Structures	A
Item 4: Concrete Surfaces	M
Item 5: Tilting/Sliding/Settlement of Concrete & Sheet Pile Structures	M
Item 6: Foundation of Concrete Structures	M
Item 7: Monolith Joints	M
Item 8: Underseepage Relief Wells/Toe Drainage Systems	N/A
Item 9: Seepage	A

Generally, the floodwall foundation portions of the project are considered in good condition with some maintenance deficiencies existing along portions of the project, but no overall 'Unacceptable' ratings were given. Since the 2005 Reconstruction Guidance restricts the study from correcting maintenance deficiencies, correcting the items dealing with the floodwall foundations were generally considered outside the scope of the study.

7.3. Geology

The Ohio River Flood Plain deposits, on which the levee system was constructed, consist of Pleistocene glacial outwash (Wisconsian) material and unconsolidated alluvium that washed from the upper part of the Ohio River basin. The Pleistocene glaciers of the last two million years did not extend far enough south to cover Jefferson and Bullitt Counties, however they did extend close enough to have direct and indirect effects on the county's streams and landscape. The Illinoisan Stage, and possibly the Kansan Stage prior to that, involved extension of the ice essentially down to the position of the present Ohio River. The ice and the sediments it deposited blocked old north-flowing streams, forcing them to pond within their valleys. The resulting lakes formed the lacustrine silt deposits found in the tributary bottomlands. The lake level eventually reached an elevation to breach the drainage divide to the southwest, downcutting to create the beginning the new Ohio River (Conkin, 2003).

During the more recent Wisconsian Stage, glacial ice advanced only about halfway across Indiana. Sediment-laden meltwater from these glaciers eroded rock layers to form the deep bedrock valley beneath the floodplain, now largely filled with relatively well-drained river sediments (up to 20 feet thick) underlain by sandy glacial outwash (up to 100 feet thick), while the tributary bottomlands are typically underlain by thick deposits of lacustrine silt. The geologic map of Jefferson County (Figure 7-1) shows the rather sharp boundary between the older Silurian, Devonian, and Mississippian rocks and the much younger Quaternary sediments of the floodplain.

Figure 7-1: Generalized Geological Map of Jefferson County
(Conkin, 2003)

After the Pleistocene glacial retreats, the Ohio River meandered freely over the glacial outwash plain creating several terraces (10-20 feet in height) until the river was constrained by modern dams and levees. It eroded channels in the sediments and exposed the Silurian and Devonian limestones that trend across the valley. The resulting geology is illustrated in Figure 7-2.

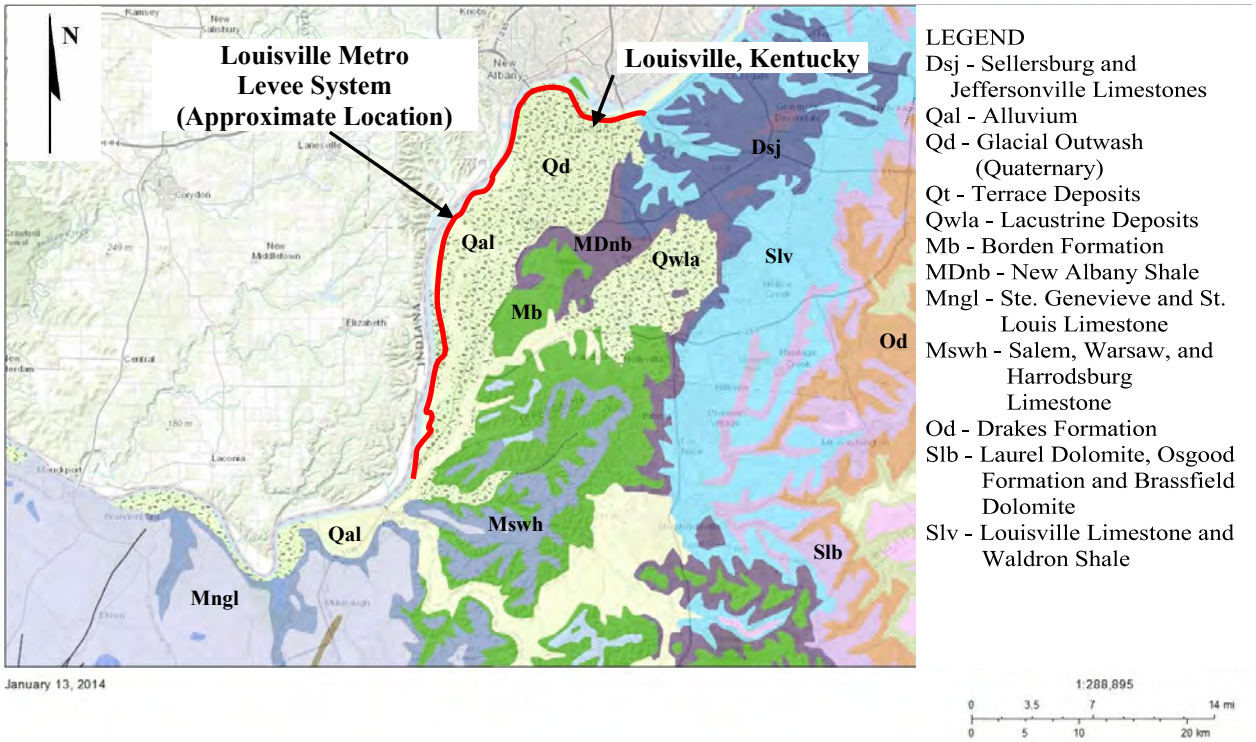

Figure 7-2: Surficial Geology of the Louisville Metro Area (KGS, 2014)

The glacial outwash is composed mainly of sand and gravel with an average thickness of 100 feet (Lyverse, 1996). Igneous rock cobbles as great as 8 inches and commonly more than 2½ inches in diameter have been reported in the outwash soils (Price, 1964; Walker 1957). Within the floodplain, the glacial outwash is commonly overlain by alluvial clays, silts, and sands varying from 5 to 30 feet in thickness; but may be thicker along natural levees (USGS, 1986). A conceptual cross-section of the Ohio River Valley is shown in Figure 7-3.

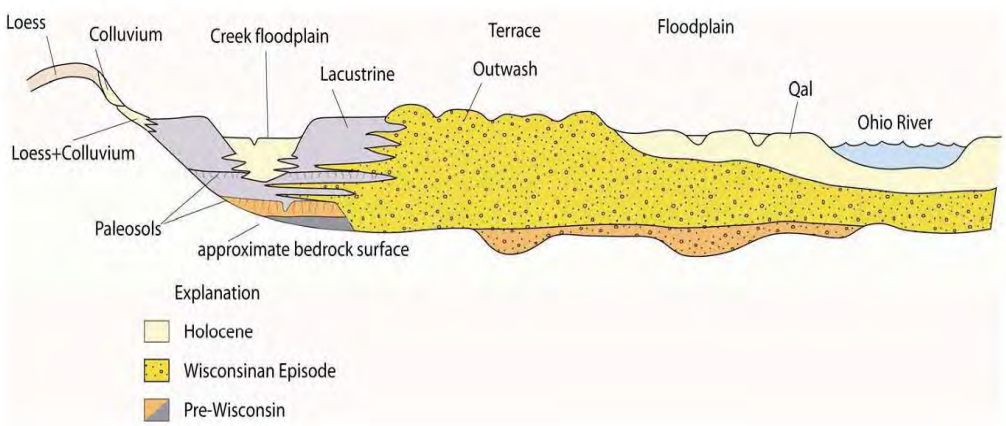

Figure 7-3: Conceptual Cross-section of the Ohio River Valley

7.4. New Paddy's Run Pump Station Foundation Design

The measure involving a full replacement of the Paddy's Run pump station has geotechnical considerations related to the foundation support for the pump station, seepage considerations involved

with excavating into/adjacent the levee embankment, and seepage considerations involved with the long term project due to the impact of the potential new station to current relief wells in the area. At the time of this report, this measure (replacement of the station) is NOT part of a selected alternative.

7.4.1. Available Information

A 2015 investigation and report prepared by Stantec involved three borings in the area in order to evaluate the need of the existing relief wells in the ponding area. These three borings are directly adjacent and one likely within the new station's location, and provide excellent information on the subgrade conditions. In general, in the adjacent ponding area, there is about 16-25 feet of a clay blanket overlying gravelly sands. Refusal, assumed to be top of rock, was encountered at approximate elevation 338, which is about 75 feet below the surface of B-2 (Elevation 413). See Figure 7-4: Stantec Report Boring Layout.

Figure 7-4: Stantec Report Boring Layout

7.4.2. Foundation Design

With the station being a tall, large formed and poured concrete structure with heavy pumps and equipment within, there is a likelihood of the station needing to be placed on deep foundations. Due to the upper clay stratum likely still being present at the base of the structure, there is likely settlement concerns. Differential settlement concerns are crucial at a pump station since any movement to take the pumps out of plumb could cause a serious performance concern. For this reason, deep foundations, likely driven piling, are recommended at this preliminary phase. Other alternatives such as rock piers, drilled piers, or auger cast piles may be options as well but each have limitations involved with the foundation being in an area of seepage concern. If future investigation indicates that the foundation of the structure will be within the sand and gravel, it will be possible that it can be a mat foundation resting on this stratum.

7.4.3. Seepage Concerns

The 2015 Stantec Report evaluated the uplift factor of safety involved with the clay blanket and the pervious sands encountered below. The required uplift design guidance per EM 1110-2-1913 and ETL 1110-2-569 is to have a vertical gradient no greater than 0.5. More simplistic guidance is that the head pressure under the clay blanket should not exceed the overburden weight of the blanket. The Stantec report concluded that the uplift (referred to in the report as heave) factor of safety was not sufficient for the adjacent drainage ditch in the ponding area. There are currently relief wells present, but they have not been maintained or pump tested to determine their adequacy, and there are known siltation issues with their design. The ponding area is generally drawn down during flood scenarios so that the CSO system works effectively. This increases the differential head/decreases the uplift factor of safety as well in the ponding area.

The SQRA also considered this location as a potential backward erosion piping (BEP) location during the risk assessment. It takes into consideration several other factors that would need to occur for the levee to progress to breach. In addition to the uplift factor of safety, this assessment considers the likelihood of a clean, fine erodible sand from the uplift exit location all the way to the water source (riverside of the levee somewhere), the distance of the entry and exit (global gradient) and how erodible the sand is, and the likelihood of a backward erosion pipe being able to hold a roof. This location was not considered to contribute greatly to the project risk, but is discussed as another potential area of concern. In the event that the new pump station at this location is part of the selected alternative, consideration to the potential for seepage related levee risk needs to be thoroughly investigated, and the final station configuration should address any concerns.

7.4.4. Future Information Needed and Risk

At this time, no additional geotechnical information is needed at this location since it currently is not part of a planned alternative. If a new station were to be included in a selected alternative in the future, a full geotechnical investigation to supplement the foundation design and seepage control measures would be recommended.

Risk associated with the new station is largely dependent on the foundation load requirements. The assumed foundation type of driven piling however is considered to be relatively conservative, with a low likelihood of a more expensive foundation type required.

7.5. Butchertown I-Wall Remediation

Improvement to sections of I-wall in Butchertown are part of the base alternative. This section discusses the background involved with the I-walls, the SQRA results, analyses performed, existing information, information needed, and project risk involved with the current assumptions.

Following the SQRA, the team elected to further evaluate the more susceptible I-walls in addition to the two monoliths considered the risk driver at Sta. 76+95 – 77+38 in order to potentially include repairs or buttressing in order to reduce the risk as low as reasonably possible. Luckily, this is a fairly short list with a few individual sections expected to potentially have a Factor of Safety (FoS) less than the criteria chosen. The below table from ETL-1110-2-575 (Figure 7-5) lists the required factors of safety for the rotational stability. 'Ordinary' and 'well defined' refer to the confidence the designer has in the soil strengths. Since much of the analyses is based on the original borings from design (1940's) this evaluation is considered 'Ordinary', with little confidence in the soil strengths. The evaluation however utilizes conservative values for both drained and undrained analyses.

7.5.1. I-Wall Analysis

The I-wall on the Louisville metro system does not get loaded at the 1% ACE flood loading, and the frequency of the stage we are analyzing (top of the floodwall) is consistently less frequent that 0.1%. However, there are significant consequences associated with this levee system, and with the level of uncertainty in the hydraulics as well as the soil strengths, the team has elected to utilize a criteria of a FoS of 1.5 for this evaluation in order to determine which sections of wall should be considered for enhancements.

	Rotational Stability		Global Stability		Seepage	
Annual Chance of Exceedance	Well Defined	Ordinary	Well Defined	Ordinary	Well Defined	Ordinary
10% and greater	1.7	2.0	1.6	1.8	2.0	2.8
1%	1.5	1.7	1.5	1.7	1.6	2.0
0.2%	1.3	1.3	1.4	1.6	1.3	1.6
0.1% and below	1.1	1.1	1.3	1.4	1.3	1.6

Note:

Interpolation between points in the table using the log of the annual chance of exceedance is permitted, but extrapolation is not. For instance, a wall evaluated at the top of wall of 0.33% annual chance of exceedance and Ordinary project information would be evaluated for rotational stability with a minimum permitted factor of safety of 1.42. However, if the water level at the top of a wall had a chance of exceedance of 0.08%, the minimum permitted rotational factor of safety would be 1.1, and not extrapolated beyond.

Figure 7-5: ETL 1110-2-575 Minimum Factors of Safety for I-wall Analysis

Several stretches of I-walls (both Type 1 and 2) on the Louisville Metro project were evaluated during the SQRA. Upon inspection multiple locations were found to have several feet of fill landside of the wall, giving them adequate passive resistance. Other locations had similar factors of safety to the location at Sta. 76+95 – 77+38 that was deemed the risk driver, yet due to the elevation at the top of wall, significant overtopping would occur in other locations prior to the maximum loading being achieved. This would result in significant non-breach consequences approaching the incremental flood limit, and should the wall fail at that time incremental life loss would be very limited. Some of these areas however were still evaluated for enhancements in this study due to the hydraulic stage frequency and profile uncertainty. The wall sections that underwent further evaluation are discussed below. The I-wall at Sta. 76+95 – 77+38 is analyzed in the SQRA and is not further evaluated in this study. It is considered a location that should be selected for stability enhancements. Additionally, the I-wall from Station 205+00 to 210+00 is adjacent the Canal Generating Station building which is scheduled to be demolished. This section of I-wall will be cut off and no longer be a part of the system with the T-wall recommended in the alternatives. It therefore has not undergone further evaluation, but is likely a section with similar factors of safety to those in this analysis and further justifies the remedial floodwall at the Canal Generating Station.

I-walls for the Louisville Metro System range in height up to 10 feet, measured from the top of ground to the top of wall on the landside. A significant portion of the I-walls did not meet current criteria when analyzed with a water loading to top of wall during the Phase II I-wall evaluation.

During the Phase II evaluation, a simplified global stability analysis was used assuming drained conditions for the sandy clay foundation with a crack depth to the bottom tip of the sheet piles (CWALSHT).

The study team further evaluated five cross-sections discussed in the SQRA using CI-Wall v1.0. Each location was reviewed to determine which had the highest likelihood of failure. These monoliths were field measured on the landside to determine the exact stickup height.

Table 7-3: I-wall Sections Further Evaluated in Study

Station	Type	No. of Monoliths	Measured Monolith No.
23+80 – 25+80	Type II	multiple	45
77+96 – 79+36	Type I	6	271, 272
85+23 – 84+23	Type I & II	5	302
85+76	Type II	1	303
503+38	Type II	multiple	-

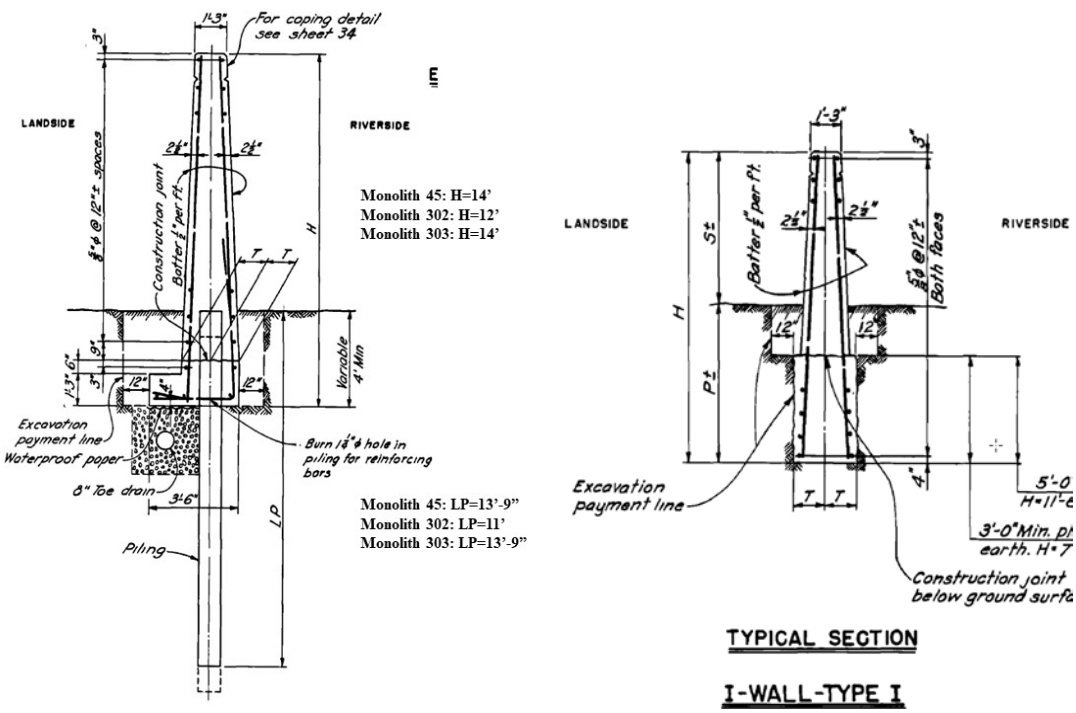

Figure 7-6: Cross Section of Typical Type I and II

Figure 7-7: I-wall at Station 23+80

The Type II I-wall monoliths at Sta. 23+80 have a maximum height of 9.16 feet. This section of floodwall was found to have a top of wall elevation greater than the 2 feet of overtopping profile, meaning there is unlikely to be incremental consequences associated with this wall with a failure near the top. It has similar embedment ratio to the risk driving location evaluated in the SQRA.

Figure 7-8: I-wall at Station 85+76 at West Side of Clay Street Closure

The Type II I-wall monolith at Sta. 85+76 (Figure 7-8) is at the west side of Clay Street Closure and has a maximum height of 8.45 feet. This wall is constrained on one side by the closure, and the closure structure building on the other side. It also has concrete paving beyond the landside for a significant length. There is one monolith of Type II east of the Clay St closure with Type I beyond (Figure 7-9) from Sta. 85+23 to 84+23. The tallest section adjacent the closure has 7.5 feet of stickup with 11 feet of embedment.

Figure 7-9: I-wall at Station 85+23 at East Side of Clay Street Closure

Figure 7-10: I-wall Station 77+96 to 79+36

There is very limited boring data (Figure 7-11) for these sections of the project. Borings for Sta. 29+23 shows that this section has a foundation of primarily silt and some cinders. Borings near Sta. 78+31 show that this section is made up of silts with some sand. Borings near station 85+86 depict a subsurface primarily made up of sand, silt, sandy silt, and some debris materials. Excavation for this area was accomplished with a backhoe equipped with a special bucket and blade for trenching operations. Final shaping of the excavation to conform to the bases of these structures was accomplished with pneumatic spades and hand labor. Due to the sandy nature of the sub-grade, corrugated sheeting was driven and left in place in multiple locations in order to 'shore' the excavation for sheetpile driving and/or concrete placement.

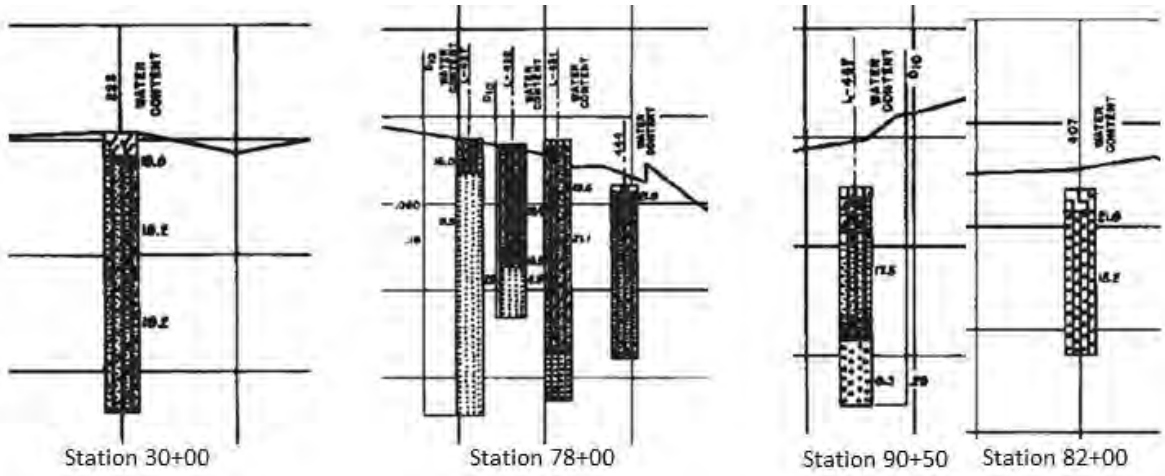

Figure 7-11: Borings used near Each Monolith

Monolith 302 and 303 are adjacent to the Clay St Closure, Monolith 271 the W. Frankfort Ave Closure, and monolith 45 is adjacent to the Ohio St Closure. The interaction between the monoliths and adjacent structures is not taken into account in the CI-Wall analysis. There is sheet piling in the Clay St Closure and it is very probable per as-built details it connects to the monoliths on either side of the closure (Figure 7-12). The sheet piling for monolith 45 and 271 does extend into the closure structure 1 sheet wide and is expected to provide some resistance to rotation but is not expected to be sufficient to dramatically affect the deflection under significant loading.

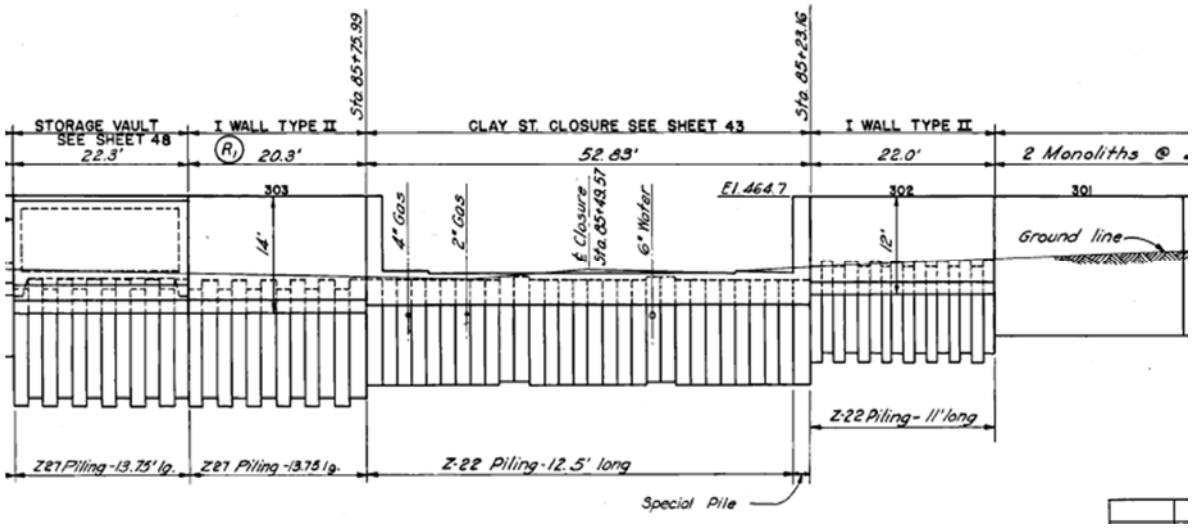

Figure 7-12: Profile of I-Wall Monolith 303 and 302 from Station 85+23 to 85+76

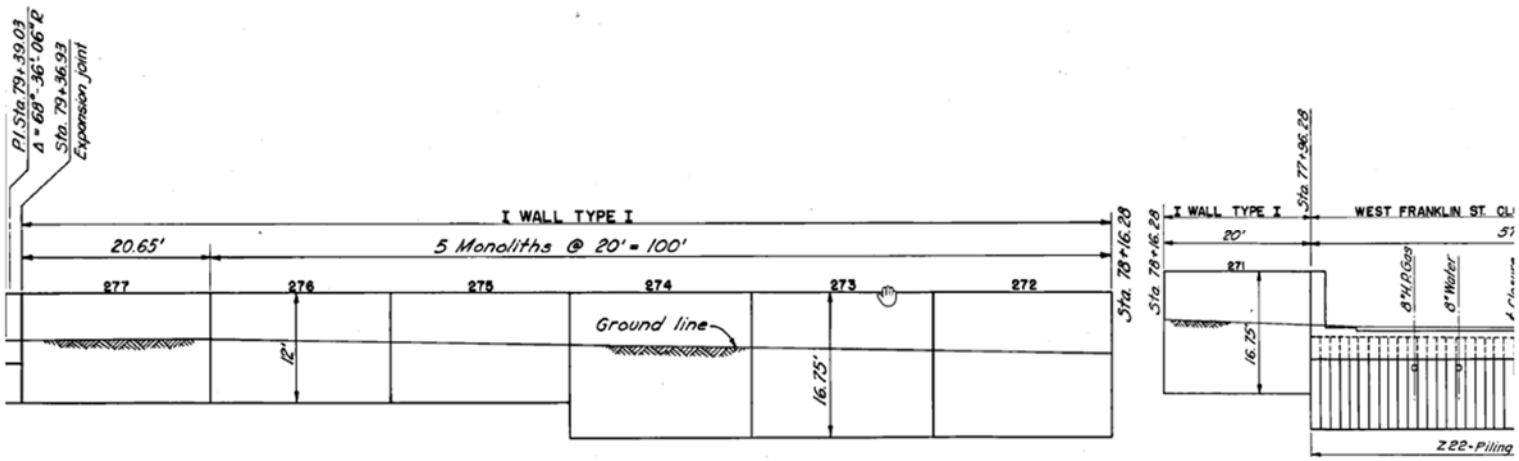

Figure 7-13: Profile of Type I I-wall Station 77+96 to 79+39

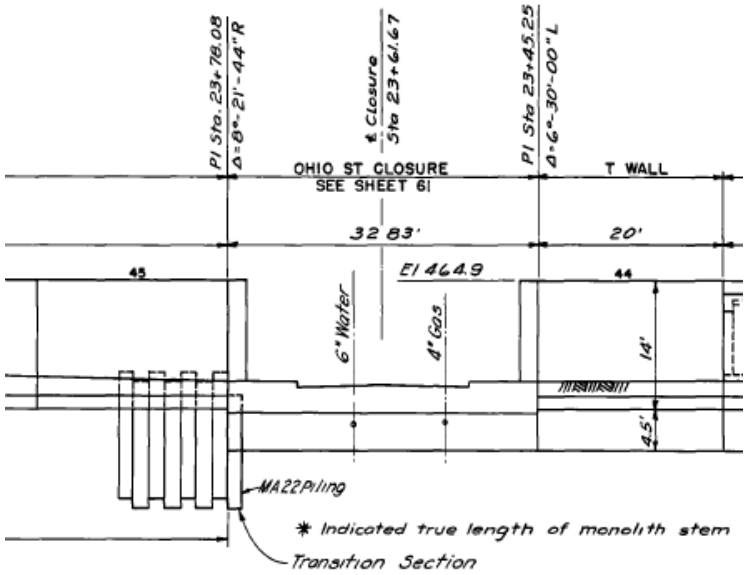

Figure 7-14: Profile of I-Wall Monolith 45 from Station 23+45 to 23+78

Local borings showed silty sand with trace clay for the majority of the wall depth. The team believes while there is clay present, it may not respond in an undrained condition. Duration of the rising leg of the hydrograph for water on the wall was approximately 7 days to top of wall giving little time for pore pressure dissipation. Therefore, both drained and undrained soil conditions were considered.

The typical cross-sections for monoliths analyzed along with the corresponding dimensions are shown in Figure 7-12, Figure 7-13, and Figure 7-14. Undrained and drained analyses were completed in CI-Wall for these areas as shown in Table 7-4. All of the cases analyzed including those which did include gap formation had factors of safety over 1.0.

Mock analyses with an additional 1 foot of embedment were ran for all drained analyses that yielded a factor of safety below 1.5. This simulation accounted for reducing the stickup height and increasing the embedment length by one foot for monoliths 277 and 302. Analyses resulted in factors of safety exceeding the 1.50 value. Therefore, it is suggested that remediation be taken on these monoliths by adding a minimum of one foot of soil with sufficient width beyond the wall to engage full passive resistance.

Table 7-4: CI-wall Analysis Results

Station**	Ca, psf	C, psf	Phi'	Delta	Water Load	Stickup, ft	Embedment, ft	FoS	Gap Depth, ft	Tip of Wall Elevation, ft
23+78 Q Case	400	600	0	0	top	9.16	14.59	2.0	12.53	-14.93
S Case	0	0	30	14	top	9.16	14.59	1.50	0	-15.08
78+31 S Case	0	0	30	14	top	7.16	9.59	1.20	0	--9.98
Q Case	400	600	0	0	top	7.16	9.59	1.50	7.31	-9.51
With 1' of additional passive resistance	0	0	30	14	top	6.16	10.59	3.20	0	-11.04
85+76W Q Case	400	600	0	0	top	8.45	15.3	2.5	12.99	-15.24
S Case	0	0	30	14	top	8.45	15.3	1.60	0	-14.64
85+23E Q Case	400	600	0	0	top	7.5	11.5	2.1	9.39	-11.36
S Case	0	0	30	14	top	7.5	11.5	1.40	0	-11.57
With 1' of additional passive resistance	0	0	30	14	top	6.5	12.5	1.80	0	-12.27
77+20* S Case	0	0	30	14	top	9.0	13.75	1.3		
Q Case	500	15	0	0	top	9.0	13.75	1.4	5	-13.5
S Case	0	50	27	0	top	9.0	13.75	1.0	2.6	-13.5
503+38 S Case	0	50	27	14	top	8	10	1.2	2.62	-10.48
Q Case	450	900	-	-	top	8	10	2.5	7.77	-9.77

*from the SQRA.

** S case refers to the consolidated drained (CD) triaxial test representing the drained soil condition. Q case refers to the unconsolidated, undrained (UU) triaxial test representing the undrained soil condition. Either Q case or S case is selected for the soil within the CI-wall analyses. All analyses considered the floodside gap formation.

7.5.2. I-Wall Recommendations

Based on the analysis, three areas have been identified to be modified in order to effectively increase the passive FoS to above 1.5. These are; Sta. 77+20 (from the SQRA risk driving location), Sta. 77+96 to 79+36 which is a stretch of Type I I-wall just downstream of the previous, and Station 85+23 to 84+23, just upstream of the Clay Street Closure structure.

Figure 7-15: I-wall Remedial Locations

For the two monoliths at Sta. 77+20, one alternative is to replace the I-wall with a modified T or L wall. It is not considered likely that the adjacent landside grade could readily accept buttressing, due to the nearby structure and the required grade of the sidewalk. Buttressing is also considered an option if able to overcome these issues. The plan presented in the alternatives formulation however is for replacement with a T or L wall. The sidewalk should be replaced as well with light reinforcement such as weld wire fabric across the joints.

For Sta. 77+96 to 79+36, there are approximately 5 - 6 monoliths that are recommended to be provided additional passive resistance by buttressing with a compacted dense grade material from 1 to 2 feet thick, and the sidewalk replaced adjacent this stretch of wall with light reinforcement across the joints. The fill should extend a minimum of 20 feet from the wall. The last (northernmost) monolith is expected to need to be replaced with a T or L wall, as it is unlikely the grade will meet ADA requirements as it transitions from the new fill down to the intersection.

For Sta. 85+23 – 84+23, there are 3 - 5 monoliths that will need additional passive resistance of 1 to 2 feet thick extending a minimum of 20 feet from the wall. A short retaining wall will be needed to contain this fill adjacent the Clay St sidewalk (Figure 7-16).

Sta. 503+38 has a drained FoS of 1.2. This floodwall is founded in an embankment of controlled cohesive fill however, unlike the majority of the other I-wall in Butchertown. There is a high degree of confidence the soils would respond in an undrained condition, which has a FoS of 2.5. This area is therefore not recommended to receive further remediation. One potential need for this area is for it to be evaluated with future CI-wall software being developed by ERDC, which would include consideration of the sloping riverward face and the effect it will have on the stability. When loaded, however, there is significant water pressure helping to keep the passive tip of the sheet in place.

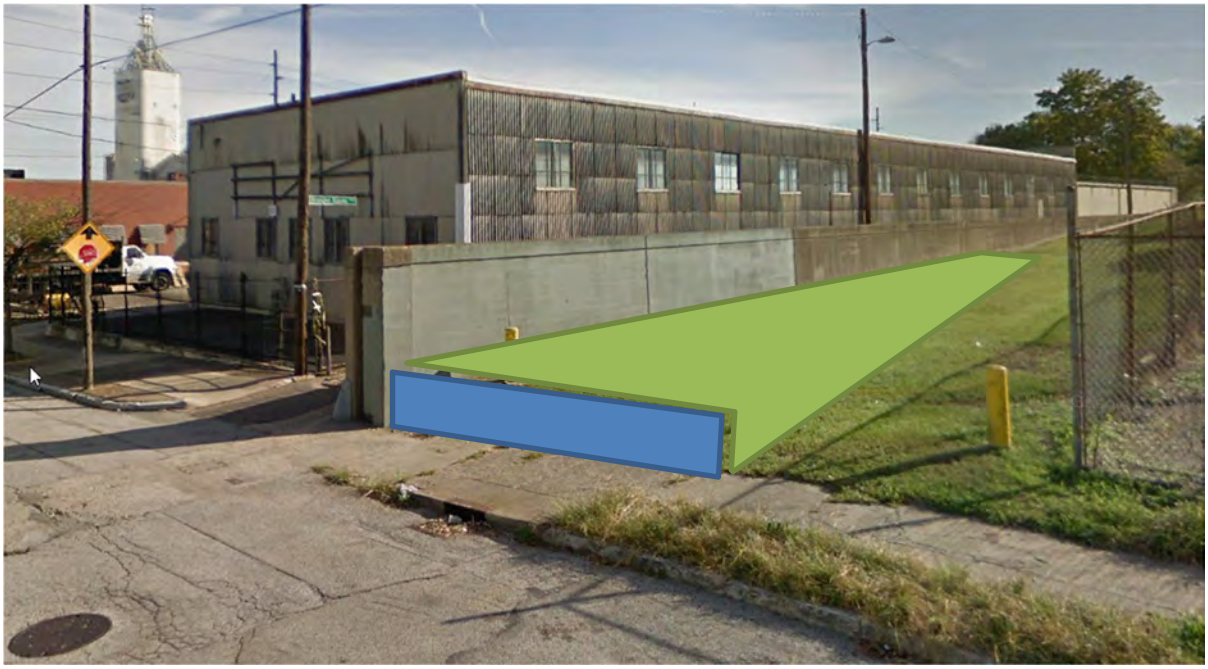

Figure 7-16: Buttressing and Retaining Wall behind I-wall at Station 85+23

7.5.3. Future Information Needed and Risk

The sections of the Butchertown I-wall evaluated in this study should be included in the geotechnical investigation to ensure adequate design strengths and parameters are utilized, with soil test borings distributed as deemed appropriate along the affected sections. The Pond Creek I-wall (Sta. 503+28) should be re-analyzed with upcoming CI-wall version 2.0.

The risk involved with these measures are that there is low strength soils found in the investigation, and further remedial action is required. This could result in over-excavation of soils or the need for additional monoliths to be remediated. It could also cause some of the sections planned for buttressing to be instead reconstructed as a different wall type. The risk for softer soils being encountered is low (10 percent chance), since the analysis utilized conservative values. Cost implications on the 'project scale' are also low, but could be as much as a 50 to 100 percent increase in the cost of these individual measures.

7.6. New Floodwall at Canal Generating Station

The Canal Generating Station is scheduled for demolition. Currently the levee system utilizes the eastern wall of this structure as part of the line of protection. With it demolished, it would leave a gap in the protection. The I-wall just upstream of the Canal Generating Station is considered to be one of the more failure prone sections. With the new alignment, this section of I-wall would be eliminated.

Both a floodwall (T-wall) and levee embankment were considered. A floodwall was selected since it was considered the conservative measure. The floodwall measure also alleviated real estate considerations (a T-wall occupies less real estate than a levee) and eliminated concerns associated with identifying a suitable borrow source for the levee embankment material. A levee embankment

may be considered in the future if the real estate, borrow, and seepage concerns can be adequately addressed.

A significant double concrete intake culvert passes under the proposed alignment. This would need to be effectively abandoned/filled in order to reduce risk associated with the structure. The soil properties in the area are largely considered to be alluvial with sands/silts/clays intermixed and inevitably some fill. A geotechnical evaluation and investigation will be needed in this area during project engineering and design (PED). There are likely seepage concerns in the area as well, and a sheetpile cutoff wall extending down from the floodwall key is to be expected.

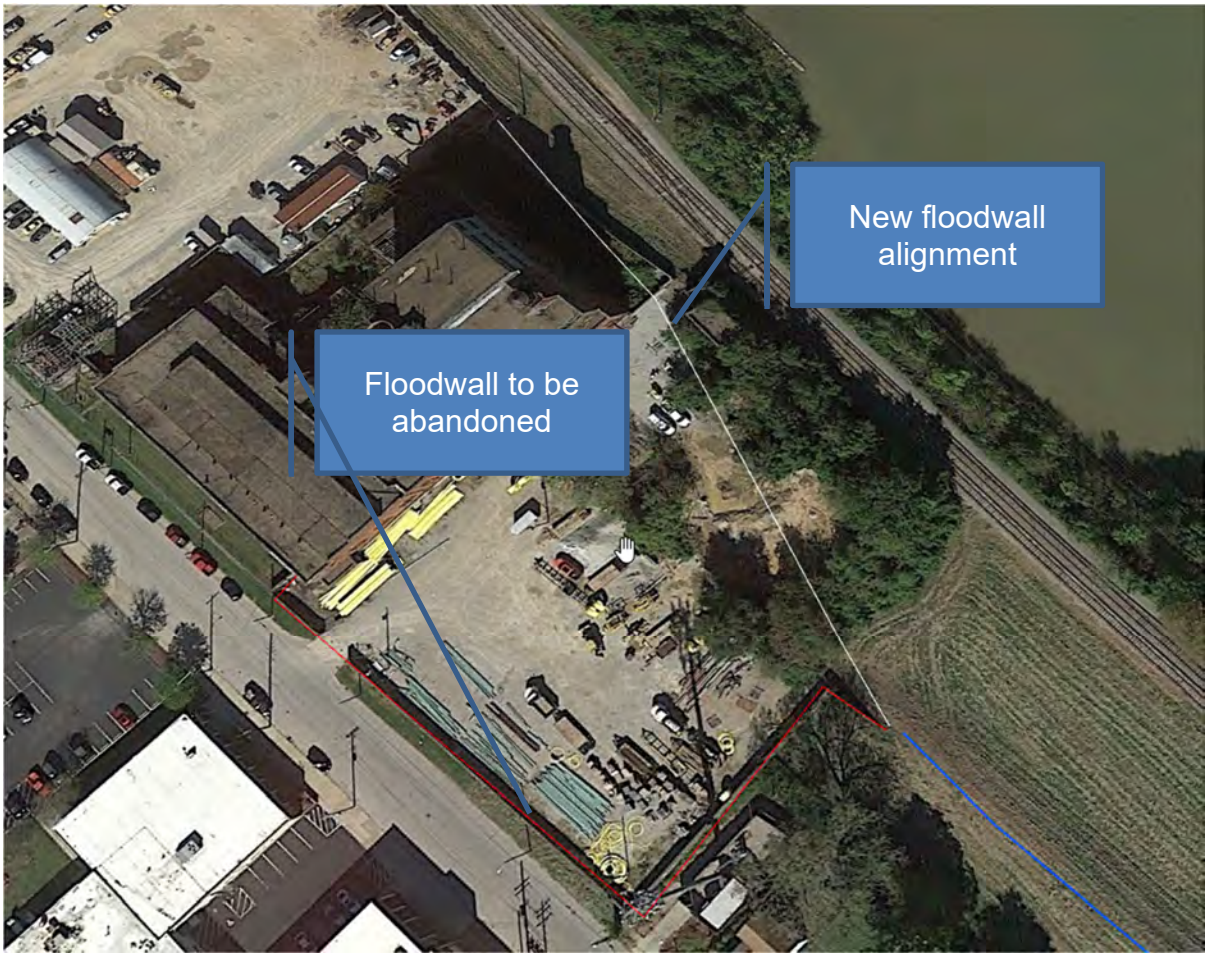

Figure 7-17: Canal Generating Station New Floodwall Alignment

7.6.1. Future Information Needed and Risk

The soil parameters utilized in this analysis are considered conservative, however some verification as well as general investigation for construction purposes is recommended during design. This area should be included in the geotechnical investigation to verify design strengths and to search for undocumented fill, with soil test borings distributed as deemed appropriate along the planned alignment.

An investigation into the double concrete box culverts is also recommended (e.g., location, depth, condition, etc.). It is possible that LG&E may be required to properly abandon this culvert as part of the Section 408 Alteration for the demolition of the Canal Generating Station building.

There is significant risk (25 to 50 percent chance) with the foundation excavation for the new wall alignment encountering fill. There is also the potential that the culverts cannot be filled and would instead need to be removed. This is considered unlikely (10 percent chance). Cost implications on the 'project scale' are low, but could be as much as a 50 to 100 percent increase in the cost of this individual measure.

7.7. 27th Street Closure

The 27th Street closure will be permanently closed by constructing a concrete bulkhead landside of the railroad bridge and backfilling the void with approximately 830 cubic yards of controlled low strength material (CLSM). The backfill will impart new loading onto the underlying soils. The implications of backfilling this closure (e.g., settlement of the embankment and railroad abutment/track) will be further evaluated during the design phase.

Complete removal of the closure structure/abutments and replacement with an earthen embankment was considered. However, backfilling the closure with CLSM was selected to reduce the risk associated with an opening in the levee during the construction process (this closure is first installed), to minimize disruption to the overlying railroad track, and to eliminate concerns associated with identifying a suitable borrow source.

7.7.1. Future Information Needed and Risk

Soil test borings to better define the subsurface conditions in this area will be advanced in the affected area during the design phase.

The risk involved with this measure is that low strength or otherwise unsuitable soils are encountered during the investigation, requiring special measures to support the planned new backfill. This scenario is considered unlikely. Cost implications on the 'project scale' are low should poor subsurface conditions be encountered, but could be as much as a 100 percent increase in the cost of this individual measure.

7.8. Johnsontown Road Vault

The existing closure vault is to be demolished and replaced with a new closure vault after regarding of the area. This vault will be of similar size and location as the existing building. The deterioration of the vault was related to drainage issues, not subsurface conditions. As such, no new subsurface investigation of this area is planned at this time. New foundations will be designed using the design parameters in the original design (modified, if appropriate, to reflect updates to the design manuals since the original construction). Changes to the foundation system were deemed unnecessary since the current foundation system is the most cost effective and expedient foundation system for the type of construction planned.

7.8.1. Future Information Needed and Risk

For the reasons previously provided, no new subsurface investigation of this area (i.e., soil test borings) is planned at this time.

The risk involved with this measure is that low strength or otherwise unsuitable soils are uncovered during construction, requiring changes to the design or use of a new foundation system. This is considered unlikely given the suitable past performance of the existing building from a soil-support perspective (building degradation related to drainage issues) and the similarity of the existing and new construction (essentially the same building).

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8.1. References

The following references were used in the compilation of this report:

1. EC 1110-2-6066, *Design of I-Walls,* Dated 1 April 2011. U.S. Army Corps of Engineers.
2. ECB 2017-3, *Design and Evaluation of I-Walls Including Sheet Pile Walls,* Dated 27 January 2017. U.S. Army Corps of Engineers.
3. EM 1110-2-2002, *Evaluation and Repair of Concrete Structures,* Dated 30 June 1995. U.S. Army Corps of Engineers.
4. EM 1110-2-2100, *Stability Analysis of Concrete Structures,* Dated 1 December 2019. U.S. Army Corps of Engineers.
5. EM 1110-2-2102, *Water stops and Other Preformed Joint Materials for Civil Works Structures,* Dated 30 September 2019. U.S. Army Corps of Engineers.
6. EM 1110-2-2104, *Strength Design for Reinforced Concrete Hydraulic Structures,* Dated 30 November 2016. U.S. Army Corps of Engineers.
7. EM 1110-2-2502, *Retaining and Floodwalls,* Dated 29 September 1989. U.S. Army Corps of Engineers.
8. EM 1110-2-2504, *Design of Sheet Pile Walls,* Dated 31 March 1994. U.S. Army Corps of Engineers.
9. EM 1110-2-3104, *Structural and Architectural Design of Pumping Stations,* Dated 30 June 1989. U.S. Army Corps of Engineers.
10. EM 1110-2-6050, *Response Spectra and Seismic Analysis for Concrete Hydraulic Structures,* Dated 30 June 1999. U.S. Army Corps of Engineers.
11. EM 1110-2-6053, *Earthquake Design and Evaluation of Concrete Hydraulic Structures,* Dated 1 May 2007. U.S. Army Corps of Engineers.
12. EM 1110-2-6054, *Inspection, Evaluation, and Repair of Hydraulic Steel Structures,* Dated 1 December 2001. U.S. Army Corps of Engineers.
13. ER 1110-2-1150, *Engineering and Design for Civil Works Projects,* Dated 31 August 1999. U.S. Army Corps of Engineers.
14. ER 1110-2-1806, *Earthquake Design and Evaluation for Civil Works Projects,* Dated 31 May 2016. U.S. Army Corps of Engineers.
15. ETL 1110-2-584, *Design of Hydraulic Steel Structures,* Dated 30 June 2014. U.S. Army Corps of Engineers.
16. ETL 1110-2-575, *Evaluation of I-Walls,* Dated 1 September 2011. U.S. Army Corps of Engineers.
17. ACI 201.1R-08, *Guide for Conduction a Visual Inspection of Concrete in Service,* Dated 2008. American Concrete Institute.
18. ACI 224.1R-07, *Causes, Evaluation, and Repair of Cracks in Concrete Structures,* Dated 2007, American Concrete Institute.
19. ACI 311.4R-05, *Guide for Concrete Inspection,* Dated 2005. American Concrete Institute.
20. ACI 318-14, *Building Code Requirements for Structural Concrete and Commentary,* Dated 2014. American Concrete Institute.

21. ACI 546R-14, *Guide to Concrete Repair,* Dated September 2014. American Concrete Institute.
22. *AISC Steel Construction Manual 14th Edition,* Dated 2010, American Institute of Steel Construction.
23. ASCE 7, *Minimum Design Loads for Buildings and Other Structures,* Dated 2010. U.S. Army Corps of Engineers.
24. *2019 Metro Louisville Flood Protection Periodic Inspection Report,* Dated 2019. U.S. Army Corps of Engineers.
25. *2019 Metro Louisville Flood Protection Periodic Inspection Report,* Dated 2019. Stantec.
26. *2010 Metro Louisville Flood Protection Periodic Inspection Report,* Dated 30 March 2011. Stantec.

8.2. General Description of Structural Features

The Metro Louisville Flood Protection System consists of approximately 23,000 linear feet (lf) of reinforced concrete floodwall. This includes the lengths of all closures, storage vaults, T-Walls, and I-Walls.

T-Walls consist of approximately 13,900 lf (approximately 643 monoliths) ranging from 14 to 31 feet (ft) in length and 7 to 31 ft in height (measured from the bottom of the base to the top of the wall {T.O.W.}). Monoliths were typically constructed with flat bases and keys— as shown in Figure 8-1.

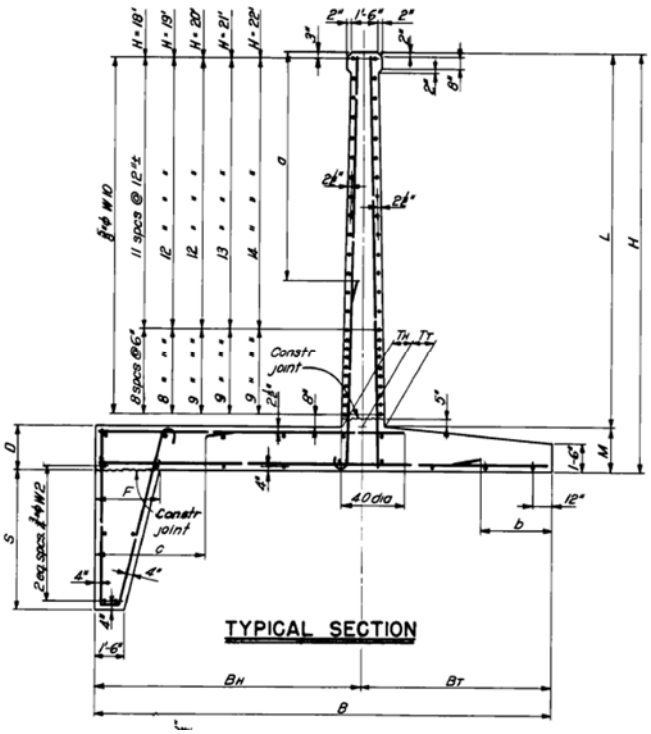

Figure 8-1: Typical T-Wall Section

I-Walls in the Metro Louisville Flood Protection System total approximately 4,500 lf (198 monoliths) ranging from 10.5 to 35 ft. in length and 5.5 to 12 ft. in height. I-Walls are typically shorter than the more prevalent T-Walls. There are two types of I-walls on this project (Type I and Type II). Type I I-Walls are cantilevered walls without an embedded sheet pile— as shown in Figure 8-2. Type II I-Walls are cantilevered walls with an embedded sheet pile— shown in Figure 8-3.

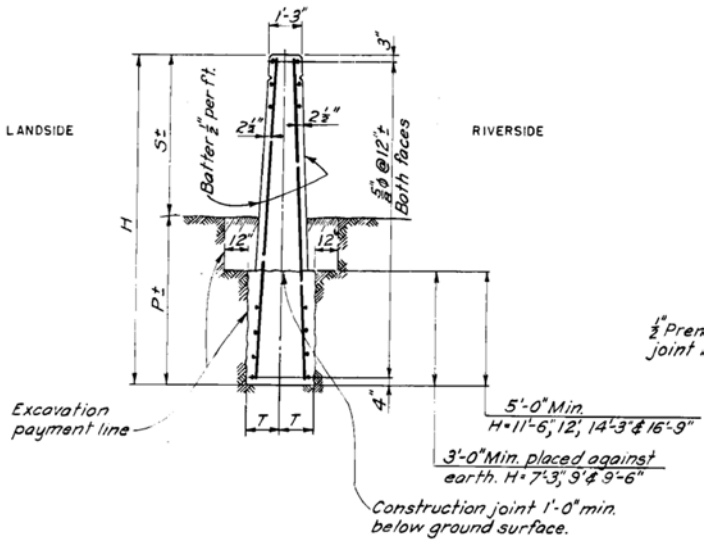

Figure 8-2: Typical Type I I-Wall Section

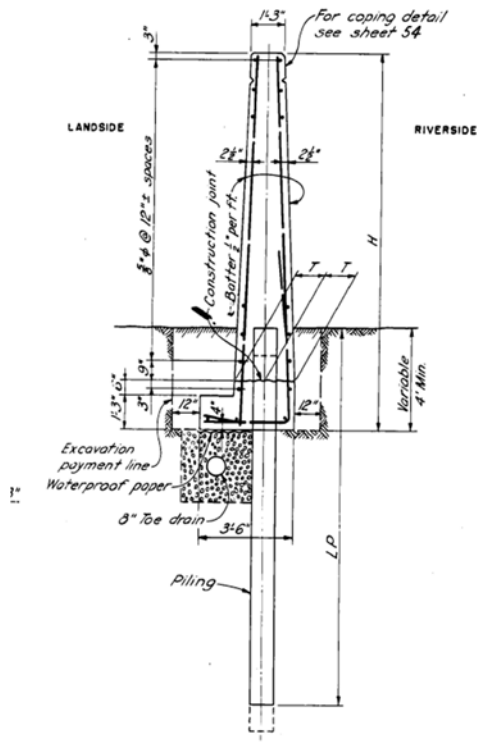

Figure 8-3: Typical Type II I-Wall Section

There are 66 removable steel closures (sandbag closures have been excluded) of various sizes with a total length of approximately 3,150 lf. Most of the steel closure structures are vertical sheeting panels bearing on purlins spanning between vertical supports (either concrete abutment walls or steel trusses) or "post and panel" type. Foundations for most closures are similar to the adjacent I-Wall or T-Wall foundations. One notable exception to this is the Louisville Slugger Field closure, as shown in Photo

8-1 and Figure 8-4. The Slugger Field closure is a “post and panel” type closure with stackable, horizontally spanning aluminum panels that slide between vertical posts and bear on truncated I-Walls. The Louisville Slugger Field closure is approximately 800 lf long, or 25% of the total accumulated length of the closures on the project. These panels are approximately 20 feet wide and 6 feet 6 inches tall.

Photo 8-1: Louisville Slugger Field Closure Sill

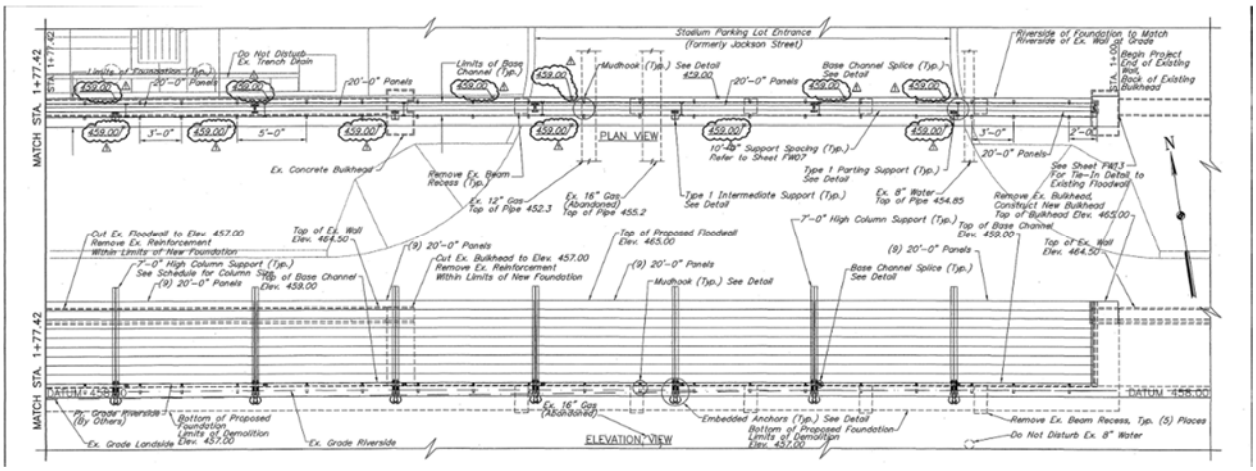

Figure 8-4: Typical Louisville Slugger Field Closure Details

There are 31 cast-in-place (CIP) gatewells and 112 sluice gates/flap gates. Gatewells 5 and 13 on the Southwest Jefferson reach are integral parts of the floodwall.

The project has 15 pump stations ranging in capacity from 35,500 gallons per minute (GPM) to 1,840,328 GPM. Buchanan Street, 4th Street, 5th Street, 10th Street and 17th Street pump stations are integral parts of the floodwall. Beargrass Creek, 27th Street, 34th Street, Shawnee Park, State

Fairgrounds, Paddy's Run, Upper Mill Creek, Riverport, Lower Mill Creek, and Pond Creek pump stations are integral parts of the levee.

8.3. Floodwalls and Closures

8.3.1. Field Inspections

A Periodic Inspection (PI) was completed in conjunction with this study. USACE and a third party consultant completed the 2019 PI. The consultant completed an inspection of all gatewells, gates, and pump stations; USACE completed an inspection of the floodwall, closures, and earthen levee. The USACE structural portion of the inspection took place on 12 February 2019 (for the floodwall beneath the American Life and BB&T buildings) and from 11 to 15 March 2019. During the USACE inspection, three structural engineers and one geotechnical engineer examined the entire length of the project's reinforced concrete floodwalls. A camera mounted to a telescoping pole was used to conduct a T.O.W. inspection. One team of two engineers inspected either the landside or riverside of the floodwall while the remaining two engineers conducted a T.O.W. inspection and the opposite side of the wall inspection. The camera mounted to a telescoping pole also allowed for the top of closure vaults to be inspected and roof conditions to be assessed. The operation and maintenance (O&M) items included in the PI were not considered in this project. Volume 3 contains the full PI.

A structural assessment of Paddy's Run Pump Station was conducted separate from the PI to determine the scope of repairs required for rehabilitation. A summary of the inspection is detailed in Section 8.8.1

8.3.1.1. Differential Movements

Tilting, sliding, and settlement were observed in multiple monoliths. Typical differential movement is shown in Photo 8-2. However, no indication of active movements were observed, based on comparison of measurements from the 2019 PI and the measurements performed by Heritage Engineering in June 2015. Table 8-1 shows differential movements of one inch or greater observed during the 2019 PI.

Differential movements one inch or greater have the potential to damage the water stop. Core samples were taken of potentially damaged water stops for the Paducah Reconstruction Feasibility Report; from these cores it was determined that differential movements of greater than 1 inch could damage water stops. Damaged water stops negatively impact the performance of the floodwall, due to leakage through the walls and the potential for erosion.

8.3.1.2. Water Stops

Water stops damaged due to differential movements must be repaired to address performance deficiencies due to leakage. External water stops will be designed and installed to address performance deficiencies in 26 of the noted deficiencies. External water stops that consist of steel plates, adhesive anchors, and a PVC seal will be used. Water stops of this type are relatively inexpensive, simple to install, and replacement of the seals can be accomplished with hand tools.

Photo 8-2: Typical Differential Movement

Table 8-1: 2019 PI-Observed Floodwall Differential Movements of One Inch or Greater

Approximate Station	Estimated Differential Movement	Tilting/Sliding/Settlement	PI Point
4+87	2”	Tilting	0020
55+90	1”	Tilting	0194
56+50	1”	Tilting	0197
56+70	1 ½”	Tilting	0200
55+50	1”	Settlement	0212
59+90	1”	Tilting	0221
78+80	1”	Tilting	0275
128+20	1”	Tilting	0401
133+00	1”	Tilting	0416
129+00	1 ½”	Tilting	0425
145+50	1”	Tilting	0458
143+75	1”	Titling	0461
143+00	1”	Tilting	0467
215+50	2 ½”	Tilting	0560
502+80	1”	Tilting	0761
325+60	1”	Settlement	0827
88+00	1”	Settlement	0899
829+30	1”	Tilting	0929
835+40	1 ½”	Tilting	0950
875+00	1”	Tilting	1046
873+30	1”	Titling	1049
149+80	2” to 3”	Tilting	1340
150+30	2” to 3”	Titling	1346
150+70	1”	Tilting	1352
153+00	1”	Tilting	1364
155+60	3” at floodwall base 1” at floodwall top	Sliding	1367
157+00	1 ½”	Tilting	1376
114+50	2”	Tilting	1472

8.3.1.3. PI Observations

Several degraded areas of concrete were noted in the 2019 PI (pump stations, gatewells, closures, and floodwalls). Areas of spalling, cracking, exposed reinforcement, efflorescence, and potential Alkali-Aggregate Reaction (AAR) were observed. Concrete surface degradation is generally considered an O&M task. See Volume 3 for the full 2019 PI.

8.3.2. Johnsontown Road Closure Vault

The Johnsontown Road Closure Vault, as shown in Figure 8-5, was noted to have significant deterioration due to its age and grading that does not meet original design specifications in the 2019 PI (see PI point LOME_2019_p_0863 in Volume 3). Grade is six inches higher than indicated in the design documents. Grading has contributed to water intrusion into the vault, likely resulting in deterioration of the structure. Moisture intrusion because of missing weep holes or clogged weep holes in the brick has resulted in joint reinforcement corrosion. As a result of the joint reinforcement corrosion, the mortar in the bed joints is spalling. Multiple areas of the inside face of the CMU are cracking.

8.3.3. Johnsontown Road Closure Vault Recommendation

Replacement of the Johnsontown Road Closure Vault with a similar structure is recommended. Re-grading or providing additional drainage pipes away from the structure to reduce water intrusion will be required. The out-to-out dimensions of the structure will be maintained. A larger door or double doors will be added to ease the removal of closure parts. Details of the replacement closure vault are shown in Volume 3 Sheet JT-S-101.

Figure 8-5: Johnsontown Road Closure Vault

Retrieved from Google Earth

8.4. Pond Creek I-Walls

I-Walls adjacent to Pond Creek Pump Station were identified as not meeting the new I-Wall design requirements in the 2019 Semi Quantitative Risk Assessment (SQRA), which was completed concurrently with the Metro Louisville Flood Protection Feasibility Study. The reinforcing bars on the tension side (riverside face) of the I-Walls are not anchored to or through the sheet piling, as shown in Figure 8-6, in accordance with modern design guidance. Lack of anchorage of the tension bars allows the I-Wall to rotate about the top of the sheet pile, which leads to a brittle failure under a hydrostatic loading condition less than the original design load.

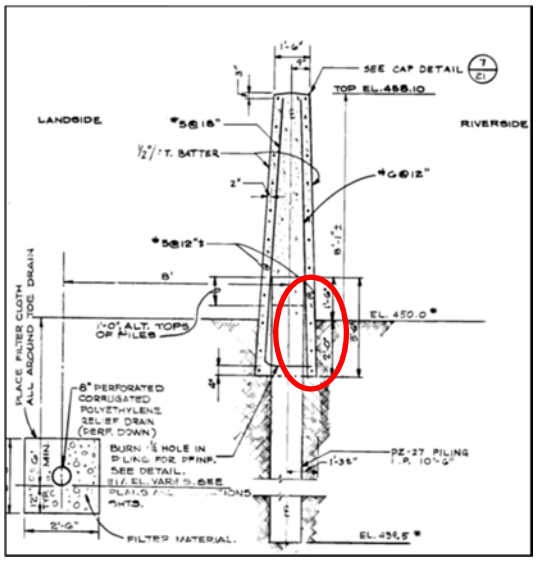

Figure 8-6: Typical Pond Creek I-Wall

8.4.1. Pond Creek I-Wall Repair Recommendation

The Pond Creek I-Wall repair recommendation is not straightforward. The simplest repair would be to place backfill against the landside face of the I-wall to increase the amount of passive resistance provided by the soil, which would eliminate the tension reinforcing bar issues in the wall. However, this is not feasible due to the close proximity of a garage on the north section of I-Wall and a substation on the south section of I-Wall as shown in Figure 8-7. Due to these obstructions, an alternate strengthening method was developed.

The key consideration for the repair is anchoring the tension-reinforcing bar to the sheet pile. Post-installed anchors in epoxy drilled through the concrete and sheet piling, can be designed to perform like shear studs on the sheet pile and create a composite section between the concrete and sheet pile. Using a strut and tie method as the force transfer mechanism it is the opinion of the structural team that this anchoring system will efficiently transfer forces from the tension bars to the sheet pile. To accomplish the anchoring, Ground Penetrating Radar (GPR) mapping of the sheet pile and reinforcing will be needed prior to final design to ensure the most efficient layout and number of anchors are used. Additionally, to verify that construction is as indicated in the as-builts demolition of the bottom one-foot section on the flood side of a single monolith will be required; reinforcing will remain and a temporary concrete repair of the demolished section will be needed. Volume 3 Sheet PC-S-102 shows the conceptual details of this design.

Figure 8-7: Screenshot of Pond Creek Pumping Station
Retrieved form Google Earth

Figure 8-8: Screenshot of Canal Street Generating Station
Retrieved from Google Earth

8.5. Canal Station

The abandoned Canal Station foundation was constructed integrally with the floodwall (approximately from Station 210+00 to Station 212+60) as shown in Figure 8-8. The generating station is not in service, was previously condemned, has numerous structural issues in the foundation integral with the floodwall, and is anticipated to be demolished in the future by the owner (Louisville Gas and Electric) or their representative.

8.5.1. Canal Station Recommendations

Prior to demolition of Canal Station, a new floodwall section will need to be constructed. Demolition of the existing I-Wall from Station 212+60 to Station 215+00 is anticipated. A T-Wall is recommended from approximately Station 205+00 to Station 215+00; see Volume 3 Sheet CN-S-101. An assumed 20 foot deep cutoff wall will extend down from the shear key; a sloped base will be used to provide sliding resistance. Assumptions for ground elevations and the design flood height were made for design, such as water to the T.O.W., safety factors of 1.33 for sliding and overturning with 75% of the base in compression, and 2.0 for bearing. The cutoff wall was assumed ineffective.

During the design phase, an in depth analysis of the existing sheet pile I-Wall approximately from Station 212+60 to Station 215+00 will be completed. This section of sheet pile wall has adequate embedment depth, but the strength of the sheet pile has not been analyzed yet. The observed I-Wall corrosion will be investigated via historical research for coatings applied to the sheet pile and the below grade conditions of the sheet pile I-Wall will be investigated. If a determination is made that the sheet pile I-Wall is sound, the total length of new wall may be shortened or the below grade section of the existing wall may be used as a cutoff wall. Additionally, the cutoff wall could be considered to provide lateral resistance in order to provide a more economical design. See the Volume 2 Appendix E for alignments.

8.6. 10th Street Closure Structure

The 10th Street closure is placed in service at lower river elevations (when compared to other closures), so it is installed more frequently than other closures. It must be installed with multiple personnel and large equipment. In an effort to increase worker safety (by removing or reducing overhead lifts and large equipment from the installation process), reduce the risk of not getting the closure installed in time, and to simplify the closure plan for the city of Louisville, two options were evaluated: permanently sealing the roadway closure and leaving a man door for access (alternative #1) and a double leaf swing gate (alternate #2).

8.6.1. 10th Street Closure Alternate #1

Permanently sealing the 10th Street Closure is the more economical and simple alternate. Typically, closures are permanently sealed by installing the existing steel closure, placing forms around the existing closure, adding reinforcing and tying the reinforcing to the existing closure, and encasing it in concrete. This is a proven method used at other locations and is recommended to be used at this location, due to its comparable low construction and O&M costs. With the exception of an increase in dead load, load paths and loads remain the same. See Volume 3, Sheet 10-S-101 alternative 1.

8.6.2. 10th Street Closure Alternate #2

A swing gate and roller gate were evaluated to replace the current gate. The swing gate was chosen over a roller gate due to the clearance required from the I-64 piers in close proximity to the floodwall.

The swing gate was designed without consideration of composite action between the skin plate and framing members. During the design phase, a gate with a composite skin plate will be considered in an effort to save cost. The gate was designed with water to the T.O.W., because the top of the gate is below the floodwall T.O.W.; the floodwall in this location extends approximately 10 feet above the gate. Alternate #2, due to its higher cost , will be considered a betterment. See Volume 3 Sheet 10-S-101, 10-S-201, and 10-S-301 alternate 2.

8.7. Butchertown I-Wall

During the 2019 Semi-Quantitative Risk Analysis (SQRA), the I-Walls between monoliths 269 and 270 near Station 77+00 and monolith 271 near Station 77+96.00 were identified as having inadequate global stability safety factors. See Figure 8-9 and Figure 8-10. I-Walls will need to be stabilized or replaced.

Additionally, near Station 85+00 approximately two feet of fill will be added on the protected side of the I-Wall. This fill will require a small two feet high by ten feet long retaining wall. The wall will slope down to existing grade as it moves away from the I-Wall. Investigation and design of this wall will be completed in the design phase of the project.

8.7.1. Butchertown I-Wall Alternate #1

I-Walls can be stabilized by several different methods. Backfilling the protected side of a floodwall is cost effective, but not feasible in this application, because a structure is located approximately 4 feet east of the I-Walls near Station 77+00.

A modified T-Wall replacement was also explored to address the global stability of the existing I-Wall. I-Walls would be removed and replaced with a modified T-Wall. The existing I-Walls would be cut near grade to serve as a cutoff wall, new toe drains would be installed, and refurbishment or replacement of the toe drains of the adjacent floodwalls would be required. Shoring and bracing of the excavation would need to be designed such that the adjacent structure is not damaged from the new T-Wall construction. See Volume 3 Sheet BT-S-101 for wall details. Design assumptions include water at the T.O.W., Phi=30°, γ_{SAT}=115pcf, and the cutoff walls/toe drains were ineffective. Global stability of the modified T-Wall was analyzed using CT-Wall.

8.7.2. Butchertown I-Wall Alternate #2

Deep founded king piles installed next to the I-Walls could increase the global stability of the wall. The I-Wall would span horizontally between king piles and transfer the lateral loads into the piles. The piles would then take the load deeper into the ground down to suitable soil. . King piles are economical, require a smaller construction easement and excavation, and construction time would be shortened. An analysis of a king pile system has yet to be completed and will be considered during final design.

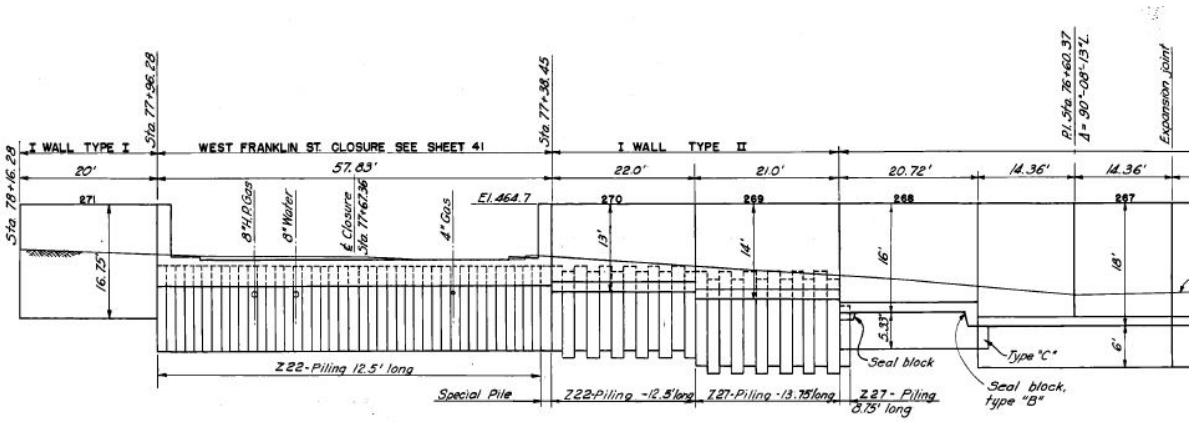

Figure 8-9: Monolith 269, 270, and 271 Profile View

Figure 8-10: Screenshot of the Butchertown I-Wall Section near Station 77+00.

Retrieved from Google Earth

8.8. Pump Stations

Mechanical and electrical modifications will be conducted at 14 of the 15 pump stations. The scope and complexity of this work will vary by station and will require different levels of structural analysis and design based on the specific equipment selected. Structural modifications could range from providing different anchorages to major building modifications. The full scope of this work is dependent on mechanical and electrical equipment selection and specifications; structural analysis and design other than listed in Sections 8.8.1.2, 8.8.2.1, 8.8.2.2, and 8.8.3 will be determined during the design phase of the project.

8.8.1. Paddy's Run Pump Station Inspection

The Paddy's Run Pump Station has numerous performance deficiencies. The station lacks a crane large enough to conduct proper maintenance of the pumps. The largest lift the Paddy's Run crane is

expected to make is approximately 25 tons. The current crane capacity is 20 tons, however, two 20 ton hoists are supported by a single 30 ton bridge crane support. This could cause a safety issue as someone could potentially attempt a 40 ton lift, thereby over-loading the support's rated capacity. The end wall crane support columns do not extend to the roof and are not adequately braced out of plane. Additionally, one end wall crane support column has a large spall that must be repaired to restore the full bearing capacity for the crane rail; as shown in Photo 8-3.

There are numerous structural degradation issues. There are several areas of concrete and brick that show significant cracking; as shown in Photo 8-4 and Photo 8-5. Potential AAR is typical at the wall cracks. Multiple areas of the concrete walls have spalled exposing reinforcing; as shown in Photo 8-6 and Photo 8-7. Deterioration of the bottom of the concrete pump support beams are the most concerning ; as shown in Photo 8-8 and Photo 8-9. The exposed reinforcing from the spalls will be investigated further to determine the strength reduction of the concrete beam. Significant spalling was also observed on the tension face of the western most trash rack beams; as shown in Photo 8-10.

Cracking due to corroded lintels is present above most openings in the brick wall and sealed openings (lintels were left in-place when openings were sealed); as shown in Photo 8-5 and Photo 8-11. Cracking was observed at the exterior corners of the wet well (at the brick to wet well interface); as shown in Photo 8-12. Cracking was also observed in several areas of the wet well. Openings in the baffle walls showed cracking at the corners (Photo 8-13), there were several cracks in the exterior walls (Photo 8-14 and Photo 8-15), as well as cracking in the wet well maintenance access floor (Photo 8-16).

Signs of significant leaks were observed inside of the station, at the motor floor level; as shown in Photo 8-17. The leaks have caused brick deterioration, efflorescence, and safety issues related to water leaking on an electrical box; as shown in Photo 8-17. Further deterioration of the brick could result in additional water leaking (causing damage/corrosion to the structure or equipment) or an instability of the brick shear walls. Corrosion has deteriorated access ladders in the pump station; as shown in Photo 8-18.

The ground is eroding beneath the high voltage yard pad and an equipment pad adjacent to it. The equipment pad had been significantly undermined; as shown in Photo 8-19.

Photo 8-3: Crane Support Bearing Area Spall

Photo 8-4: Cracking with Potential AAR

Photo 8-5: Brick Cracking

Photo 8-6: Spalling with Exposed Reinforcing

Photo 8-7: Spalling with Exposed Reinforcing

Photo 8-8: Pump Support Beam Spalling with Exposed Reinforcing

Photo 8-9: Pump Support Beam Spalling with Exposed Reinforcing

Photo 8-10: Trash Rack Support Beam with Exposed Reinforcing

Photo 8-11: Sealed Opening with Corroded Lintel Left In-Place

Photo 8-12: Typical Foundation (Wet Well) Wall Cracking

Photo 8-13: Typical Corner Cracking at Wet Well Maintenance Platform Wall Openings

Photo 8-14: Wet Well Wall Cracking

Photo 8-15: Typical Wet Well Wall Cracking

Photo 8-16: Wet Well Maintenance Access Floor Cracking

Photo 8-17: Evidence of Leaking Through Brick

Photo 8-18: Typical Corrosion of Ladders

Photo 8-19: Typical Erosion

8.8.1.1. Paddy's Run Pump Station Analysis

Crane support columns and frame capacities were analyzed using RAM Elements. Assumptions were made about materials and bracing; the concrete (f'_c=3 ksi), the reinforcing yield strength (f_y=40 ksi), and the columns were assumed to not be braced by the brick walls. Considering ASCE 7, EM 1110-2-2104, EM 1110-2-3104 code requirements for dead loads, crane loads, wind loads, seismic loads, etc., the current crane support columns are inadequate. See Table 8-2 for a detailed load description. The current concrete frames failed due to wind loadings in-plane of the frame.

Table 8-2: Paddy's Run Pump Station- Assumed Loads

Load Case	Magnitude	Units
Wind	115	MPH
Dead Load-Crane	15.830	Kip
Dead Load- Crane Rails	100	PLF
Live Load- Crane	60	Kip
Live Load- Roof	50	PSF
Crane Thrust Load	3.367	KIP
Crane Lateral Load	15.166	KIP
Crane Vertical Impact Load	8.416	KIP
Max Crane Wheel Load	33.665	KIP

8.8.1.2. Paddy's Run Pump Station Alternate #1

A 30 ton crane that allows for proper maintenance of all of the mechanical equipment one of the most important improvements to the paint station. Further analysis of material strengths and modification of the existing crane columns and frames is necessary prior to installing a larger crane; testing will include compression testing of concrete cores (ASTM C42) and Windsor probe testing (ASTM C803) of the columns. GPR of the columns and pump support beams will be required to determine reinforcing layout. If material strengths meet the assumed values, interior crane column sections must be enlarged by approximately 1'-7" in-plane with the frame (i.e. the corbel will be extended to the wet well baffle/exterior walls, see Volume 3 Sheet PR-S-201 alternate 1). The corner columns must be extended to the roof and match the in-plane depth of the interior columns. Beams must be added between the end bay columns to create new concrete frames for stability. The beams will connect to the top of the columns and tie into the roof diaphragm The crane hoist will need to be replaced and the crane bridge will need to either be and load tested or replaced.

Potential Alkali-Aggregate Reaction (AAR) was observed in several areas of Paddy's Run. Potential AAR is most prevalent in near joints and edges where moisture is present. Material that shows signs of potential AAR must be removed until sound concrete is reached. Corroded reinforcing must be cleaned, coated, and patched. Minor spalling is present throughout the station, with trash rack beams having significant spalling. Spalls must have unsound concrete removed, exposed reinforcing must be cleaned and treated with anti-corrosion compounds, and concrete must be replaced.

Cracks wider than 1/100th of an inch must be pressure injected with epoxy to prevent corrosion of embedded reinforcing. Areas of delamination and spalls must have all unsound concrete removed, any exposed reinforcing must have corrosion removed and treated with an anti-corrosion compound, and removed concrete must be replaced to match the designed geometry.

Areas where water has penetrated the building envelope will be sealed. Tuck pointing of damaged mortar, installation of down spouts, and sealing of penetrations must be completed to prevent

moisture intrusion. Replace corroded lintels with new hot dipped galvanized lintels and dry pack grout to original dimensions. Access ladders that have significant corrosion must be replaced with OSHA approved Fiber Reinforced Plastic (also referred to as Fiber Reinforced Polymer {FRP}) or Corrosion Resistant Steel ladders. Rehabilitation efforts are shown in Table 8-3. Areas of soil erosion will be filled and grade will be slopped to allow proper drainage.

Electrical and mechanical modifications (pumps, trash racks, trash rakes, motor control centers, transformers, etc.) will require structural analysis and design; analysis and design limits are dependent of final selection of electrical and mechanical equipment. Analysis and design will range from providing anchorage to major structural modifications such as, modifications to doors, cranes, floors, etc.

Table 8-3: Summary of Rehabilitation Efforts- Paddy's Run Pump Station

Condition	Condition Location	Typical Photo	Recommended Repair
Crane under capacity	Motor Level	N/A	Replace the 20 ton crane with a 30 ton crane. Inspect and analyze the crane rails and bridge. Repair/replace as needed.
Crane support columns have inadequate lateral resistance	Motor Level	N/A	Enlarge the interior crane support columns by "extending the corbel" to the wet well walls. Raise corner columns to meet the roof diaphragm. Install a beam between the end bay columns to form a frame. Test existing materials to confirm assumptions.
Cracking with potential AAR	Various	8-4	Remove unsound concrete, clean and treat corroded steel, and replace concrete.
Spalling and delamination	Various	8-3, 8-6, 8-7, 8-8, 8-9, 8-10	Remove unsound concrete, clean and treat corroded steel, and replace concrete.
Cracking	Various	8-5, 8-12, 8-13, 8-14, 8-15, 8-16	Pressure inject epoxy cracks over 1/100th of an inch. Sound concrete and remove and repair any spalls/delamination.
Corroded lintels	Motor Level	8-11	Remove lintels and replace with new hot dipped galvanized lintels. Dry pack grout to design dimensions.
Corroded ladders	Wet well	8-18	Replace corroded ladders with OSHA approved FRP or corrosion resistant steel ladders.
Water intrusion into building	Motor Level/Roof	8-17	Seal or tuck point mortar joints. Seal cracks, install downspouts and seal penetrations.
Erosion	Exterior Mechanical Pad	8-19	Fill and grade surrounding area to provide proper drainage.

8.8.1.3. Paddy's Run Pump Station Alternate #2

Due to the numerous structural and mechanical performance deficiencies of the Paddy's Run Pump Station, a new pump station was explored in lieu of rehabilitation of the existing station (alternate #1). H&H data was not available during the development of alternate #2; see Volume 3 Sheet PR-S-101 to PR-S-302 alternate 2. It was assumed that mechanical equipment weights would be unchanged and ponding elevations around the new station would be to 434' ORD (433.18' NGVD29).

8.8.2. Beargrass Creek Pump Station

The inability to open gates with a differential head was identified as a risk driver during the Metro Louisville Flood Protection SQRA. In the past 65 years there have been two documented occurrences of the pumps losing power while the gates were closed and the protected side ponding elevation was higher than the Ohio River elevation. If gates could have been opened during these events, interior flooding could have been less. It was determined that opening the gates under a differential head of 7'-6" would lower the overall risk. The existing hoist machinery was not designed for differential head operation and is the limiting factor, as there is already backup power to the hoist machinery.

A second means of ingress and egress from the gate mechanical room was deemed necessary due to the potential for flooding on the interior of the station, which would cut off current access, leaving the station vulnerable to mechanical failures. There are two feasible means of installing an access platform— an internal walkway or an external walkway (alternate #1 and #2 respectively). The internal walkway is the most straightforward; however, it would require installing an additional 10 ton crane to supplement the lost crane coverage area. The external walkway will be close to the electrical substation and the minimum clear distance between the walkway and the substation is approximately 12 feet. Alternative walkway details are discussed in Section 8.8.2.2 and Section 8.8.2.3.

Electrical and mechanical modifications will require structural analysis and design; analysis and design limits are dependent of final selection of electrical and mechanical equipment. Analysis and design will range from providing anchorage to major structural modifications such as, modifications to doors, cranes, floors, etc.

8.8.2.1. Gate Modification

Modifications to the roller gates and support structure at the Beargrass Creek Pump Station are dependent on what mechanical equipment is selected and what configuration is installed. The equipment was assumed to remain in a similar configuration to existing, would be larger, an extra sheave would be added to the gate, and that lifting loads would increase. Based on the stated assumptions, two reinforcing plates will need to be added to each side of the gate lifting lugs, the lifting pins will need to be lengthened, two new continuity plates will need to be added, openings will need to be widened, a spreader beam will need to be added to reinforce the widened openings, and new anchorage will need to be provided. Access to the gate mechanical room is restricted by a 10 ton crane support beam. The exterior crane support beam will be removed to facilitate the installation of new equipment. Details are shown on Volume Sheets BG-S-101 to BG-S-103. During the design phase, a full HSS inspection of both river gates at Beargrass Creek will need to be completed and any damage to the gate— that is not O&M related— will need to be addressed.

8.8.2.2. Walkway Addition Alternate #1

Providing an additional internal access to the gate maintenance room can lower risk by allowing access during interior pump station flooding. The walkway will extend from the two staircases that provide access to the maintenance room floor, connecting landing to landing (see Volume Sheets BG-S-104, BG-S-105) The walkway could be conventional structural steel construction and would not require additional safety precautions (handrails are not viewed as additional). Maintaining crane access to the entire maintenance floor is essential and would require a second crane to be installed. An analysis of the crane supports and rails would be required during design to ensure the additional load would be acceptable.

8.8.2.3. Walkway Addition Alternate #2

An external walkway providing maintenance access from the northwestern vehicle ramp to the gate maintenance room would not require an additional crane; however, it would be in close proximity to the existing electrical substation, would need to be longer than the interior walkway, and require ladder access. Construction could be conventional structural steel with non-conductive FRP cladding (see Volume Sheets BG-S-106, to BG-S-108). Additionally, a larger platform would be required at the ladder access point near the vehicle ramp. A manhole opening would be required in the ramp above the platform; core drilling and reinforcing of the opening would be necessary.

8.8.3. Pond Creek Pump Station

In an effort to reduce vibration, cavitation, and vortices at the Pond Creek Pump Station, an FSI or vortex suppression grid will be required. Structural analysis and design for the chosen system will be completed during design phase. The scope of analysis and design will be dependent on the equipment selected and will range from providing anchorage to major structural modification of the supporting structure.

8.8.4. Pump Station General Condition

As part of the Metro Louisville Flood Protection PI all pump stations and gatewells were inspected. A summary of minimally acceptable and unacceptable structural items is shown in Table 8-4. Inspection of cranes is completed by MSD on a regular basis; however, load tests are not completed. Cranes that have not been load tested will need load tests completed prior to removing pumps for inspection, refurbishment, or replacement.

Table 8-4: Pump Station PI Observations and Recommended Actions for Minimally Acceptable (M) and Unacceptable (U) Rated Items

Approximate Station/Related Pump Station	Condition and Recommended Action (RA)	PI Rating	PI Point
PUMP STATIONS OPERATING, MAINTENANCE, TRAINING, & INSPECTION RECORDS			
7+00 Beargrass Creek	**Condition:** Beargrass Creek Pump Station. This station used to be the main office until recently; therefore, a daily logbook has not been started there yet. **RA:** Update daily log book	M	0048

PLANT BUILDING			
572+00 Paddy's Run	**Condition**: Paddy's Run Pump Station. Very old building that is in need of numerous minor repairs. **RA:** Repair minor building issues	M	0054
CRANES			
---	Could not verify that cranes had been load tested	M	---
OTHER METALLIC ITEMS (EQUIPMENT LADDERS, PLATFORM ANCHORS, ECT)			
572+00 Paddy's Run	**Condition:** Paddy's Run Pump Station. Numerous areas of moderate corrosion. **RA:** repair metal parts that have visible corrosion	M	0055

8.9. Gates and Gatewells

Multiple gates will require inspection and refurbishment; see Mechanical Appendix C. Inspection of gates and auxiliary equipment will be completed after paint has been removed. Replacement of gates under 96" x 96" will be standard manufacturers designs (designs must be found in 3 manufacturers catalogs); replacement of gates larger than 96" x 96" will be designed and detailed by the structural engineer and will conform to ETL 1110-2-584. Assumed limits of structural analysis and design will range from inspections and detailing of new rails and slots to inspections and multiple gate designs.

8.10. Recommended Plan

Alternatives were evaluated based on engineering judgment, estimated cost, ease of construction, service life, and O&M costs. Recommended plans are summarized in Table 8-5 with justifications detailed in the following sections.

Table 8-5: Recommended Plan

Location	Recommended Plan
Water Stops	Investigate and replace water stops at joints with differential movement of one inch or greater. See Section 8.3.1.2.
Johnsontown Road Closure Vault	Replace the Johnsontown Road Closure Vault and re-grade site. See Section 8.3.3.
Pond Creek Pump Station I-Walls	Post-install adhesive anchors. See Section 8.4.1.
Canal Station	Construct a new T-Wall alignment. See Section 8.5.1.
10th Street Closure	Permanently seal the closure. See Section 8.6.1.
Butchertown I-Wall	Remove existing I-Wall and replace with modified T-Wall. See Section 8.7.1.
Paddy's Run Pump Station	Structural rehabilitation. See Section 8.8.1.2.
Beargrass Creek Pump Station	Modify structural and mechanical equipment to allow opening under differential head. See

	Section 8.8.2.1. Add interior walkway (alternate #1) and additional crane to maintain coverage. See Section 8.8.2.2.
Pond Creek Pump Station	Install an FSI or vortex suppressor. See Appendix C for Mechanical details. See Section 8.8.3 for Structural details.
Gates and Gatewells	Inspect and repair gates, slots, and rails. See Section 8.9

8.10.1. Plan Selection Justification

8.10.1.1. Water Stops

Damaged water stops have the potential to cause erosion and scourer on the protected side of floodwalls. Water stop repairs will improve system performance and lower the risk of erosion on the protected side of the floodwalls.

8.10.1.2. Johnsontown Road Closure Vault

The existing closure vault has reached its design service life and needs replacement. The closure vault houses the Johnsontown Road closure parts. Maintaining a watertight structure will reduce O&M cost associated with the Johnsontown Closure.

Repair of the existing closure vault is not feasible due to the high cost of repairs and relatively low cost of replacement. Therefore, demolition of the existing structure, re-grading of the site, and construction of a new closure vault is recommended.

8.10.1.3. Pond Creek Pump Station I-Walls

The Pond Creek Pump Station I-Walls present a unique challenge. Typical methods of reinforcing the walls are not feasible (i.e. backfilling on the protected side). However, post-installed adhesive anchors while utilizing a strut and tie method of analysis to determine the exact layout and number of studs in design will allow these walls to be repaired efficiently. Cost savings can be achieved by utilizing large washers (plates) at each anchor instead of placing one large plate over the entire wall. Hot dip galvanization of steel parts will increase the life of steel parts while decreasing O&M costs.

8.10.1.4. Canal Station

Demolition of the Canal Street Generating Station in the future necessitates the construction of a new floodwall alignment. T-walls are recommended due to their reliability and robustness. During the design phase cost savings can be achieved by optimizing the foundation, stem, and cutoff wall. Analysis of the sheet pile wall from Station 212+60 to 215+00 during the design phase could provide cost savings via utilization of existing features.

8.10.1.5. 10th Street Closure

The 10th Street Closure is placed in service at relatively low river elevations; the closure is the second most frequently installed. The local sponsor must utilize large equipment and numerous personnel to install the closure. A swing gate was considered and eliminated due to the high cost of construction, fabrication, and O&M costs. Permanently sealing the closure will provide a reduction in risk to the system and eliminate the need to frequently install a closure. Vehicle access to the area on the

riverside of the floodwall can still be achieved via two closures downstream (approximately 500 ft and 700 ft downstream); pedestrian access is achieved via two man doors adjacent to the 10th Street Closure. The downstream closures are at a higher elevation and do not need to be installed as often as the 10th Street Closure. MSD could consider the double leaf swing gate as a betterment if maintaining traffic flow through the 10th Street Closure is a priority.

8.10.1.6. Butchertown I-Wall

The Butchertown I-Wall near Station 77+00 and 77+96 (monoliths 269,270, and 271) requires modification to address global stability issues. An adjacent structure prevents backfilling on the protected side of the wall; due to this structure, a modified T-Wall is recommended. During the design phase king piles will be considered in-place of the modified T-Wall to reduce costs and construction time.

8.10.1.7. Paddy's Run Pump Station

Paddy's Run Pump Station is aging and in need of many repairs, however the cost of a new station is unjustifiable when compared to the cost of rehabilitation. Columns will need to be retrofitted to meet current standards and the crane will need a new hoist installed and be load tested, or will need to be replaced. While the structural modifications are considerable, they are not costly enough to justify a new station. Alternate #1 is recommended based on a cost comparison with Alternate #2 however, if a pumping capacity increase becomes necessary— prior to rehabilitation of the existing station— Alternate #2 will be reconsidered.

8.10.1.8. Beargrass Creek Pump Station

Modifications to the Beargrass Creek Pump Station are dependent of the configuration and selection of mechanical equipment. Basic assumptions about size and configuration have led to the determination that opening the gate under 7'-6" of differential head is possible with minor structural modifications to the station and gate.

Walkway Alternate #1 (interior walkway) has been selected due to construction and safety concerns with the external walkway (alternate #2). Alternate #2 is in close proximity to an electrical substation; this proximity will hinder construction efforts and creates a safety hazard if cranes/telescopic forklifts are used. Additionally, Alternate #1 will have little to no exposure to the elements and will require less maintenance than Alternate #2. Installation of an additional crane is a concern for Alternate #1, but is not be cost prohibitive.

8.10.1.9. Pond Creek Pump Station

In an effort to reduce vibration, cavitation, and vortices at the Pond Creek Pump Station an FSI or vortex suppression grid will be required. Structural analysis and design for the chosen system will be completed during design phase. The scope of analysis and design will be dependent on the equipment selected and will range from providing anchorage to major structural modification of the supporting structure.

8.10.1.10. Gates and Gatewells

Inspection, repair and replacement of gates will reduce the risk of the levee system. Further analysis will be completed post inspection. Gates larger than 96" X 96" will be designed by the structural

engineer should replacement be necessary. Most gates are 65 years old; as such, replacement or repair of multiple gates is likely.

Appendix I – Qualitative Analysis of Climate Change Impacts Table of Contents

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9. Appendix I – Qualitative Assessment of Climate Change Impacts

Louisville, KY

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9.1. Introduction and Background

This qualitative assessment of climate change impacts is required by U.S. Army Corps of Engineers (USACE, "the Corps") Engineering and Construction Bulletin (ECB) 2018-14, "Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects." This assessment documents the qualitative effects of climate change on hydrology in the region and informs the Louisville Metro Flood Protection Feasibility Study (LMFS) being performed by the USACE Louisville District (LRL) of the potential impacts and risks drivers which can potentially be attributed to climate change.

USACE projects, programs, missions, and operations have generally proven to be robust enough to accommodate the range of natural climate variability over their operating life spans. However, recent scientific evidence shows that in some places and for some impacts relevant to USACE operations, climate change is shifting the climatological baseline about which that natural climate variability occurs, and may be changing the range of that variability as well. This is relevant to USACE because the assumptions of stationary climatic baselines and a fixed range of natural variability as captured in the historic hydrologic record may no longer be appropriate for long-term projections of the climatologic parameters, which are important in hydrologic assessments for flood risk management in watersheds such as the Ohio River Basin.

Following the devastating floods on the Ohio River in 1937, the Flood Control Act of 1938 authorized flood damage reduction projects in the Ohio River Basin. One of the projects is in Louisville, KY where the Corps planned and implemented a levee and floodwall system. The system consists of numerous pumping stations designed to accommodate interior drainage during flood events. The Louisville Metro Flood Protection System was constructed between 1947 and 1956. The project, consisting of 67,321 feet of earthen levee and 21,518 feet of concrete floodwall, provides protection for the City of Louisville against Ohio River floods up to the 1937 flood with a freeboard of 3 feet.

Louisville, KY is located along the Ohio River in the 4-digit Hydrologic Unit Code (HUC) 0514 Lower Ohio. The HUC-4 region is approximately 12,600 square miles and spans the Ohio River from Carrolton, KY to its confluence with the Mississippi River near Cairo, IL. Louisville is located approximately 60 miles downstream of Carrollton, KY. The watershed of the Ohio River at Louisville is roughly 91,000 square miles and extends to portions of New York, Pennsylvania, Maryland, West Virginia, Virginia, North Carolina, Ohio, Indiana, and Kentucky.

Figure 9-1. Ohio River Watershed including USACE Districts and Political Boundaries (project area circled in red)

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Figure 9-1 displays a watershed map for the Ohio River Basin with the project area circled in red. Each pastel hue represents the portion of the Ohio River watershed under the authority of the various USACE districts. Yellow represents LRL. There are 859 real-time stream gages located within the Ohio River watershed, 482 of which are located upstream of the City of Louisville. A series of navigation locks and dams (L&D) span the entire profile of the Ohio River from Olmsted L&D near the downstream confluence with the Mississippi River, upstream to Emsworth L&D near Pittsburgh. Additionally, there are numerous flood risk management reservoirs located within the watershed. Twenty of these are located within Louisville District alone and a majority of them were impounded since the Louisville Metro Flood Protection system was constructed. Many of the stream gages are affected by flood risk management projects, including upstream regulation and impoundment.

In order to separate out the hydrologic influence of observed climate change from other significant anthropogenic impacts, such as upstream regulation, an effort was made to identify relatively "pristine" gages which are largely free of the effects of watershed modification. These gages, more or less, represent natural run-of-the-river morphologic conditions, allowing for greater insight into the impacts which may have been caused by climate change. While the pristine gages chosen for analysis were selected primarily because of the lack of regulation within their upstream watershed, preference was also given to sites with lengthy annual peak streamflow period of record and to sites with relatively large drainage areas. Land use change over time, such as urbanization and changing forestry practices, were not considered when selecting pristine gages, which may have some impact on nonstationarity analysis.

Table 9-1. Relevant Stream Gages used in Qualitative Analysis

USGS Gage Num.	USGS Site Name	Peak Streamflow POR	Peak Streamflow Observations	Drainage Area, mi^2	Impacted or Pristine?
03294500	OHIO RIVER AT LOUISVILLE, KY	1832 - 2017	154	91,170	Impacted
03292500	SOUTH FORK BEARGRASS CREEK AT LOUISVILLE, KY	1940 - 2017	74	17.2	Impacted
03293000	M FK BEARGRASS CR AT OLD CANNONS LN	1943 - 2017	74	18.4	Impacted
03302000	POND CREEK NEAR LOUISVILLE, KY	1937 - 2017	74	64.0	Impacted
03298000	FLOYDS FORK AT FISHERVILLE, KY	1937 - 2017	75	138.0	Pristine

In addition to analyzing the relatively pristine gages, various other gages of interest were selected as hydrologically representative of the Louisville Metro Area. These gages are dispersed spatially throughout the watershed as well as through a range land uses, as both of these variables influence the hydrology of the gage. These gages and relevant parameters such as drainage area and peak streamflow period of record (POR) are in Table 9-1. Gages marked as "impacted" in the right-most column have experienced a high degree of commercial, residential, or industrial development within their watershed, as is common within Louisville. Additionally, these gages are impacted by a complex interaction of sub-surface storm drainage pipe network and numerous stormwater detention basins. Floyds Fork at Fisherville was identified as a relatively pristine gage near the vicinity of the study area and the land use is dominated by deciduous forest and agricultural land use. While this gage is by no means untouched by development or hydrologic alteration, it is comparably pristine when contrasted with the other gages, particularly Beargrass Creek or Pond Creek, and can serve as a useful reference site for comparisons. It should also be noted that upstream reservoir operation on the Ohio River was assumed to be consistent and uniform across the period of regulation. While there have been numerous deviations from the

authorized water control plan, these changes were assumed to be relatively minor from a statistical and operational perspective.

9.1.1. Historic Climate within the Louisville Metro Area

Climate in Louisville, KY is humid subtropical with four distinct seasons. Spring-like conditions typically begin in mid-to-late March, summer from mid-to-late-May to late September, with fall in the October-November period. Seasonal extremes in both temperature and precipitation are not uncommon during early spring and late fall.

Records from the National Climatic Data Center for Louisville show an average annual rainfall of 44.91 inches and an average daily temperature of 58.2°F. These average values are based on a 29 year period from 1981 - 2010. Extremes from the entire period of record include a maximum observed temperature of 107°F in 1901, 1930, and 1936, as well as a minimum observed temperature of -22°F in 1994. Of the top ten wettest days in Louisville, KY there are seven have occurred during the months of March (4), April (1), and October (2). The highest precipitation amount occurred on 1 March 1997, with 10.48 inches of rain in a single day. Figure 9-2 displays historic average monthly temperature and precipitation totals for the Bluegrass Region according to the Kentucky Climate Center for a period of record of 1895 – 2016.

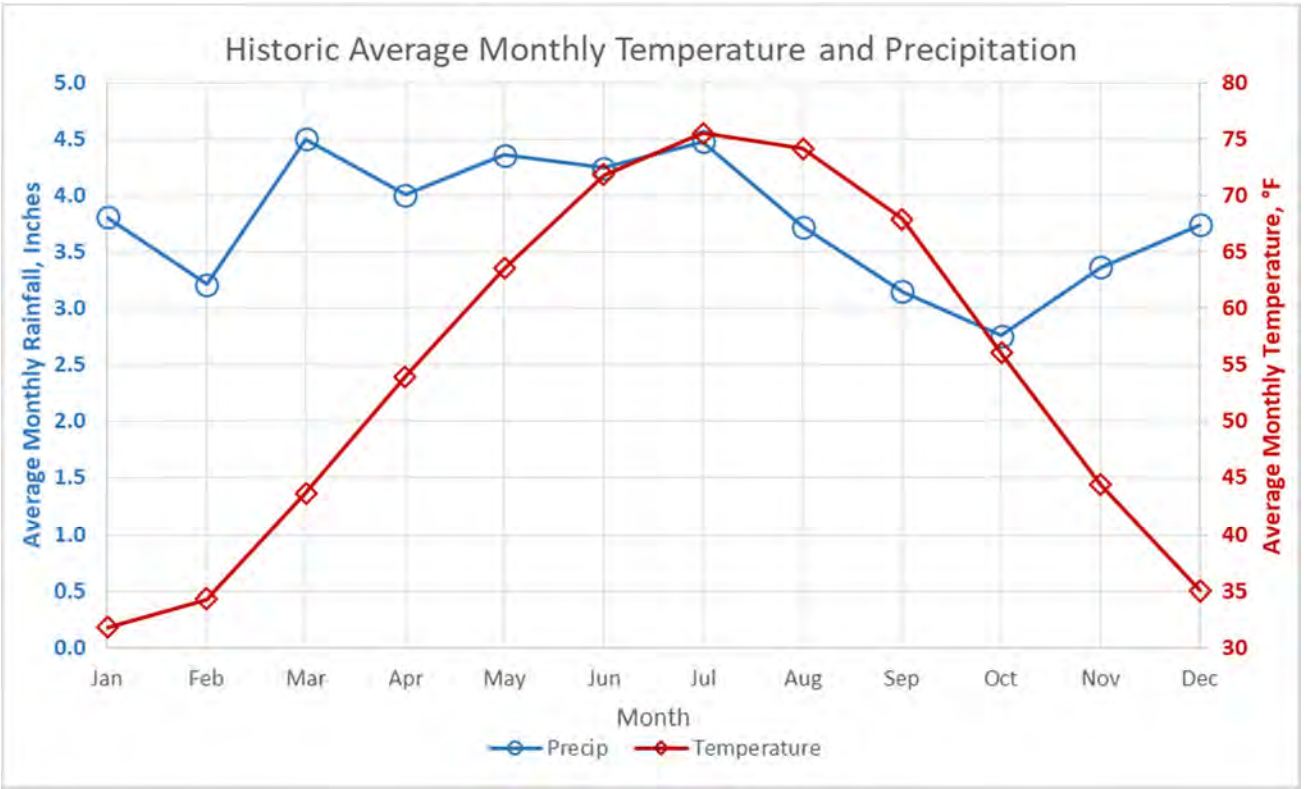

Figure 9-2. Historic Average Monthly Temperature and Precipitation

9.1.2. Observed Trends in Temperature and Precipitation

An assessment of observed trends in historic temperature and precipitation was conducted using local climate data available from the National Weather Service in Louisville, KY. Data analyzed includes seasonal mean and average annual temperature, as well as annual precipitation and maximum seasonal average precipitation. This data, associated trends, and statistical significance values are displayed in Figure 9-3 and Figure 9-4.

A statistically significant, increasing trend was identified when examining spring mean seasonal temperatures. The magnitude of this trend is relatively low, 0.011°F per year, but is the largest of any of the seasons examined. Other seasons (winter, summer, and autumn) did not exhibit statistically significant trends at a 95% confidence level (p-value < 0.05). The annual average temperature showed an increasing trend with a p-value of 0.14. While this trend is not strictly significant, the relatively low p-value shows some indication of a potential upward trend. While not all detected trends can be considered significant, it should be noted that all seasons showed upward sloping trends.

Additionally, both the total annual precipitation and maximum seasonal average precipitation datasets showed statistically significant increasing trends at a 95% confidence level. It should be noted that the magnitude of these precipitation trends is well below 0.1 inches per year, with the annual total precipitation regression trend line increasing 0.042 inches per year.

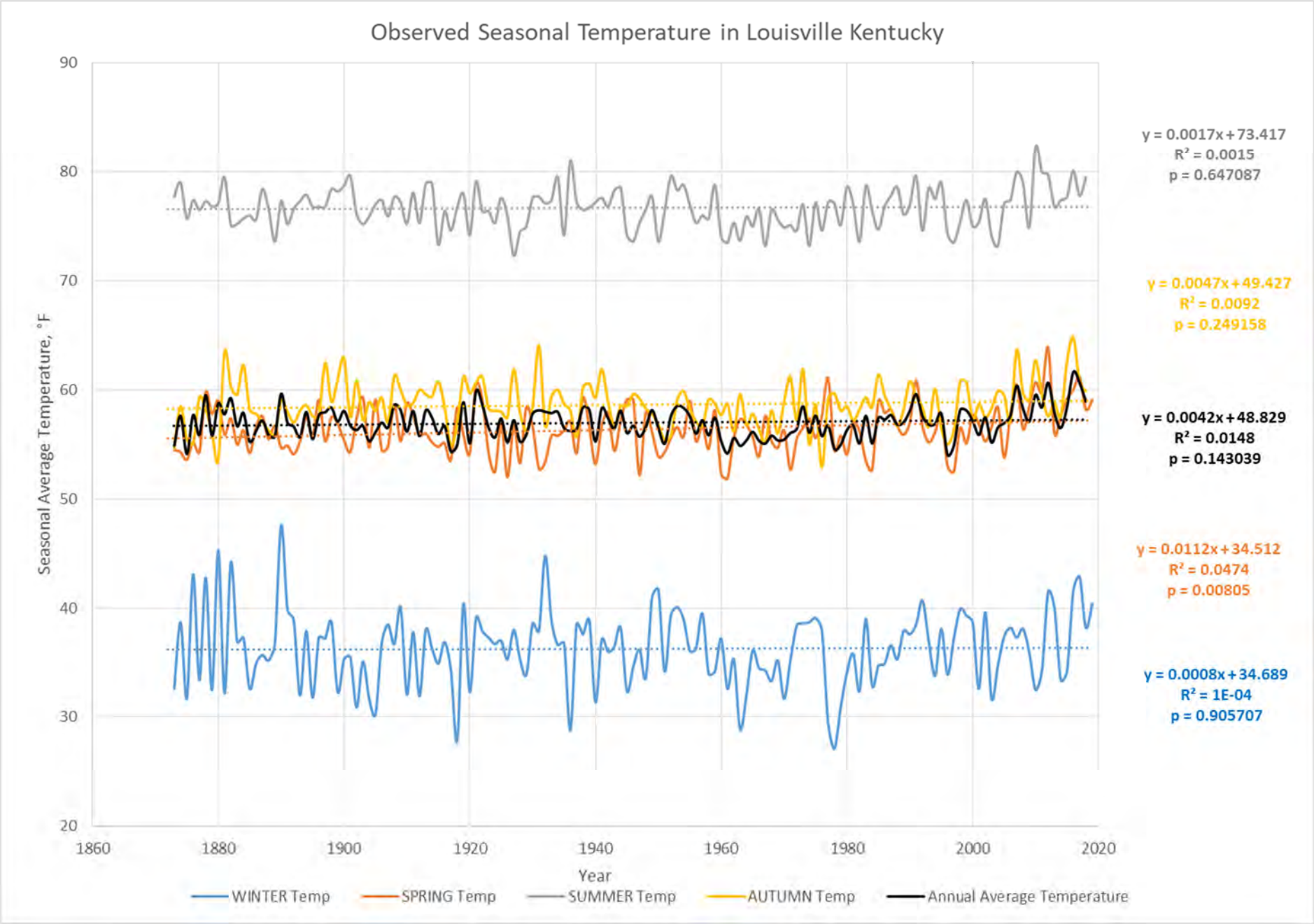

Figure 9-3. Trends in Observed Temperature

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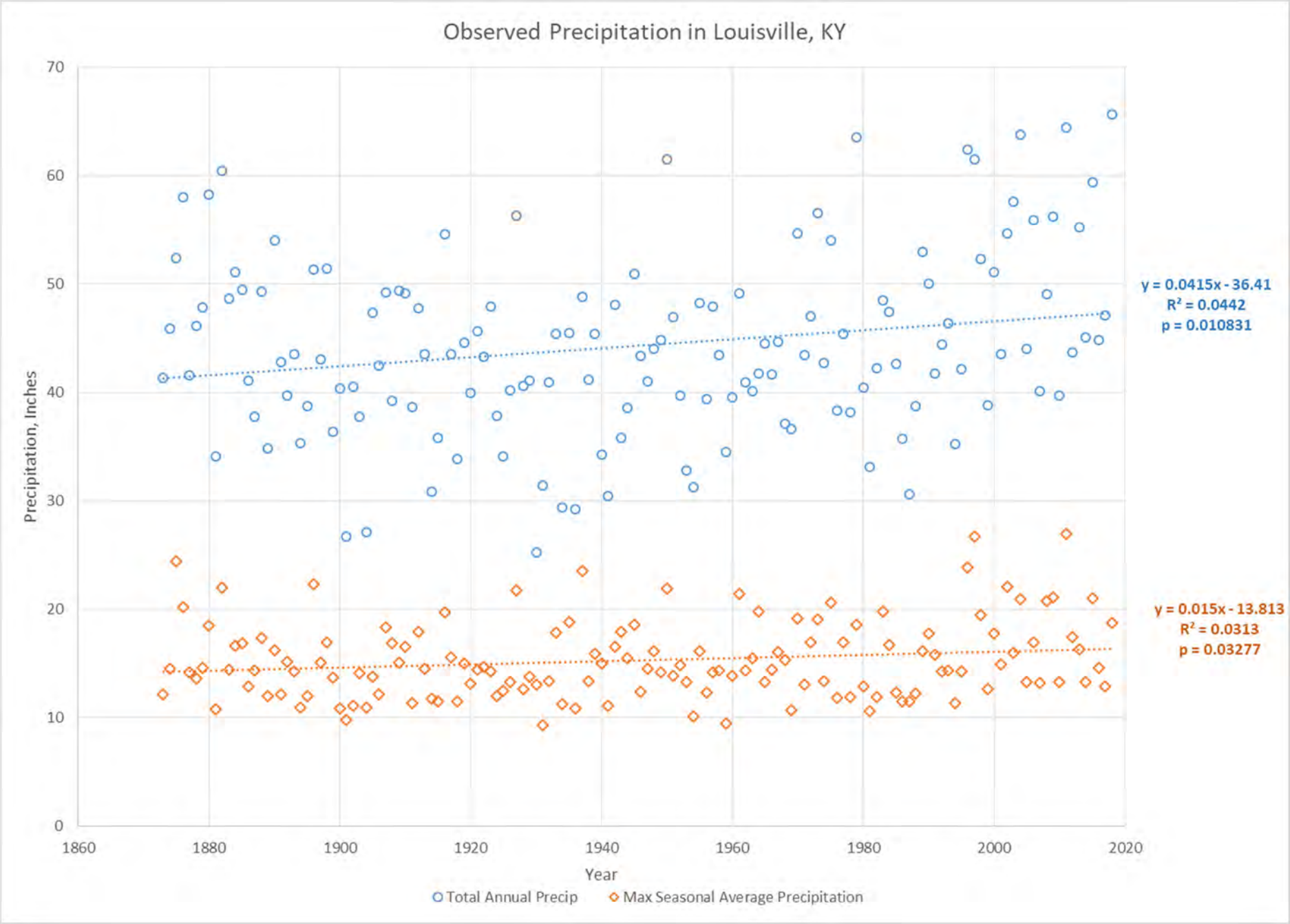

Figure 9-4. Trends in Annual and Maximum Seasonal Average Precipitation

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9.2. Observed Trends in Current Climate and Climate Change

9.2.1. Literature Review

9.2.1.1. Recent US Climate Change and Hydrology Literature Syntheses

A September 2015 report conducted by the USACE Institute of Water Resources summarizes the available peer reviewed literature related to trends in both observed and projected hydrometeorological variables for the Ohio Region (HUC02 05), which includes the Ohio River and Louisville Project Area. Figure 9-5 below summarizes the findings from the literature synthesis and results are discussed in additional detail in the following paragraphs. It should be noted that this figure was produced in 2015 and substantial research has occurred since its publication. Were this figure to be updated, the number of relevant literature studies reviewed (n) would likely increase for all hydrologic variables.

Temperature. The 2015 USACE Literature Synthesis found that a majority of reports supported increasing trends in observed temperature for the Ohio Region. However, there is a general consensus that the Ohio Region spans a transition zone between a century-long warming trend of the north and a cooling trend of the south. There have been inconsistent findings about the geographic extent and seasonality of the warming and cooling zones.

Precipitation. According to the USACE Literature Synthesis: *"A mild increasing trend in precipitation in the study region, in terms of both annual totals and occurrence of storm events, has been identified by multiple authors but a clear consensus is lacking. Results show increases in precipitation in some portions of the Ohio Region and show decreases in other portions. Recent reports indicate that rainfall may be concentrated more in larger events now than in the past."*

Hydrology / Streamflow. The 2015 USACE Literature Synthesis found the studies reviewed were split on conclusions about streamflow trends in the Ohio Region for the past 60 years. However, more authors indicated an upward trend in streamflow for the region than did not.

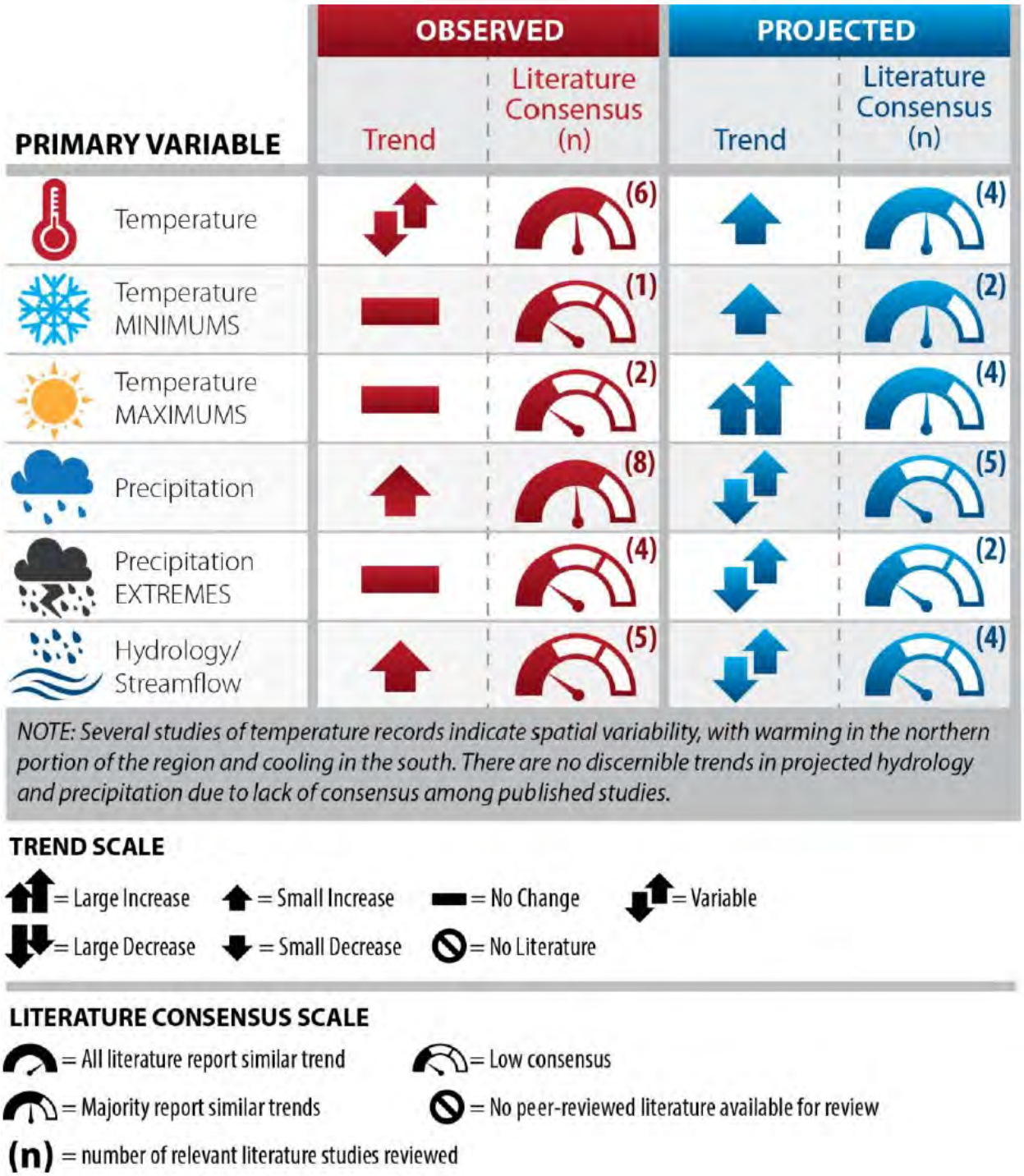

Figure 9-5. Summary of Findings from 2015 USACE Literature Synthesis, Ohio Region 05

9.2.1.2. Fourth National Climate Assessment

The Fourth National Climate Assessment (NCA4) Volume II, released in 2018, draws on science described in NCA4 Volume I and focuses on human welfare, societal, and environmental elements of climate change and variability for 10 regions and 18 national topics. Particular attention is paid to observed and projected risks, impacts, consideration of risk reduction, and implications under different mitigation pathways. Of particular interest to this qualitative analysis are the chapters regarding changing climate, water, and the Southeast region, which is fairly broad and includes the states of Kentucky, Tennessee, Arkansas, Louisiana, Mississippi, Alabama, Georgia, Florida, South Carolina, North Carolina, and Virginia. While Louisville is located within the Southeast region, it lies very near the board of the Midwest and Northeast regions as well.

Temperature. Nationally, annual average temperatures have increased over the continental U.S. by 1.2°F over the last few decades and 1.8°F relative to the beginning of the last century. Figure 9-6, adapted from NCA4, displays observed changes in temperature for the period from 1986 – 2016, as compared with the historic average from the period of 1901 – 1960 (for the continental U.S.). Note that the vicinity of the project area has experienced warming of 0 to 1 degree Fahrenheit. The magnitude of trends previously discussed and shown in Figure 9-3 (~0.3°F increase over the same period of time) closely matches the figure from the NCA4. The approximate study area is circled in red in the following figures.

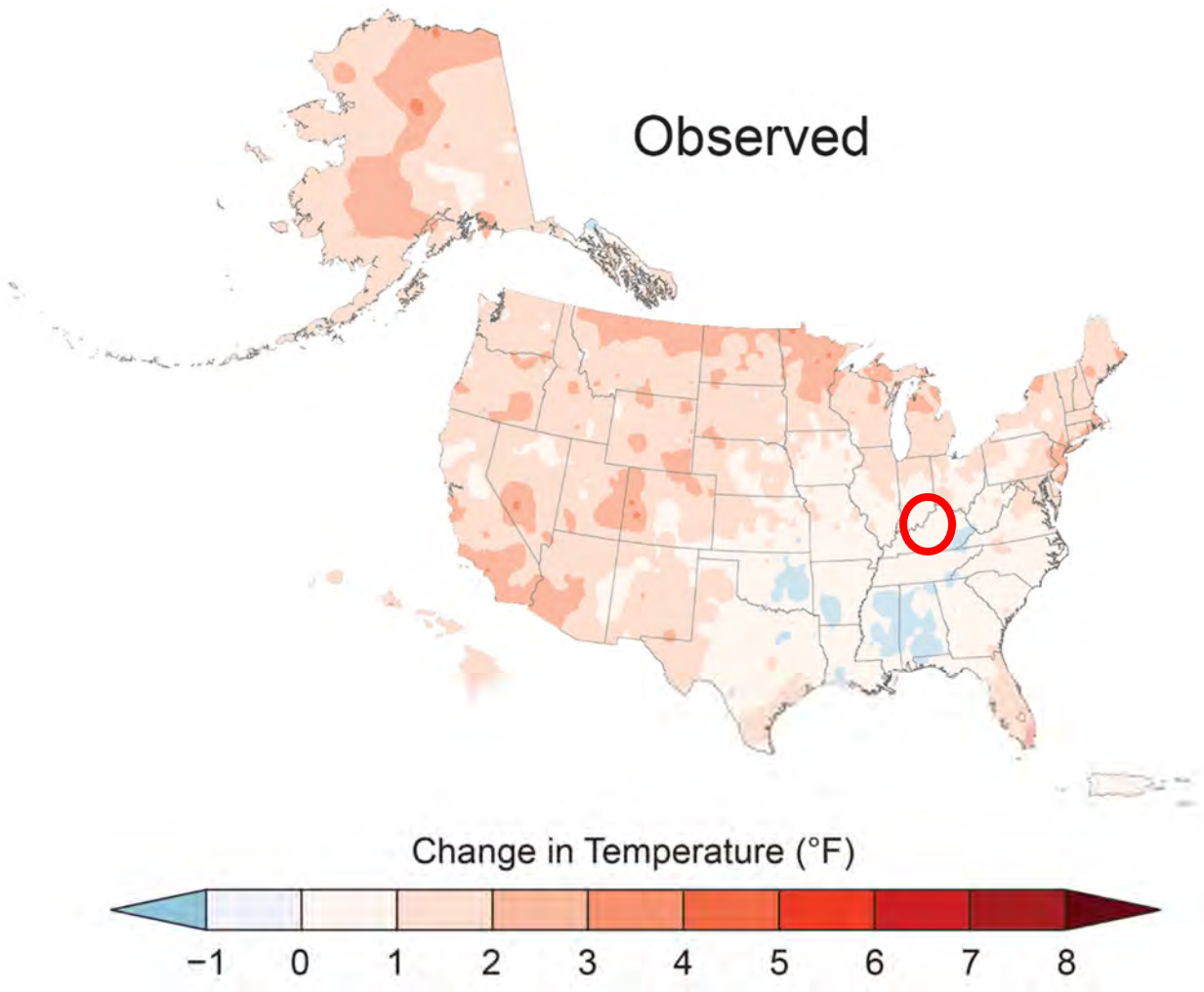

Figure 9-6. Observed changes in Temperature

Precipitation. Annual Precipitation since the beginning of the last century has increased across most of the northern and eastern U.S, whereas decreases have been observed across much of the southern and western U.S. There is much more regional variation in observed precipitation change as compared with observed temperature change, as the influence of temperature on precipitation varies greatly based upon terrain, elevation, and proximity to moisture sources. Figure 9-7 displays the percent change in annual precipitation for the period of 1986 – 2015, as compared with the historic baseline of 1901 – 1960. Looking more closely at the East-Central U.S., most of the state near the vicinity of the LMFS Project Area has observed an increase in annual precipitation between 5% and 15%. The magnitude of trends previously discussed and shown in Figure 9-4 (~6.6% increase over the same period of time) closely matches the figure from the NCA4.

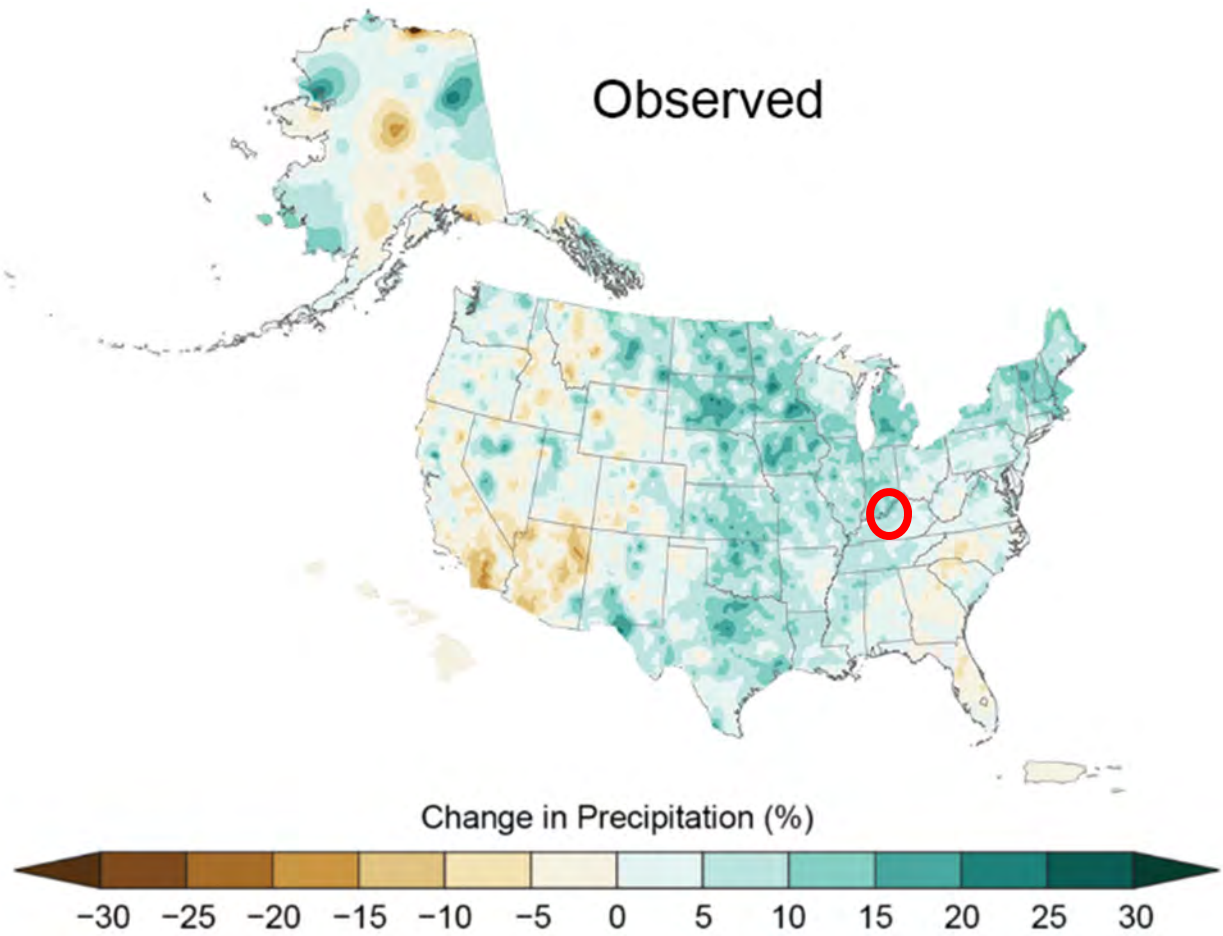

Figure 9-7. Observed changes in Precipitation

Additionally, there have been observed increases in the frequency and intensity of heavy precipitation events throughout much of the U.S. Figure 9-8 displays the percent increase in the amount of precipitation falling during the heaviest 1% of events (99th percentile of the distribution). The left map within Figure 9-8 displays the percent difference between the 1901-1960 historic baseline versus the 1986-2016 period, whereas the right map displays linear trend changes over the period between 1958 and 2016. Note that in both the left and the right side of the figure, the project area has experienced a moderate increase in the precipitation falling during extreme events. This indicates that extreme events have been becoming increasingly intense over the past decades. The observed trends in heavy precipitation are supported by well-established physical relationships between temperature and humidity. These increases in annual and extreme precipitation depths and volumes have various implications for levees, particularly with regard to interior drainage.

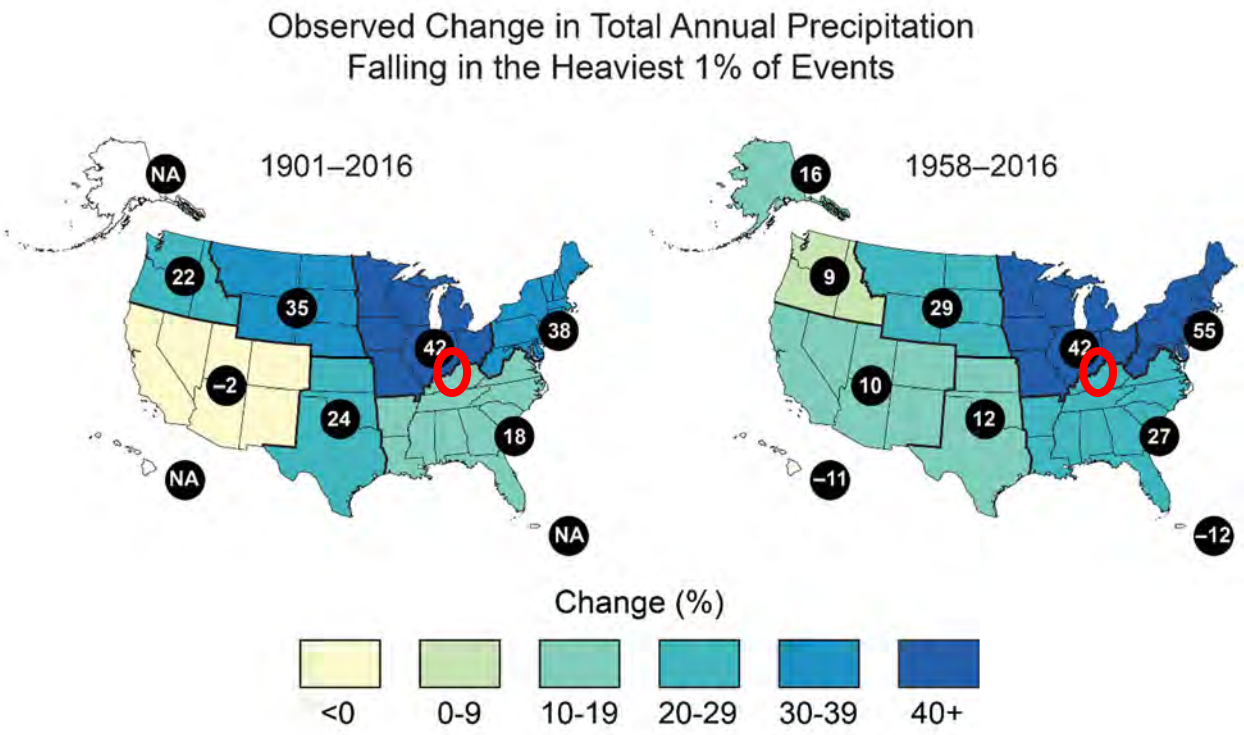

Figure 9-8. Observed percent change in the amount of precipitation falling during the heaviest 1% of events

9.2.1.3. Analysis of Historical Precipitation Intensity-Duration Frequency for Jefferson County, KY

In 2015, the Louisville Metropolitan Sewer District (MSD), using CH2M Hill as consultants, performed a study of historical precipitation trends within Louisville and recent changes to precipitation intensity-duration frequency (IDF) curves. This study utilized precipitation data from the National Weather Service (NWS) and MSD's climate stations to update IDF curves. They utilized the standard L-moment statistical techniques to generate these frequency curves from observed precipitation data. Additionally, the study examined trends in observed precipitation data with a specific emphasis on large and intense storm events.

Regarding the observed trends in precipitation, the study utilized data from the start of the station's period of record until 2014 and found that long term increasing trends were present in annual precipitation data on the 3 rain gages analyzed: Louisville Upper, Louisville WSO Airport, and Shepherdsville KY. Two of these trends were found to be statistically significant at a 90% confidence level, but the Louisville Upper gage was not. These findings are very similar to those discussed above in the *Observed Trends in Current Climate and Climate Change* section above and the blue data set displayed in Figure 9-4.

In addition to analyzing total annual precipitation, the study authors looked at trends in daily rainfall datasets and precipitation accumulation over a certain threshold. Daily rainfall datasets were analyzed using the annual maximum daily precipitation. Increasing trends were found for the annual maximum daily precipitation for all 3 gages, two of which showed statistical significance at a 90% confidence level, but the Louisville WSO Airport gage did not.

Regarding the rainfall over threshold datasets, the study authors analyzed the number of days per year with rainfall over various thresholds and found increasing trends were present on all gages. However statistical significance varied by location and threshold rainfall amount. Table 9-2 displays a summary of all trends and their statistical significance for the various locations and datasets analyzed. Note that for all 3 locations, increasing trends were significant for the number of days per year when daily rainfall exceeded 0.5 inches, 1 inch, and 2 inches. The authors did note that if rainfall data from March and April 2015 were incorporated into the analysis, then all stations show significant trends for number of days/year exceeding 3 inches of rainfall.

Table 9-2. Summary of trends and statistical significance found in Historical IDF Analysis

Station	Louisville Upper, KY	Louisville WSO, KY	Shepherdsville, KY
Annual Precipitation	No	**Yes**	**Yes**
Annual Daily Maximum	**Yes**	No	**Yes**
Number of days/year ≥ 0.25"	No	No	No
Number of days/year ≥ 0.50"	**Yes**	**Yes**	**Yes**
Number of days/year ≥ 1.00"	**Yes**	**Yes**	**Yes**
Number of days/year ≥ 2.00"	**Yes**	**Yes**	**Yes**
Number of days/year ≥ 3.00"	No	No	**Yes**

In addition to the analysis of historical trends, CH2M Hill used L-moments statistical methods to analyze stations in Jefferson County using gages from both the NWS and MSD. This effectively represents updating the precipitation frequency analysis by adding 10 years of record from 2004 (end of Atlas 14 period of record) to 2014. Table 9-3 displays a comparison between precipitation frequency estimates: Atlas 14 (A14), Atlas 14 90% Upper Confidence Limit (UCL), and the updated analysis performed by CH2M Hill in 2015. Comparing results between these 3 datasets, it is clear that both the UCL and CH2M Hill values are higher than the base A14 for all return periods. When the UCL values are compared with the CH2M Hill values, the UCL estimates are higher for return periods more frequent than 25-years, and lower for return periods of 25, 50, and 100-years. In other words, for large storm events occurring less frequently than every 25-years, the CH2M Hill analysis produces precipitation frequency estimates outside of the 90% confidence limit of Atlas 14.

Table 9-3. Comparison between Precipitation Frequency Estimates (inches). 24-hr Duration Storm.

Annual Chance Exceedance	Return Period (Years)	Atlas 14	Atlas 14 90% UCL	CH2M Hill IDF Analysis
50%	2	3.10	3.38	3.03
20%	5	3.85	4.19	4.05
10%	10	4.47	4.86	4.82
4%	25	5.37	5.83	5.91
2%	50	6.12	6.64	6.82
1%	100	6.93	7.51	7.81

Results from this CH2M Hill analysis were reviewed by Jeff Arnold (USACE Lead Climate Scientist), Kate White (Climate Preparedness and Resilience Community of Practice Lead), Gregory Karlovitz (HEC Statistical Hydrologist), and other subject matter experts throughout the Corps for validity and determination of whether these results could be incorporated into the LMFS as a basis of design. These reviews determined that the statistical methods employed are valid and that the methods incorporated a greater number of rain gage records than Atlas 14 would have, which strengthens the significance of these findings. However, many of the gage locations which were included had rather short periods of record, beginning in 2004. The period of 2004 – 2014 was an extremely wet period when compared with the pre-2000 historic baseline. Adding a number of stations which include data only from this period strongly biases the results towards higher precipitation values. Because of these statistical biases, as well as the omission of the more regional approach incorporated into Atlas 14, it was determined that the CH2M Hill precipitation frequency estimates could not be utilized as a basis of design for the project. The LMFS project delivery team elected to utilize the 90% UCL of A14 as a basis of design. This decision was informed by the findings of the CH2M Hill report as well as the opinion and review of the various reviewers mentioned previously.

9.2.2. Climate Hydrology Assessment

The Climate Hydrology Assessment Tool (CHAT) developed by USACE and was utilized to examine trends in observed annual peak streamflow for the various gage locations shown in Table 9-1. The CHAT tool is used to fit a linear regression to the peak streamflow data in addition to providing a p-value indicating the statistical significance of a given trend. Many of the gages selected for CHAT analysis have been heavily impacted by regulation and urban development over different periods of time. For gages where the observed period of record includes the effects of regulation, the annual peak streamflow dataset cannot be considered homogeneous and it is difficult to draw conclusions based upon the trends identified within these datasets. In addition to assessing the entire period of record at regulated gage sites, subsets of data prior to and after regulation were also analyzed.

The gage on the Ohio River at Louisville can be used to illustrate how periods of reservoir regulation influence trends in streamflow, in addition to substantial natural variability. Peak annual flow for this gage is available on a continuous basis from 1858 until 2014 in the CHAT. The annual peak data from 1858 – 1938 represents a pre-regulation dataset as no reservoirs were constructed upstream of the gage and large scale levee construction did not start until after the flood of 1937. Many of the navigation L&D projects were built before this, but their run-of-the-river nature has a negligible impact on annual peak flows. The time period of 1937 – 1978 represents an era of substantial levee construction, dam building, and reservoir filling; this period disrupts the homogeneity and homoscedasticity of the streamflow dataset. After 1978, reservoir operations became established, most upstream levee construction was completed, and once again the period of record can roughly be considered homogeneous in terms of reservoir operation. For these reasons, the period of record for the Ohio River at Louisville was analyzed over 3 time periods: 1. complete heterogeneous period of record, 2. pre-regulation period, and 3. post-regulation period.

When dividing the period of record into different intervals of regulation for each gage, consideration was given to ensure that the shortened record length remained adequate for trend analysis. Of the gages whose record was divided based on regulation, the shortest record length was at the Ohio River at Louisville gage with a post-regulation record length of 36 years. This length was deemed sufficient for linear regression analysis. Additionally, there is uncertainty regarding whether the post-regulation period of record reflects homogenous reservoir operation, since reservoir regulation is not always consistent over time and operational deviations are common. However, for the purposes of this analysis, reservoir operations were assumed to be consistent and the impacts of changes in regulation and deviations from typical operation were considered to be minor. Nonstationarity detection results, discussed below, offer further insight into the homogeneity of the peak streamflow dataset.

A summary of the regression trends and their statistical significance is shown in Table 9-4. Individual graphical output for each gage and period of record analyzed is shown in Figure 9-9 through Figure 9-15. Note that 3 strongly statistically significant trends (p-value < 0.05) were detected. These three gages, South Fork Beargrass Creek, Middle Fork Beargrass Creek, and Pond Creek, are all very highly impacted by urbanization, land use change, channelization, and development within the floodplain. All of these factors contribute to the increasing streamflow over time, and further they make attribution of these trends to climate change difficult. When the peak annual streamflow dataset was examined for Floyds Fork, which is located outside of the project area and is much less impacted by urbanization, no statistically significant trend was detected.

It should be made clear that statistically significant increasing trends in peak annual streamflow have been observed, and while these trends cannot be clearly attributed to climate change, which does not necessarily detract from their presence or significance. Much of the project area watershed is currently considered to be "built-out," meaning that further urbanization will be limited to small suburban areas. Additionally these new developments will be required to mitigate any increases in stormwater runoff through the use of detention basins and other methods of attenuation. For this reason and the lack of observed trends on "pristine" reference gages near the project area, it is believed that the increasing trends observed in streamflow are not likely to continue into the future. However, future re-evaluation of peak streamflow data should be conducted regularly to validate these assumptions. Trends were verified within the trend analysis tab of the nonstationarity detection tool.

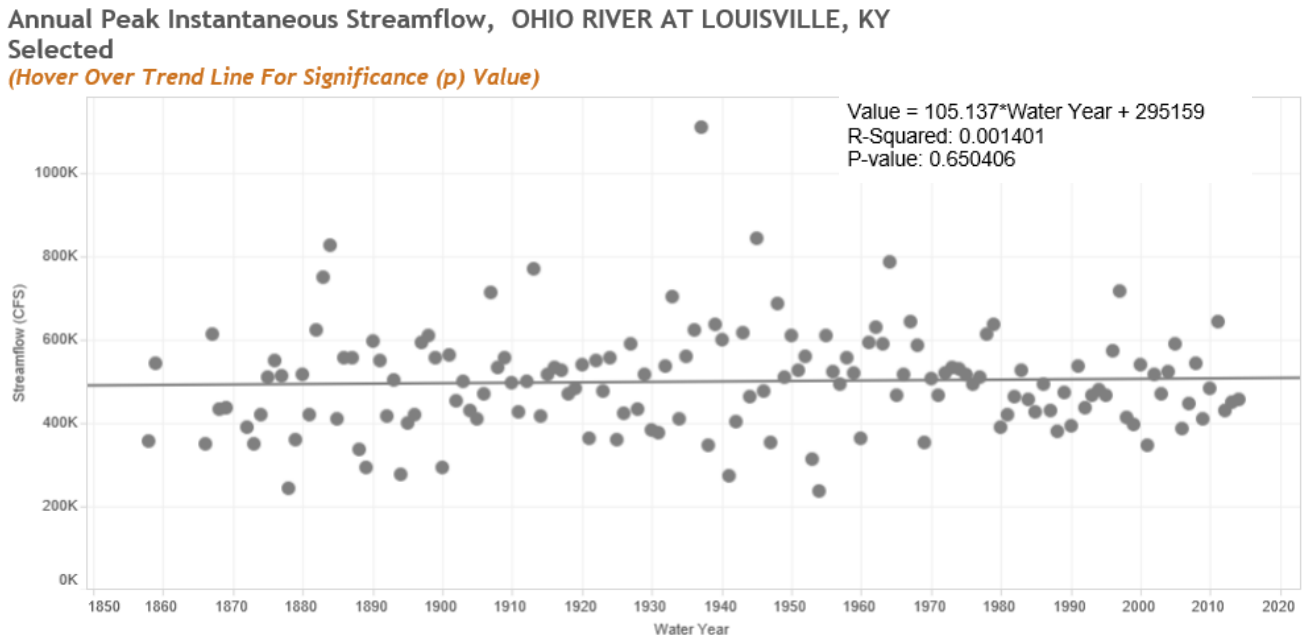

Figure 9-9: Annual Peak Streamflow on Lower Ohio River at Louisville, KY. Full POR (1858-2014). Statistically insignificant.

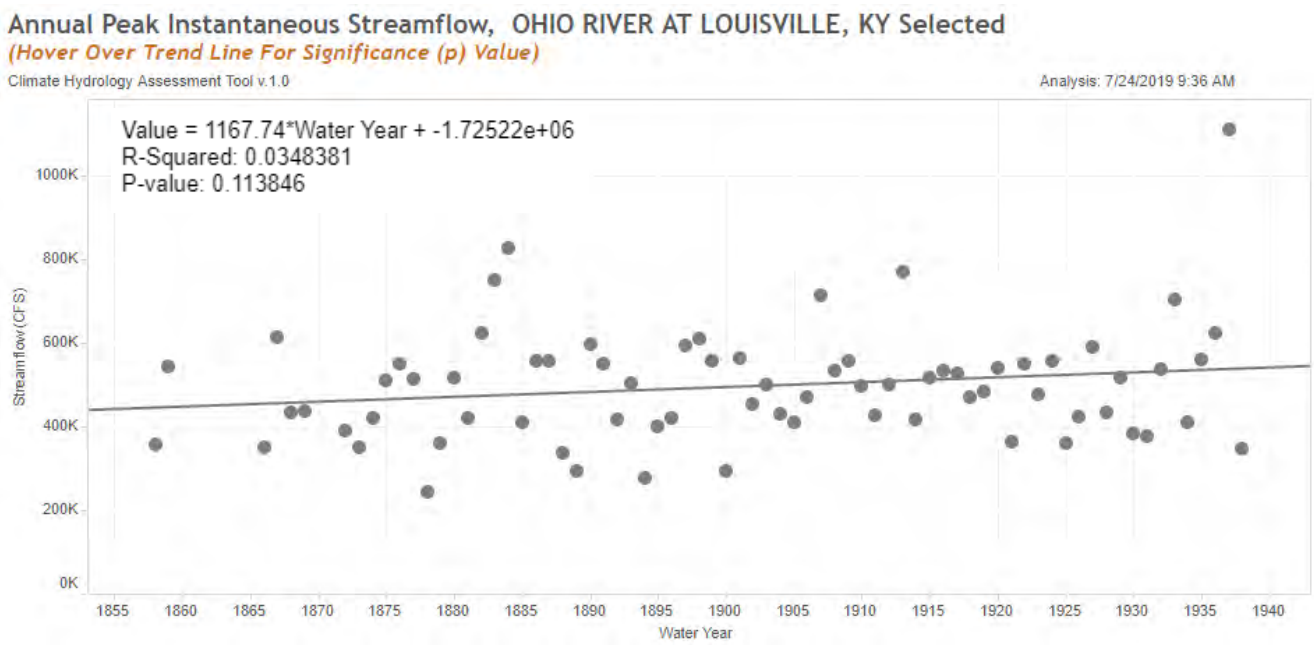

Figure 9-10: Annual Peak Streamflow on Lower Ohio River at Louisville, KY. Pre-regulation (1858-1938). Statistically Insignificant.

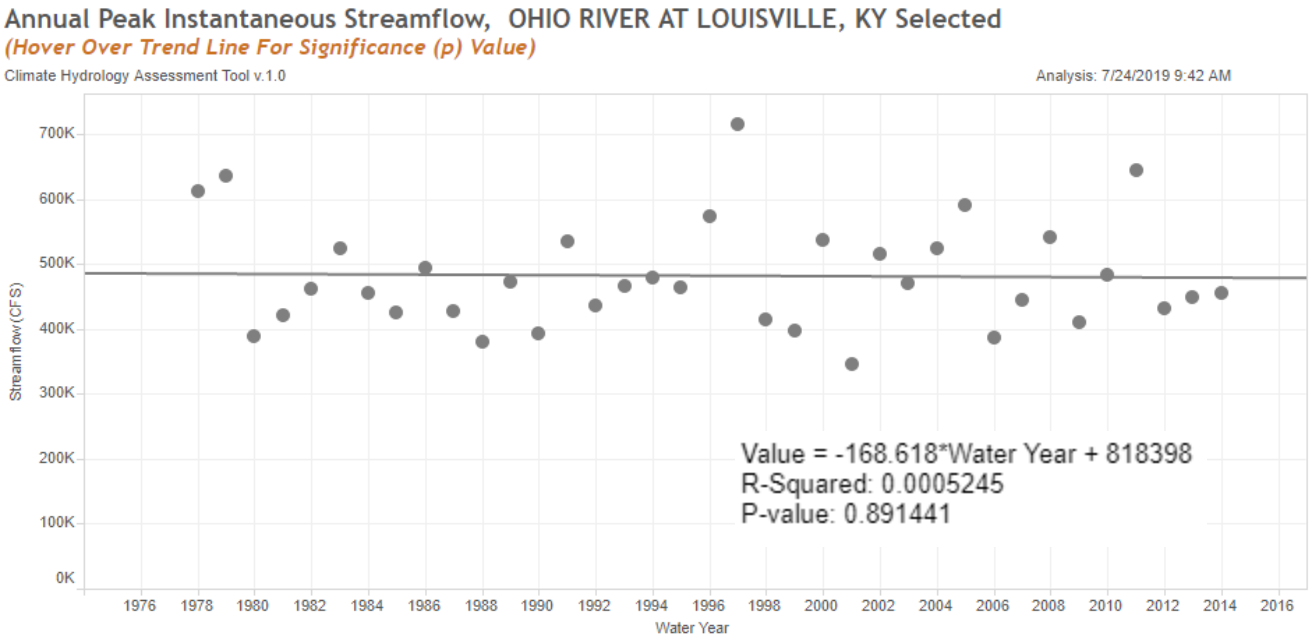

Figure 9-11. Annual Peak Streamflow on Lower Ohio River at Louisville, KY. Post-regulation (1978-2014). Statistically Insignificant.

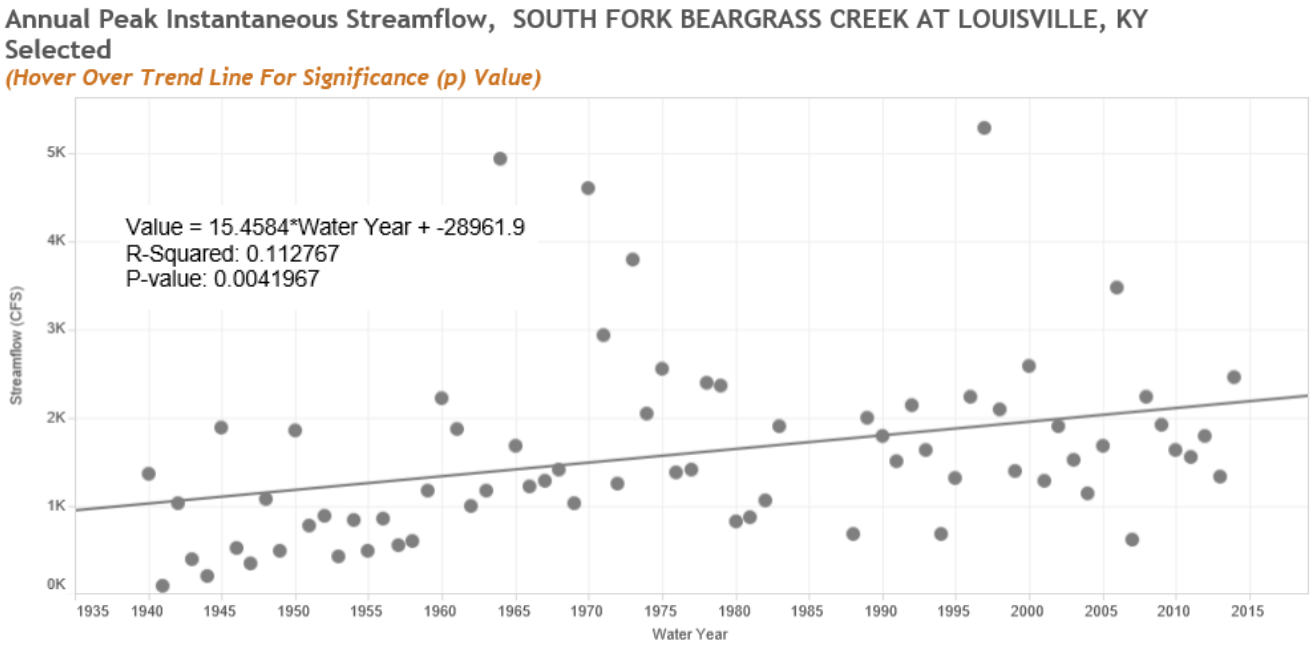

Figure 9-12: Annual Peak Streamflow at South Fork Beargrass Creek. Full POR (1940-2014). Statistically Significant.

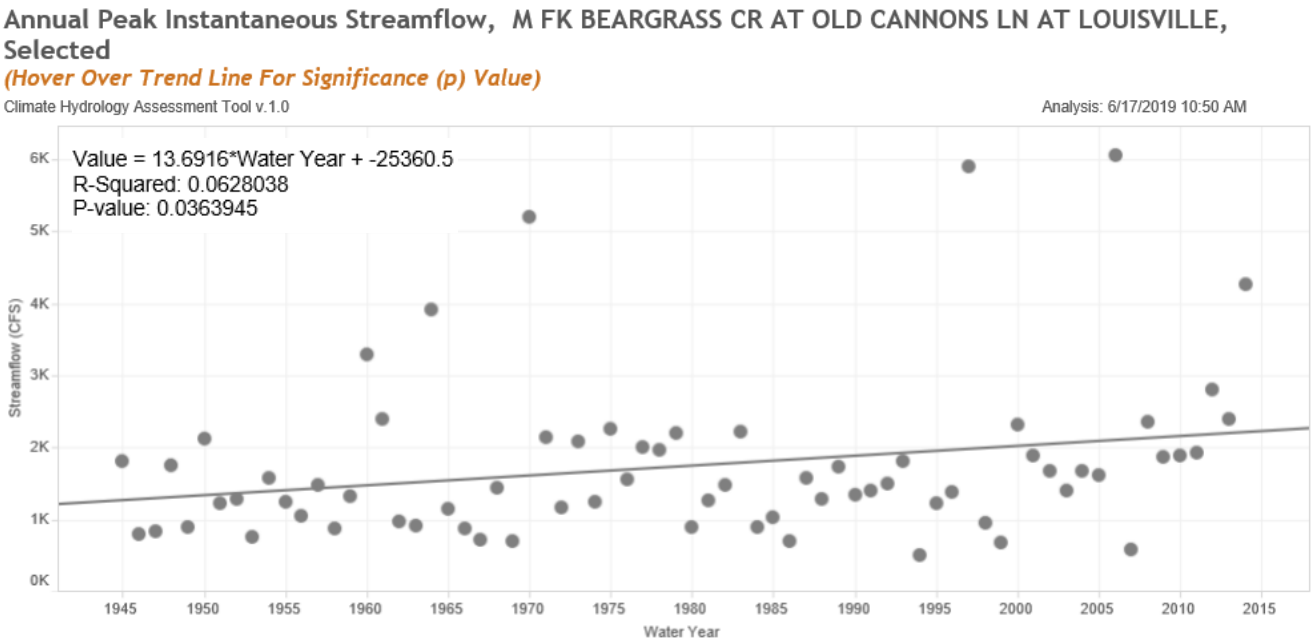

Figure 9-13: Annual Peak Streamflow at Middle Fork Beargrass Creek. Full POR (1945-2014). Statistically Significant.

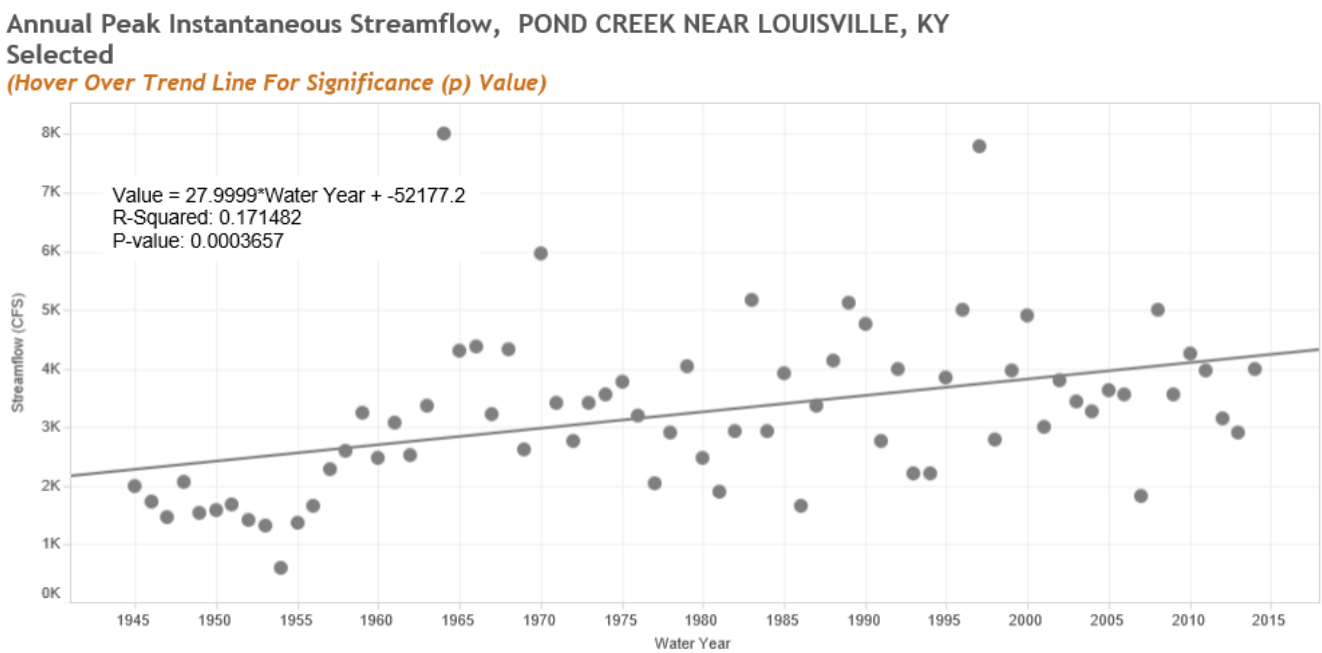

Figure 9-14: Annual Peak Streamflow at Pond Creek. Full POR (1945-2014). Statistically significant.

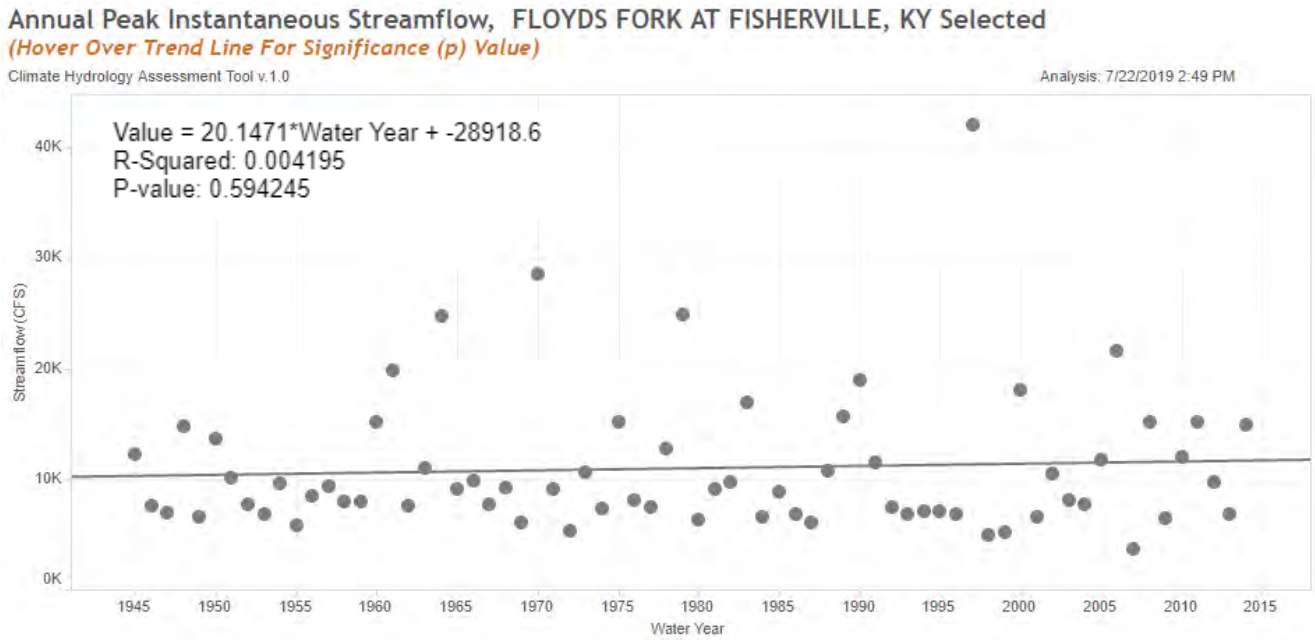

Figure 9-15: Annual Peak Streamflow at Floyds Fork at Fisherville. Full POR (1937-2014). Statistically Insignificant

Table 9-4. Summary of Observed Streamflow Trends in Annual Peak Streamflow.

Fig. Num.	Gage Number	Gage Name and Location	POR Used	POR Note	Regression Slope	P-value	Trend Direction	Trend Significance	NSD Tool Trend?
9	03294500	Ohio River at Louisville, KY	1858 – 2014	Complete, minus gaps	105	0.650	Upward	Insignificant	No
10			1858 – 1938	Pre-regulation	1168	0.114	Upward	Weak	No
11			1978 – 2014	Post-regulation	-169	0.891	Downward	Insignificant	No
12	03292500	South Fork Beargrass Creek	1940 – 2014	Complete	**15.5**	**0.004**	**Upward**	**Strong**	**Yes**
13	03293000	Middle Fork Beargrass Creek	1945 – 2014	Complete	**13.7**	**0.036**	**Upward**	**Strong**	**Yes**
14	03302000	Pond Creek	1945 – 2014	Complete	**28.0**	**< 0.001**	**Upward**	**Strong**	**Yes**
15	03298000	Floyds Fork at Fisherville	1937 - 2014	Complete	20.1	0.594	Upward	Insignificant	No

9.2.3. Nonstationarity Detection

The USACE Nonstationarity Detection (NSD) Tool was used to assess whether the assumption of stationarity, which is the assumption that the statistical characteristics of a time-series dataset are constant over the period of record, is valid for a given hydrologic time-series dataset. Nonstationarities are detected through the use of 12 different statistical tests which examine how the statistical characteristics of the dataset change with time (Engineering Technical Letter (ETL) 1100-2-3, *Guidance for Detection of Nonstationarities in Annual Maximum Discharges*; *Nonstationarity Detection Tool User Manual*, version 1.2). Abbreviations of the 12 statistical tests are shown in the table below this section. The NSD Tool was applied to the same stream gage sites listed previously in Table 9-4. A nonstationarity can be considered "strong" when it exhibits consensus among multiple nonstationarity detection methods, robustness in detection of changes in statistical properties, and a relatively large change in the magnitude of a dataset's statistical properties. Many of the statistical tests used to detect nonstationarities rely on statistical change points, these are points within the time series data where there is a break in the statistical properties of the data, such that data before and after the change point cannot be described by the same statistical characteristics. Similarly to nonstationarities, change points must also exhibit consensus, robustness, and significant magnitude of change.

Figure 9-17 displays the NSD Tool output for the complete period of record (minus historic flows with large data gaps) for the Ohio River at Louisville, KY. Note that there are multiple nonstationarities detected throughout the period of record. However, these nonstationarity detections show no consensus nor robustness as they all occur isolated in time and are not corroborated between statistical tests. Figure 9-18 displays the NSD Tool output for the complete period of record for the South Fork Beargrass Creek. Note that there is a strong nonstationarity detected around 1958 detected by the following statistical methods: CVM, KS, LP, PT, MW, and SLW. All of these detections can be considered discrete, with the exception of the smooth nonstationarity detected between 1957 and 1959 using the Lombard Wilcoxon test. This 1958 nonstationarity represents a relatively large increase in mean flow, from approximately 775 cfs to 1,900 cfs. This change in mean flow is likely driven by land use change and urbanization within the watershed. Anecdotally, much of the South Fork Beargrass Creek watershed was converted into residential land use during the 1950s and the corresponding increase in mean flow can be attributed to this change in watershed hydrologic parameters. According to US census population data, the 1950s represent a period of peak population and growth for the City of Louisville, population data is shown in Figure 9-16.

Figure 9-19 displays the NSD Tool output for the complete period of record for the Middle Fork Beargrass Creek. While the nonstationarity detected for the South Fork in 1958 is not present in the Middle Fork record, a nonstationarity was detected by 2 tests (KS and LW) in 1998/1999. This NS represents an increase in mean flow from 1,600 cfs to 2,200 cfs. Anecdotally, the upper subbasins of this watershed experienced growth and urbanization more recently than other portions of the study area which supports the finding of this later nonstationarity in the late-1990s. However, in the late 1990s, clear drivers of increasing runoff are not easily deduced in Middle Fork watershed, and therefore attribution of this NS to climate change cannot be definitively ruled out.

Figure 9-20 displays the NSD Tool output for the complete period of record for Pond Creek. This watershed displays substantial discrete nonstationarities detected between 1956 and 1964 by the following statistical methods: CVM, KS, LP, PT, MW, BAY, MD, and a smooth nonstationarity between 1954 and 1963 by the Lombard Wilcoxon test. This cluster of nonstationarities displays both consensus and robustness. Similar to the South Fork of Beargrass Creek, this watershed experienced substantial urbanization and associated land use change in the 1950s as this era represents a peak in Louisville's population. Additionally, there are various identifiable hydrologic changes which occurred in this period. These include: expansions to the airport terminal in the 1950s, completion of the General Electric

Appliance Park industrial center completed in 1951, and completion of the Ford vehicle assembly park in 1955.
Figure 9-21 displays the NSD Tool output for the complete period of record for Floyds Fork at Fisherville. This gage location represents one of the "pristine" reference locations previously discussed and displays no nonstationarity detections which are supported by either consensus or robustness.

The nonstationarity detection tool's trend analysis tab was used to independently verify the linear trend analysis performed above in the CHAT section. Agreement upon trend direction and statistical significance was found between the NSD tool and CHAT for all gages analyzed.

After performing the nonstationarity detection analysis across the Louisville Metro Feasibility Study project area for multiple gages, various conclusions can be drawn. Nonstationarities are widespread throughout the project area where intense urbanization and land use change has occurred. The period of the 1950s is of particular note as nonstationarities were found at both the South Fork Beargrass Creek gage and Pond Creek gage. These nonstationarities were not present when the less urban "pristine" reference site was examined. Additionally, these nonstationarities were not detected in the large watershed of the Ohio River. Considering these related lines of evidence, it can be assumed that the detected nonstationarities cannot likely be attributed to climate change or long-term natural climate trends, rather, land use/land cover changes are significant and do undermine the statistical stationarity of the historically observed peak streamflow records for the smaller watersheds within the Louisville Metro project area. A nonstationarity of increasing streamflow was detected on the Middle Fork of Beargrass Creek in the late 1990s. While this nonstationarity is anecdotally supported by claims of increasing urbanization similar to what has been observed during other periods of time in the watershed, attribution to specific changes in the watershed would require further investigation and analysis.

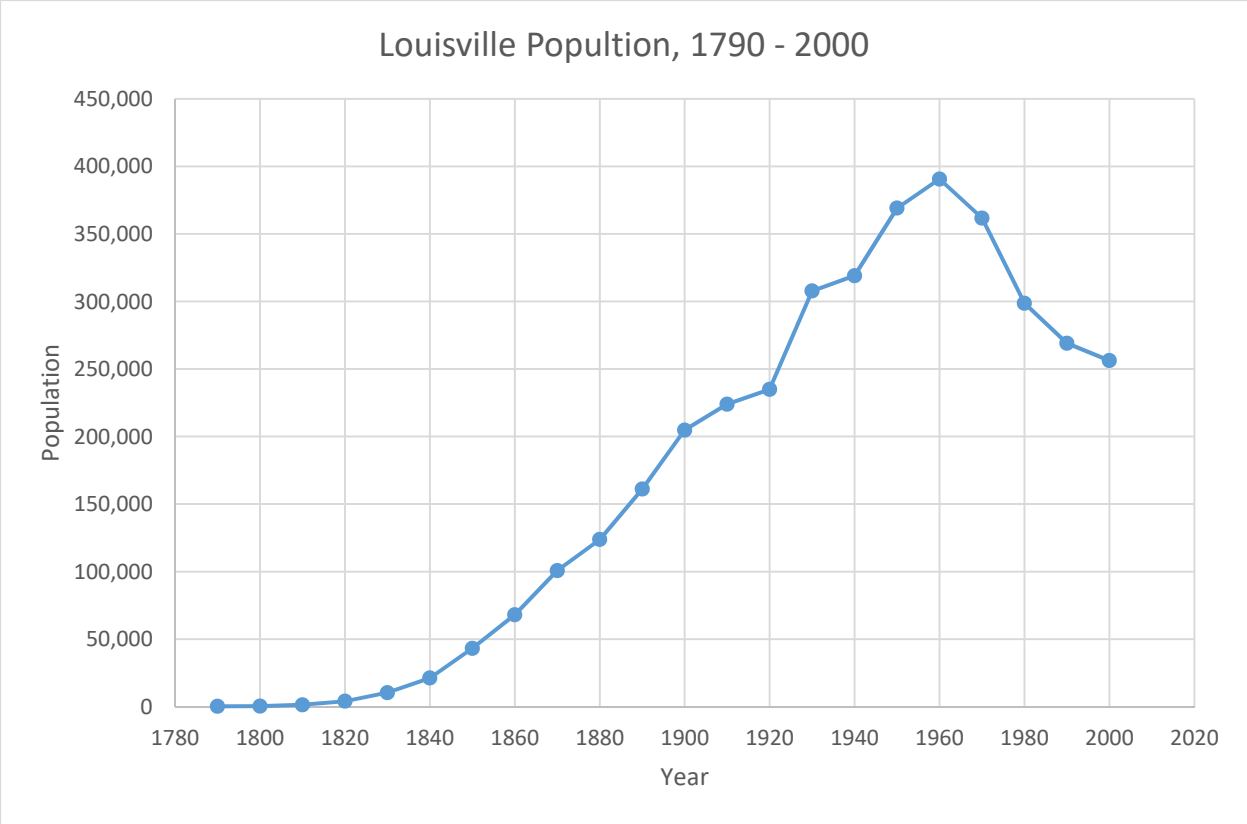

Figure 9-16. Population of Louisville over Time*

** It should be noted that data more recent than 2000 was omitted from this figure because the census changed their accounting methods to include all of Jefferson County, effectively doubling the population counted in 2010 compared with 2000. **

Nonstationarity Detection Method Abbreviation	Statistical Test Name
CVM	Cramer-Von-Mises (CPM)
KS	Kolmogorov-Smirnov (CPM)
LP	LePage (CPM)
END	Energy Divisive Method
LW	Lombard Wilcoxon
PT	Pettitt
MW	Mann-Whitney (CPM)
BAY	Bayesian
LM	Lombard Mood
MD	Mood (CPM)
SLW	Smooth Lombard Wilcoxon
SLM	Smooth Lombard Mood

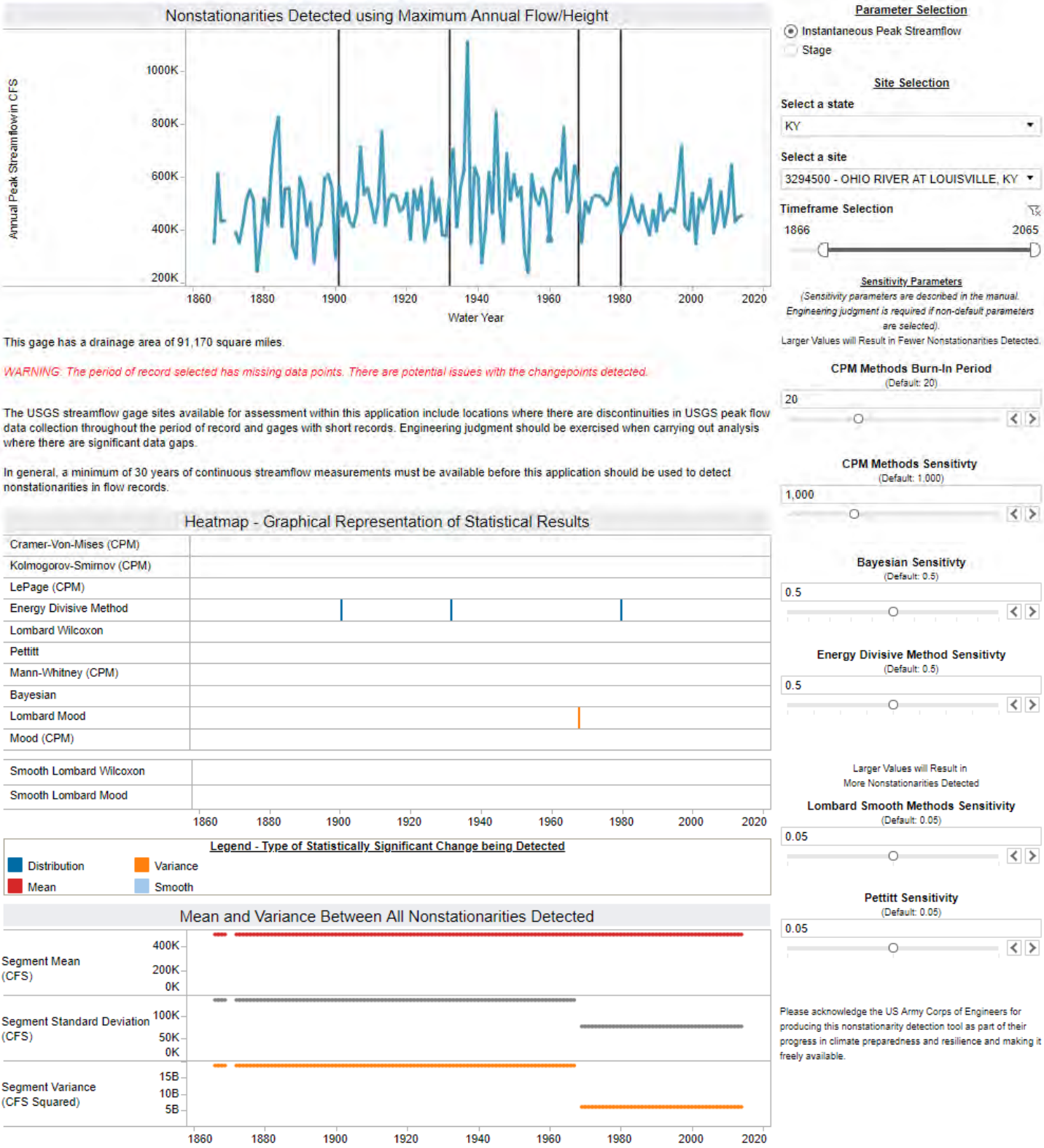

Figure 9-17. Nonstationarity Detection for Ohio River at Louisville. Complete Period of Record, 1832 - 2014.

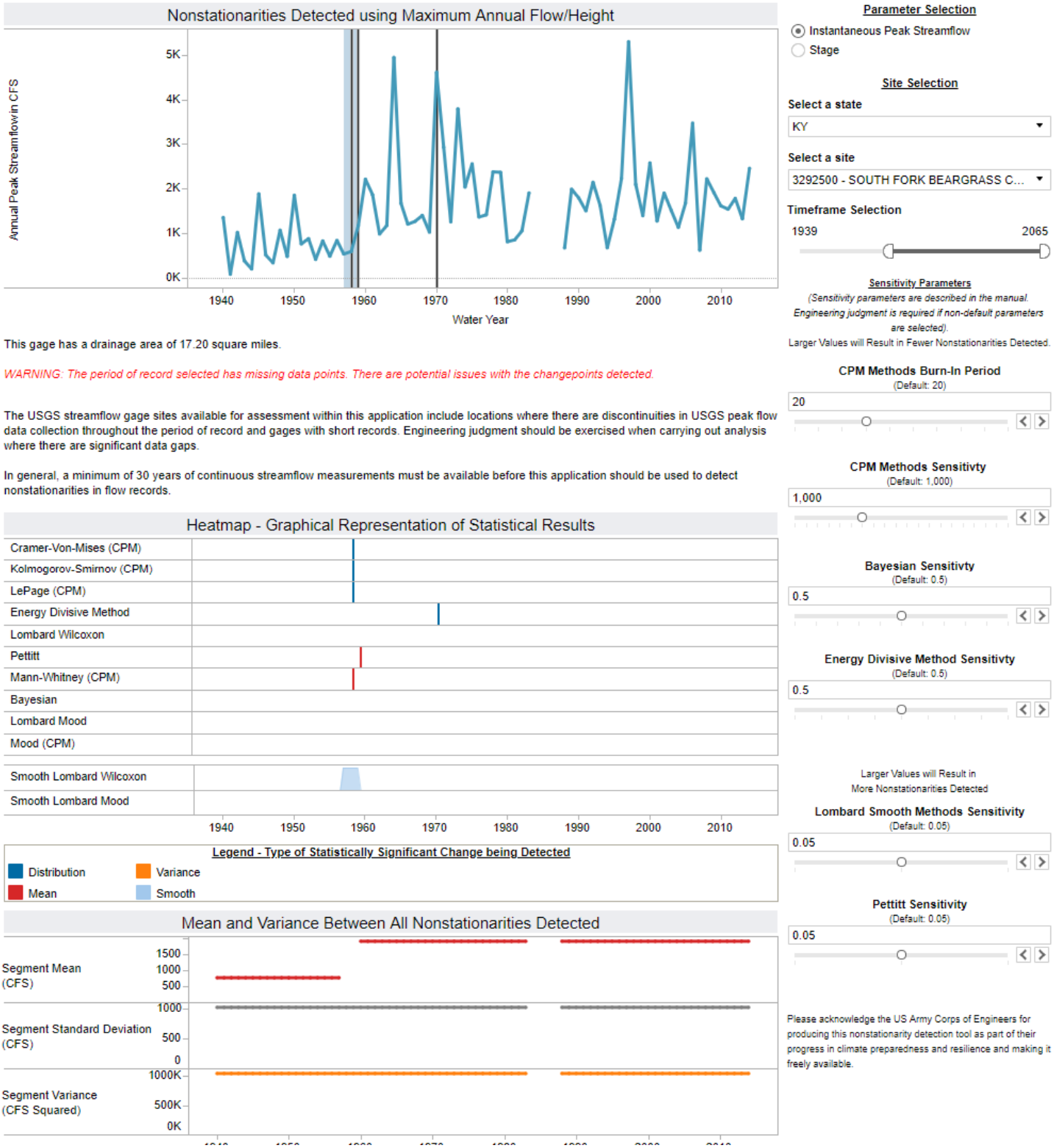

Figure 9-18. Nonstationarity Detection for the South Fork Beargrass Creek. NSD centered around 1958.

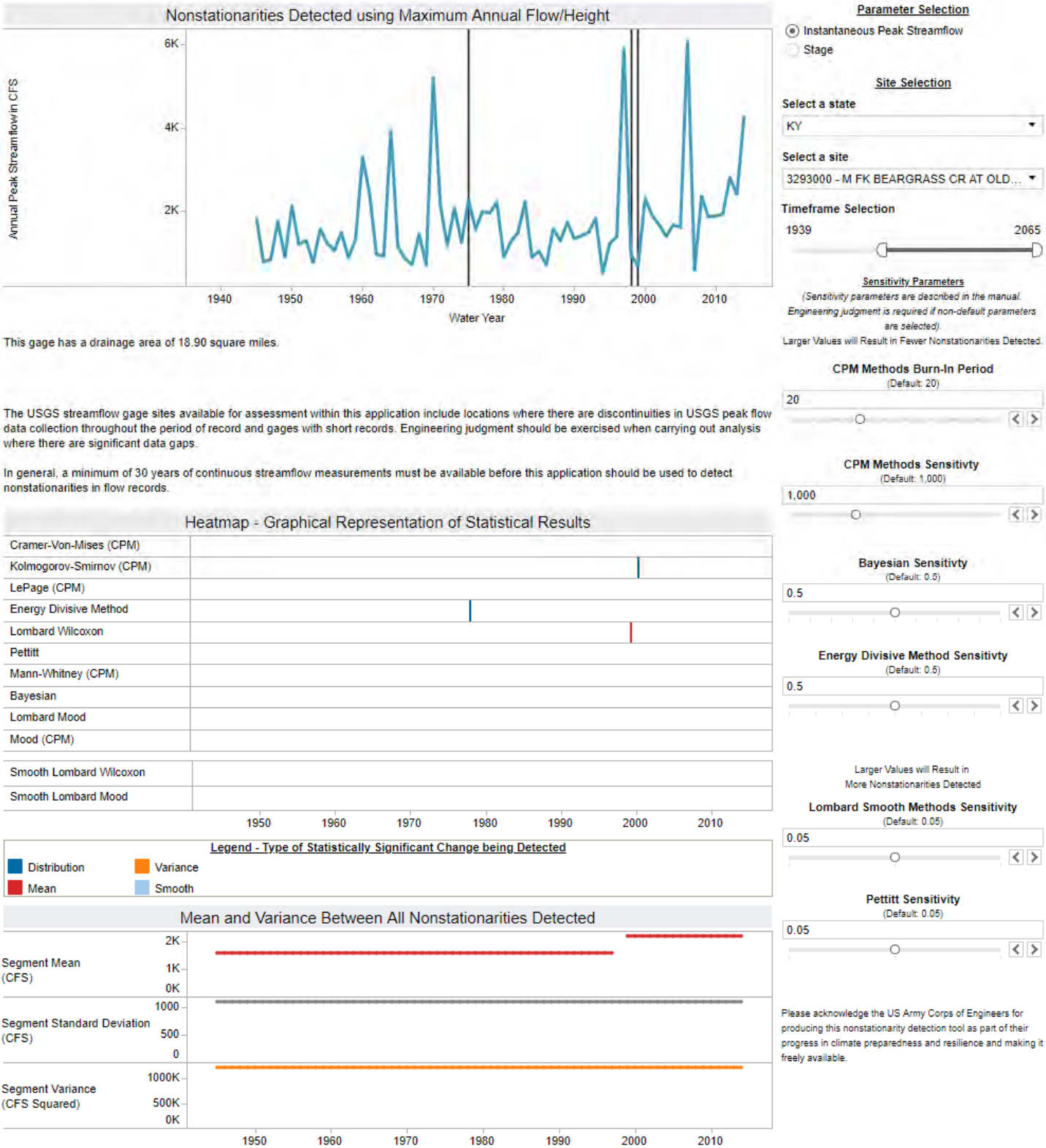

Figure 9-19: Nonstationarity Detection for Middle Fork Beargrass Creek.

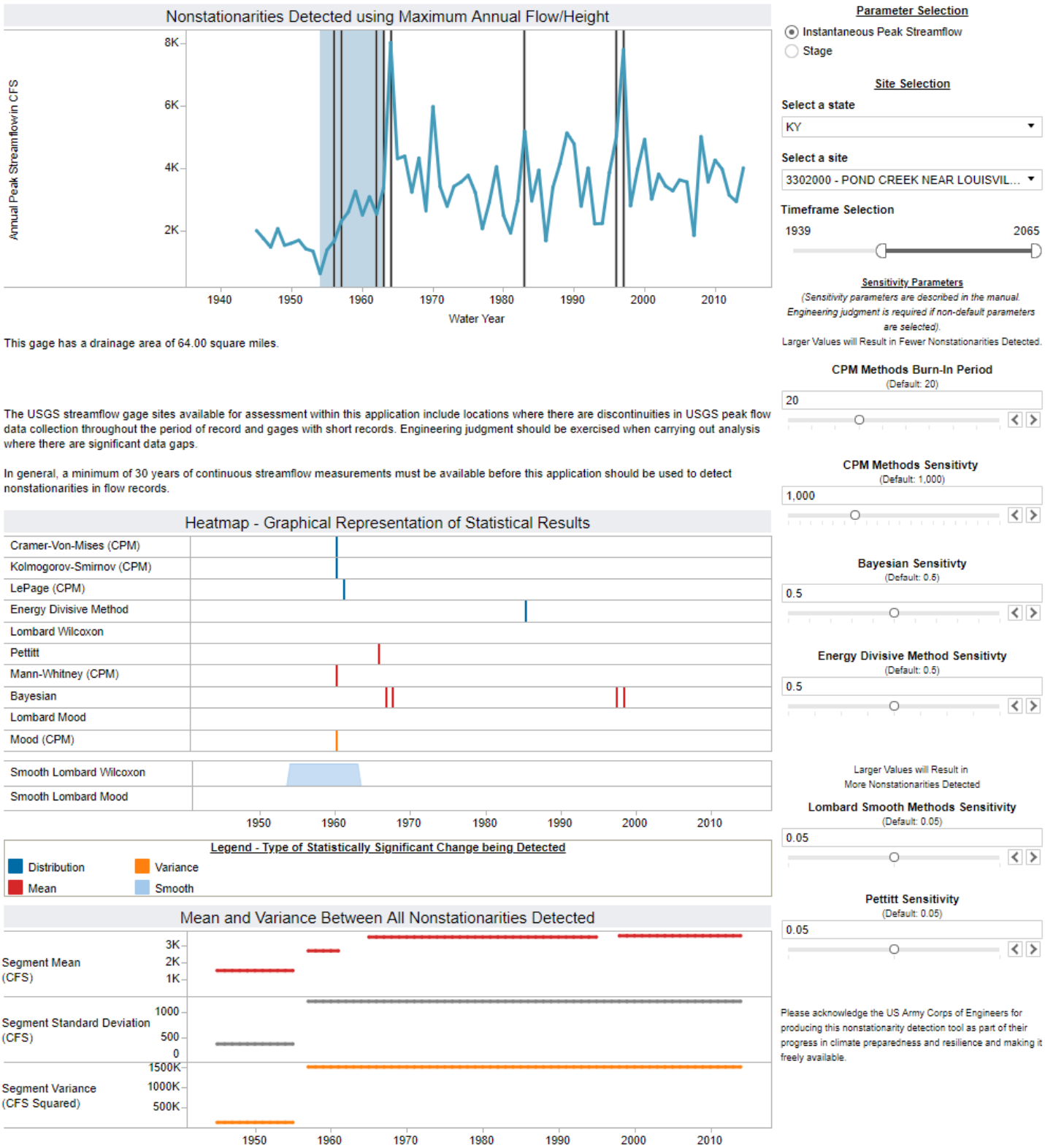

Figure 9-20. Nonstationarity Detection for Pond Creek near Louisville. 1954-1963, 1956

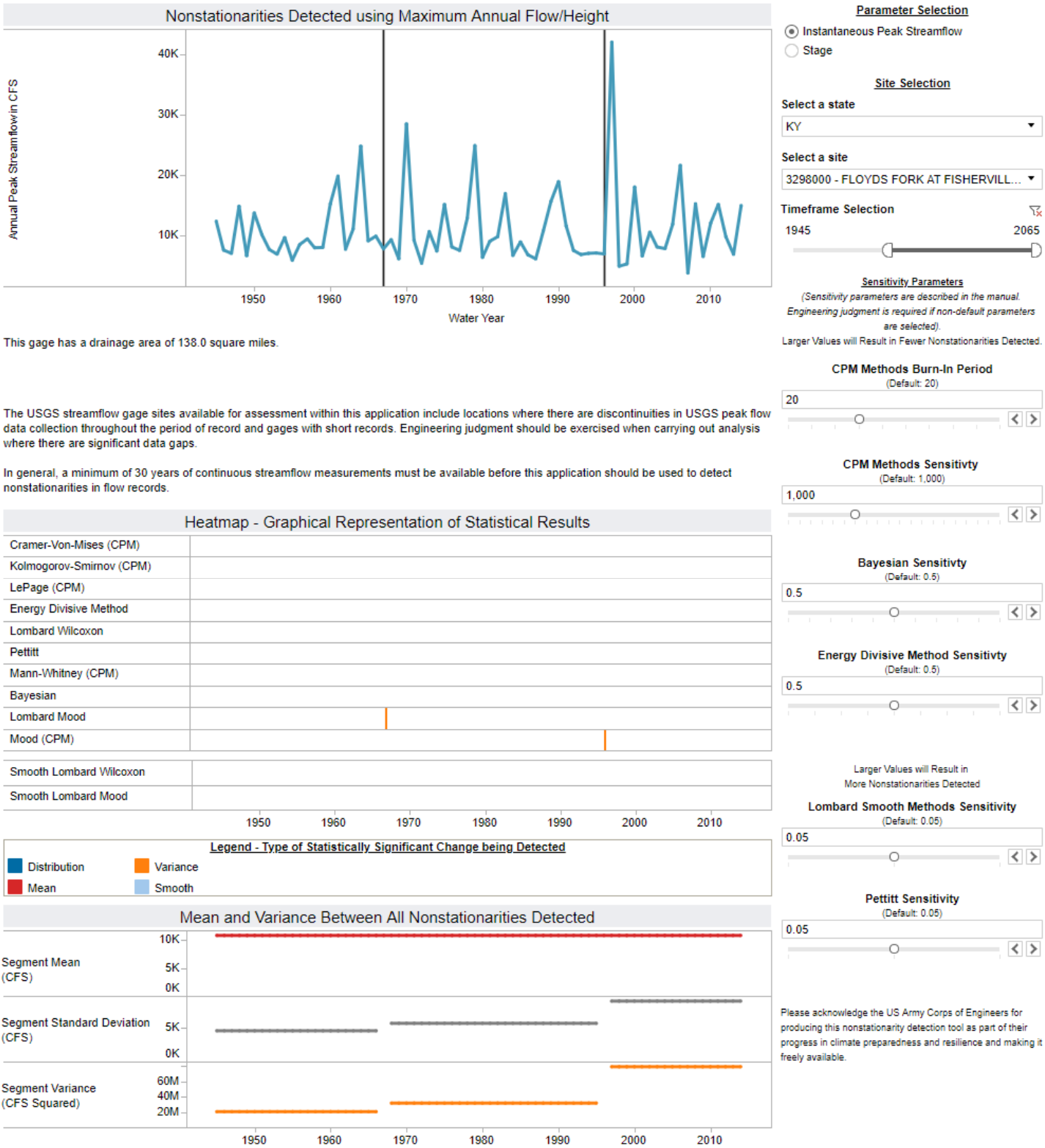

Figure 9-21. Nonstationarity Detection for Floyds Fork at Fisherville, KY

9.2.4. Summary of Observed Trends in Climate

Based on the literature review, there is consistent consensus among the available sources supporting trends of increasing temperatures within Louisville Project Area. Observed changes in precipitation have more uncertainty associated with them, however there are substantial indications that increasing trends in rainfall have been observed. Recently L-moment analysis indicates that rainfall occurrence and intensity has increased since 2004, however precipitation frequency estimates from this timeframe have not been incorporated into this study. Rather, the increases in rainfall over the historic norm have been incorporated through using the upper confidence limit of NOAA's Atlas 14. Significant changes in urban streamflow have also been observed but are largely attributed to changes in land use and urbanization and cannot be attributed solely to the impact of climate change.

9.3. Projected Trends in Future Climate and Climate Change

9.3.1. Literature Review

9.3.1.1. Recent US Climate Change and Hydrology Literature Syntheses

In addition to the observed trends discussed previously, the 2015 USACE Literature Synthesis for the Ohio Region 05 also summarizes available literature for projected future trends in various hydrometeorological variables. These variables are projected using a variety of statistical methods in conjunction with global circulation models (GCMs). Figure 9-5 above summarizes the findings of the literature synthesis regarding projected climatic trends. Additional discussion is provided in the following paragraphs.

Temperature. The 2015 USACE Literature Synthesis found strong consensus in the literature that temperatures will increase in the study area over the next century. *"The projected increase in mean annual air temperature ranges from 0 to 8°C* (0 to 14.4°F) *by the latter half of the 21st century. The largest increases are generally projected for the summer months. Reasonable consensus is also seen in the literature with respect to projected increases in extreme temperature events, including more frequent, longer, and more intense summer heat waves in the long-term future compared to the recent past."*

Precipitation. "*Projections of precipitation in the study region are less certain than those associated with air temperature. Most studies project increases, but some predictions are for decreases, or for increases in some portions of the region and decreases in others. Similarly, while the projections tend toward more intense and frequent storm events than the recent past, some show a reduction in parts of the Ohio Region."*

Hydrology / Streamflow. Low consensus exists amongst the literature with regards to projected changes in hydrology for the region. Large variability in the projected hydrologic parameters (e.g. runoff, streamflow, SWE) exist across the literature and varied with location, hydrologic modeling approach, GCM used, and adopted emission scenario.

9.3.1.2. Fourth National Climate Assessment

In addition to the observed trends discussed previously, the NCA4 offers climatic projections, as well as the implications of these projections on risk, infrastructure, engineering, and human health.

Temperature. Increases in temperature of about 2.5°F are expected over the next few decades regardless of future greenhouse gas emissions. Temperature increases ranging from 3° to 8°F are expected by the end of the century, depending on whether the world follows a higher or lower future emission scenario. Extreme temperatures are expected to increase proportionally to the average temperature increases. Figure 9-22 displays future projected, annual, average temperatures for two future time periods, the mid-21st century and late 21st century. These are compared with the historic baseline period of 1986-2015. Additionally, projections are shown for two emission scenarios, or representative concentration pathways (RCPs) of greenhouse gases. RCP8.5 is a higher emission scenario and RCP4.5 is a moderate emission scenario.

Note that in general, increases in projected temperature are greater in higher latitudes and lessen farther south in the country. The project area tends to span a north-south transitional area of warming. Regardless of spatial variation, temperature increases are projected for the entire country under all emission scenarios.

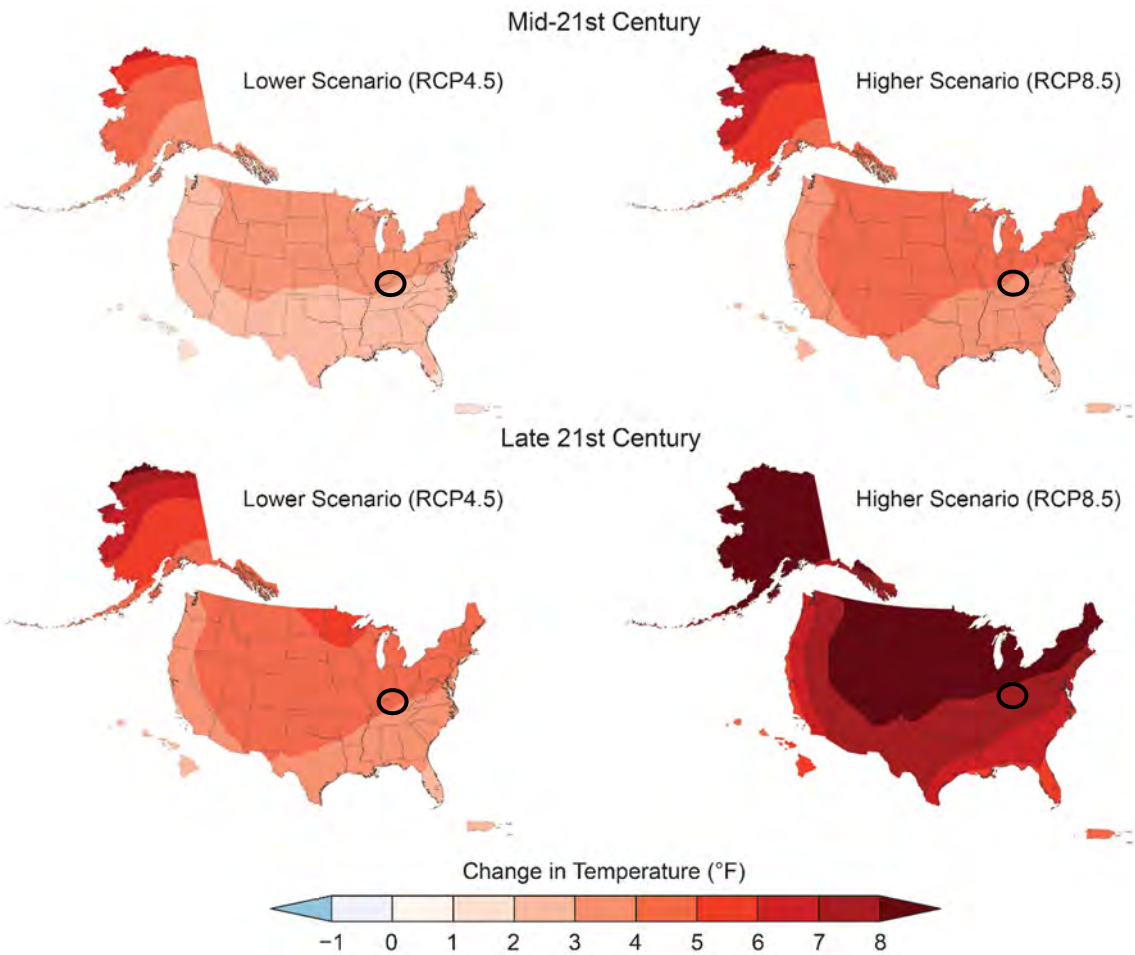

Figure 9-22. Future projections of temperature for various time frames and emission scenarios

Precipitation. Both increase and decreases in average annual precipitation are expected over the coming decades depending on location, season, and various other factors. Figure 9-23 displays the seasonal variation in annual precipitation in the later part of the century as compared with the historic period of 1986-2015. Note that there is significant variation in projections depending on location and season. Also note that red dots indicate that the projected trends due to climate change are considered to be large as compared with natural variations in climate, whereas the hatched areas show areas where the projected trends due to greenhouse gas emissions are considered to be relatively insignificant when compared to natural climate variability. Looking more closely at the LMFS project area, most of the trends in precipitation during the summer and fall months can be considered relatively insignificant. However, winter and spring precipitation both show projected increases in annual rainfall of approximately 10% - 20%. Surface soil moisture is expected to decrease across most of the U.S. and will be accompanied by large declines in snowpack in the western U.S. as winter precipitation shifts from falling as snow to falling as rain. This hydrologic shift may cause changes in the behavior of the Ohio River and other systems influenced by snow melt.

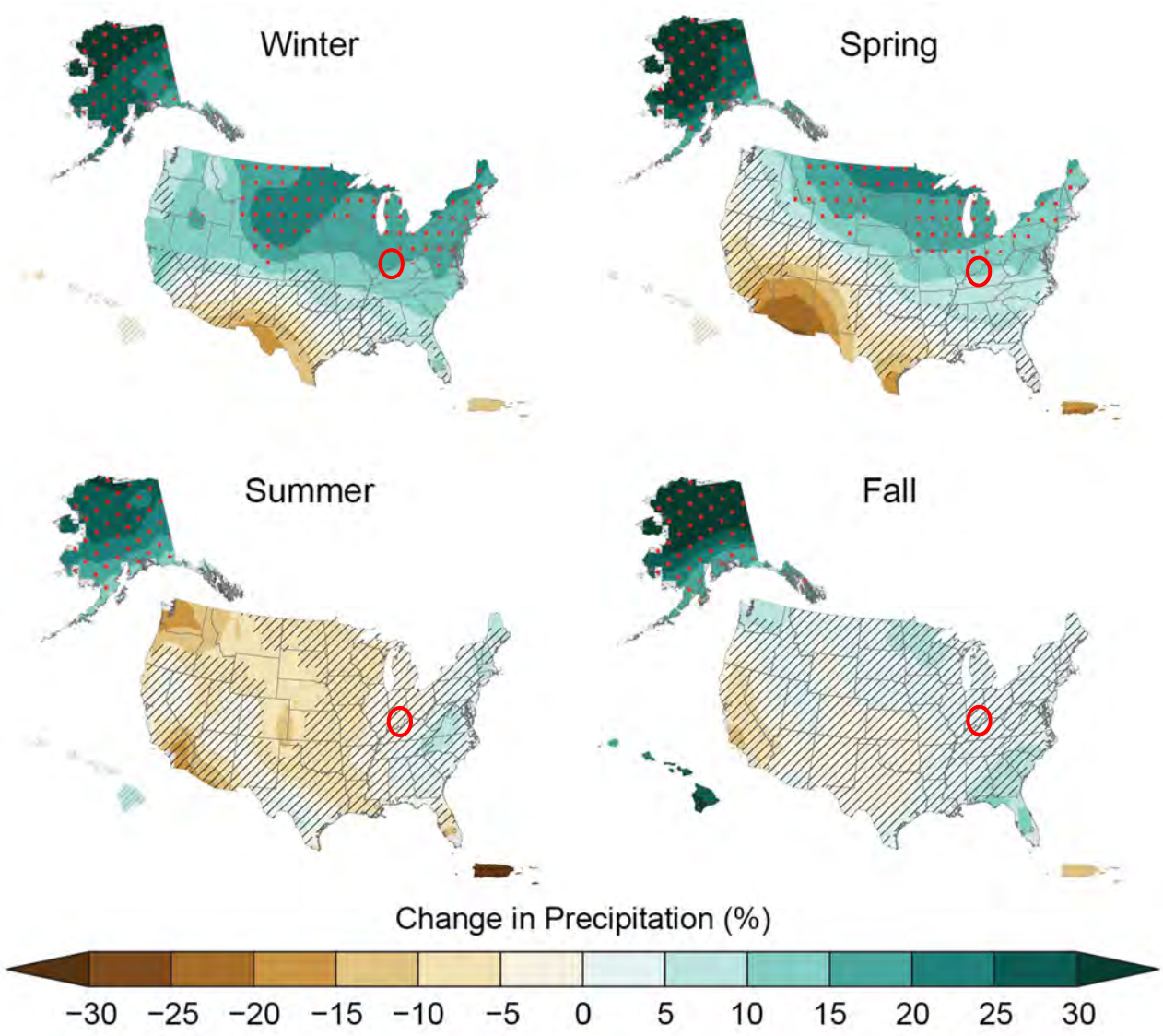

Figure 9-23. Projected percent change in future precipitation for different seasons under a high emission scenario (RCP8.5)

The observed increases in frequency and intensity of heavy precipitation discussed earlier are projected to continue, with higher emission scenarios producing stronger increasing trends. Figure 9-24 displays the projected change in total annual precipitation falling during the heaviest 1% of storms for a time period between 2070 and 2099. Note in the vicinity of the LMFS project area, under a moderate emission scenario (RCP4.5), the annual precipitation falling during the heaviest 1% of events is expected to increase by approximately 20% to 29%. Under a higher emission scenario (RCP8.5), the basin is expected to experiences extreme event precipitation increases in excess of 40%. These trends are consistent with what would be expected with warmer temperatures, as increased evaporation rates lead to higher levels of water vapor in the atmosphere which in turn leads to more frequent and intense precipitation events.

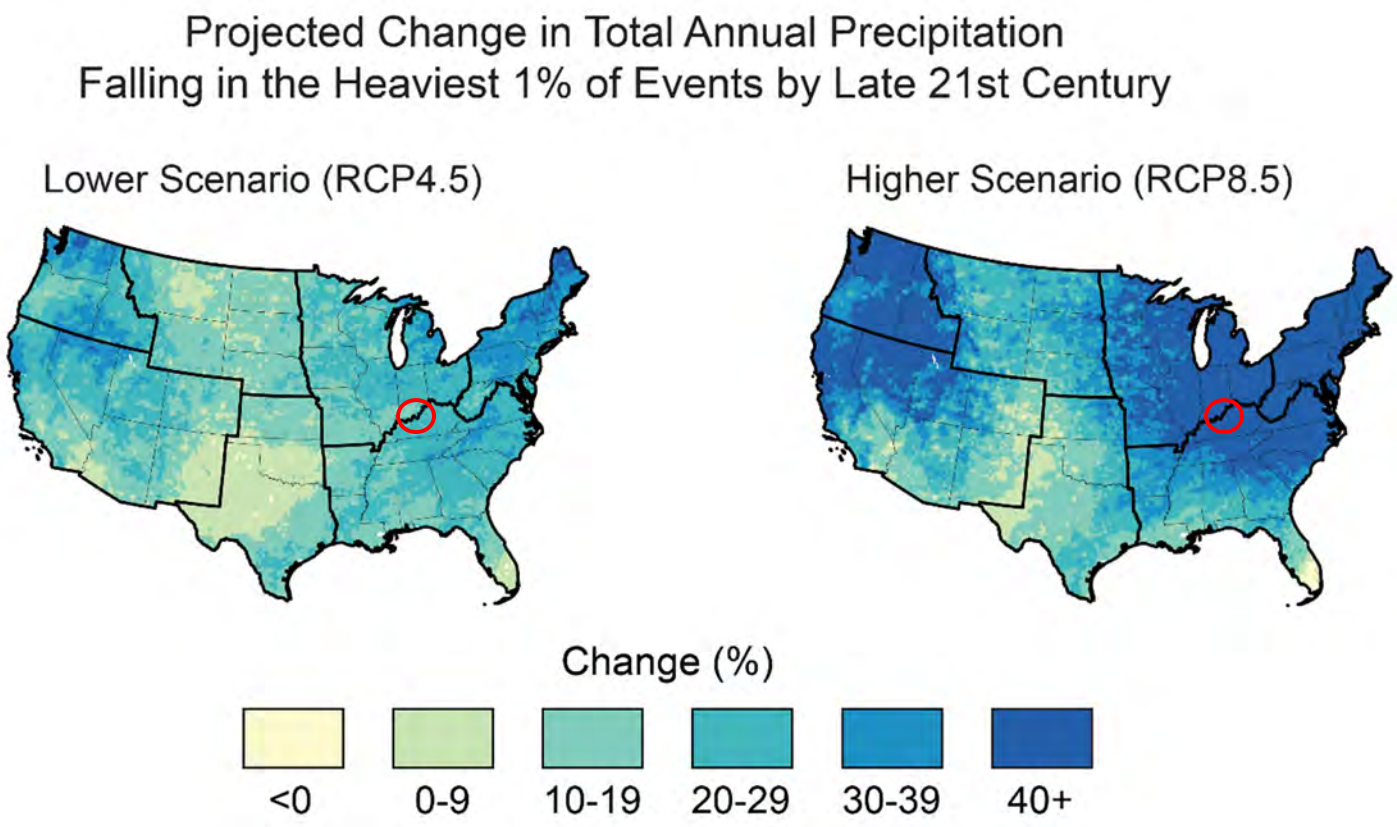

Figure 9-24. Observed percent change in the amount of precipitation falling during the heaviest 1% of events under various emission scenarios

There is potential for climate change driven changes to hydrologic conditions to increase stress on infrastructure and water supply within the Ohio River Basin and within the LMFS project area. As higher temperatures increase the proportion of cold season precipitation falling as rain rather than snow, higher streamflow is projected to occur in many basins, raising flood risks. Shifts in the timing of water supply, such as earlier snowmelt and declining summer flows will likely change the behavior of the Ohio River which influences flood pump stations' ability to convey water. Climate change is also expected to increase the risk from extreme events, both drought and flooding, potentially compromising the reliability of water supply, flood risk management, and navigation. Isolated communities and those with systems that lack redundancy are the most vulnerable.

The NCA4 goes on to qualitatively discuss some of the risks associated with projected, future climate conditions. The NCA4 report emphasizes that the likelihood of hydrometeorological phenomena like droughts, extreme storms and flood events may be misrepresented when defined using historic records that are limited in length (approximately 10-100 years). Selected points from this discussion relevant to the LMFS include:

- Extreme precipitation events are projected to increase in a warming climate and may lead to more severe rainfall driven floods and a greater risk of infrastructure failure.
- Long-lasting droughts and warm spells can compromise earthen dams and levees as a result of soil cracking due to drying, resulting in a reduction of soil strength, erosion, and land subsidence.
- The procedures used to design water resources infrastructure, estimations of probability of failure, and risk assessments for infrastructure typically rely on 10-100 years of observed data to define flood and rainfall intensity, frequency, and duration. This approach assumes that frequency and severity of extremes do not change significantly with time. However, numerous studies suggest that the severity and frequency of climatic extremes, such as precipitation and heat waves, have in fact been changing due to human-driven climate change. These changes represent a regionally variable risk of increased frequency and severity of floods and drought. Additionally, tree ring based reconstructions of climate over the past 500 years for the U.S. illustrates a much wider range of climate variability than does the instrumental record (beginning around 1900). This historic variability includes wet and dry periods with statistics very different from those of the 20th century. Infrastructure design that uses recent historic data may underrepresent the risk seen from the paleo record, even without considering future climate change.
- Statistical methods have been developed for defining climate risk and frequency analysis that incorporate observed and/or projected changes in extremes. However, these methods have not yet been widely incorporated into infrastructure design codes, risk assessments, or operational guidelines.
- Extreme rainfall events have increased in frequency and intensity in the Southeast, and there is high confidence they will continue to increase in the future. The region, as a whole, has experienced increases in the number of days with more than 3 inches of precipitation and a 16% increase in observed 5-year maximum daily precipitation (the amount falling in an event expected to occur only once every 5 years). Both the frequency and severity of extreme precipitation events are projected to continue increasing in the region under both lower and higher scenarios.
- The growing number of extreme rainfall events is stressing the deteriorating infrastructure in the Southeast. Many transportation and storm water systems have not been designed to withstand these events.

9.3.1.3. Ohio River Basin – Formulating Climate Change Mitigation/Adaptation Strategies – Climate Change Pilot Study Report (Drum et. al., 2017)

In 2017 the USACE Institute for Water Resources (IWR) in coordination with Huntington District, Lakes and Rivers Division (LRD), Ohio River Basin Alliance, and various other agencies, published a multidisciplinary report providing downscaled climate modeling information for the entire Ohio River Basin with forecasted precipitation and temperature data, along with streamflow at various gaging points throughout the basin. The projections are presented at the HUC-4 subbasin level through three 30-year time periods between 2011 and 2099.

In general the modeling results indicate a gradual increase in annual mean temperatures from 2011 to 2040 of an approximate magnitude of one-half degree per decade. From 2041 to 2099, the rate of warming increases to one-full degree per decade. Changes in streamflow show much more variability than temperature across the Ohio River Basin. HUC-4 watersheds in the northeast, east, and south of the Ohio River are expected to see increases in precipitation and streamflow of up to 50%. Conversely, HUC-4 watersheds located to the north and west of the Ohio River are expected to experience decreasing precipitation, particularly in the fall-season, resulting in decreasing streamflows – up to 50% reductions – during the coming decades. The report states that the factors of safety incorporated into many civil works designs, such as dams and levees, can allow the projects to absorb and withstand impacts through annual and seasonal operational modifications.

Regarding Local Protection Projects, which include levees and floodwalls such as those found in the Louisville Metro Flood Protection System, the report states that these facilities were planned, designed, and constructed using historic hydrologic data at the time of their inception. Consideration for future changes in precipitation was not generally incorporated into the design of these projects and this creates a potential vulnerability regarding impacts of climate change. Projected forecasts that include greater peak river flows increase the risk that a floodwall or levee could be overtopped. However this statement does not specifically apply to the Louisville Flood Protection system as its levee/floodwall crests were designed to the 1937 flood elevation plus 3 feet of freeboard. Due to the construction of upstream reservoirs and their associated increase in floodwater storage, the annual chance exceedance assigned to the 1937 flood has become less frequent over time. The 1937 flood now has an estimated annual chance exceedance of less than 0.1% (greater than 1,000-yr recurrence). Additional details are located in Appendix B – Hydraulics and Hydrology.

9.3.1.4. Analysis of Projected Changes in Precipitation IDF Values Based on Climate Change Projections

CH2M Hill performed a 2015 analysis projecting precipitation values into the future and developing precipitation frequency estimates, comparable with Atlas 14, from these projected values. This was done in addition to the previously discussed CH2M Hill analysis in the Observed Trends Literature Review section above. The future climate projections were accomplished using a circulation model known as SimCLIM, which utilizes 22 daily general circulation models and two emission scenarios at two different future time periods, 2035 and 2065. Selected emission scenarios include Representative Concentration Pathway (RCP) 8.5, which represents a “high” growth scenario for greenhouse gasses, and RCP 6.0 representing a “moderate” growth scenario.

When compared with the CH2M Hill precipitation frequency estimates discussed above and shown in Table 9-3, the estimates increase from 10% to 16% by the year 2065. For example, for the 100-yr 24-hr storm, the precipitation depth is projected to increase from 7.81 inches to between 8.56 and 9.05 inches. Figure 9-25 displays a comparison between the precipitation projections and the “historical” baseline for a range of return periods. Note that the “historical” baseline is referring to the 2015 study previously discussed where CH2M Hill updated Atlas 14 estimates with new data and stations through 2014. Table 9-5 shows the ECP 6.0 projections compared with A14 estimates and the previous CH2M Hill analysis. All projections were done using a 3-station average of the previously analyzed gages. The direction and

magnitudes of these increasing trends is comparable with other findings, such as that of the National Climate Assessment and the CHAT tool. Incorporation of these updated rainfall values as a basis of design for the LMFS is outside the scope of this qualitative assessment of climate change, however this analysis was taken into consideration when selecting the upper confidence limit of A14.

Table 9-5. Comparison between Projected Precipitation Frequency Estimates (inches). 24-hr Duration Storm

Annual Chance Exceedance	Return Period (Years)	Atlas 14	Atlas 14 90% UCL	CH2M Hill "Historical" Analysis	RCP 6.0 2035 Projected Median	RCP 6.0 2065 Projected Median
50%	2	3.10	3.38	3.03	3.04	3.04
20%	5	3.85	4.19	4.05	4.16	4.24
10%	10	4.47	4.86	4.82	5.00	5.13
4%	25	5.37	5.83	5.91	6.19	6.39
2%	50	6.12	6.64	6.82	7.18	7.43
1%	100	6.93	7.51	7.81	8.25	8.56

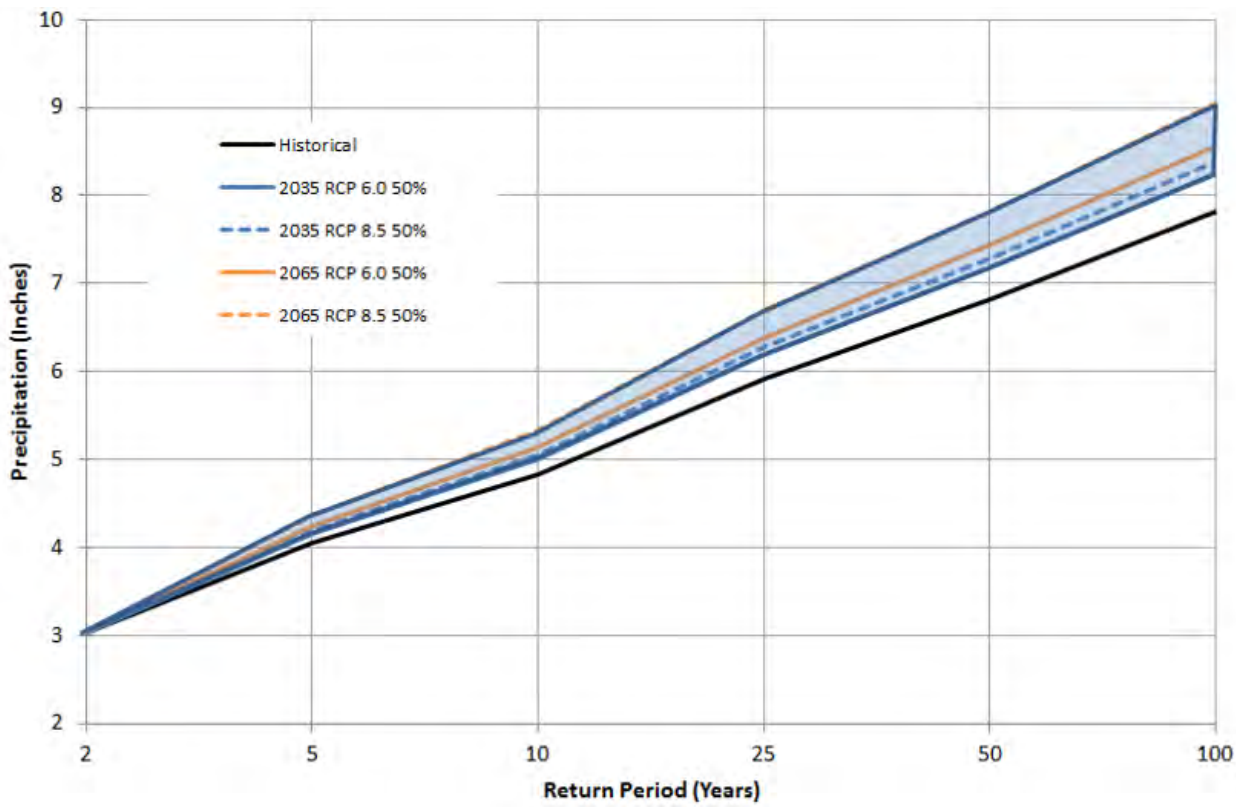

Figure 9-25. Comparison between Historical (2015 CH2M Hill Study) and Projected 24-hr Precipitation Frequency Estimate

9.3.2. Climate Hydrology Assessment

The USACE Climate Hydrology Assessment Tool (CHAT) was used to assess projected, future trends within the Lower Ohio River Basin watershed, HUC-0514. The tool displays the range of projected annual maximum monthly streamflows from 1950 - 2099, with the projections from 1950 – 1999 representing hindcast projections and 2000 – 2099 representing forecasted projections.

Figure 9-26 displays the range of projections for 93 combinations of CMIP5 GCMs and RCPs produced using BCSD statistical downscaling. These flows are simulated using an unregulated VIC hydrologic model at the outlet of the Lower Ohio River Basin (HUC-0514) which is near the confluence of the Ohio River and Mississippi River near Cairo, IL. At this outlet, the Ohio River has a drainage area of approximately 203,000 mi^2 (according to the national hydrography dataset), as compared with the drainage area at the Louisville Project area of 91,170 mi^2. It should be noted that the hindcast projections do not replicate historically observed precipitation or streamflow and should therefore not be compared directly with historical observations. This is in part because observed streamflows are impacted by regulation, while the VIC model used to produce the results displayed in Figure 9-26 is representative of the unregulated condition.

Upon examination of the range of model results, there is a clear increasing trend in the higher projections, whereas the lower projections appear to be relatively stable and unchanging through time. The spread of the model results also increases with time, which is to be expected as uncertainty in future projection increases as time moves away from the model initiation point. Sources of variation and the significant uncertainty associated with these models include the boundary conditions applied to the GCMs, as well as variation between GCMs and selection of RCPs applied. Each GCM and RCP independently incorporate significant assumptions regarding future conditions, thus introducing more uncertainty into the climate changed projected hydrology. Climate model downscaling and a limited temporal resolution further contribute to the uncertainty associated with CHAT results. There is also uncertainty associated with the hydrologic models. The large spread of results shown in Figure 9-26 highlights current climatic and hydrologic modeling limitations and associated uncertainty.

Figure 9-27 displays only the mean result of the range of the 93 projections of future, climate-changed hydrology which are shown in Figure 9-26. A linear regression line was fit to this mean and displays an increasing trend with a slope of approximately 49 cfs/yr. It should be noted that the p-value associated with this trend is less than 0.0001, indicating that the trend should be considered as statistically significant.

These outputs from the CHAT qualitatively suggest that annual maximum monthly flows, and therefore annual peak flows, are expected to increase in the future relative to the current time. Another important caveat is that the CHAT tool is simulating an unregulated watershed. Reservoir operations can be expected to decrease the variance of flows shown in the CHAT, as well as decrease the magnitude of their peaks. The results indicated by the CHAT largely agree with many of the trends found within the literature review regarding projected future extreme event streamflow.

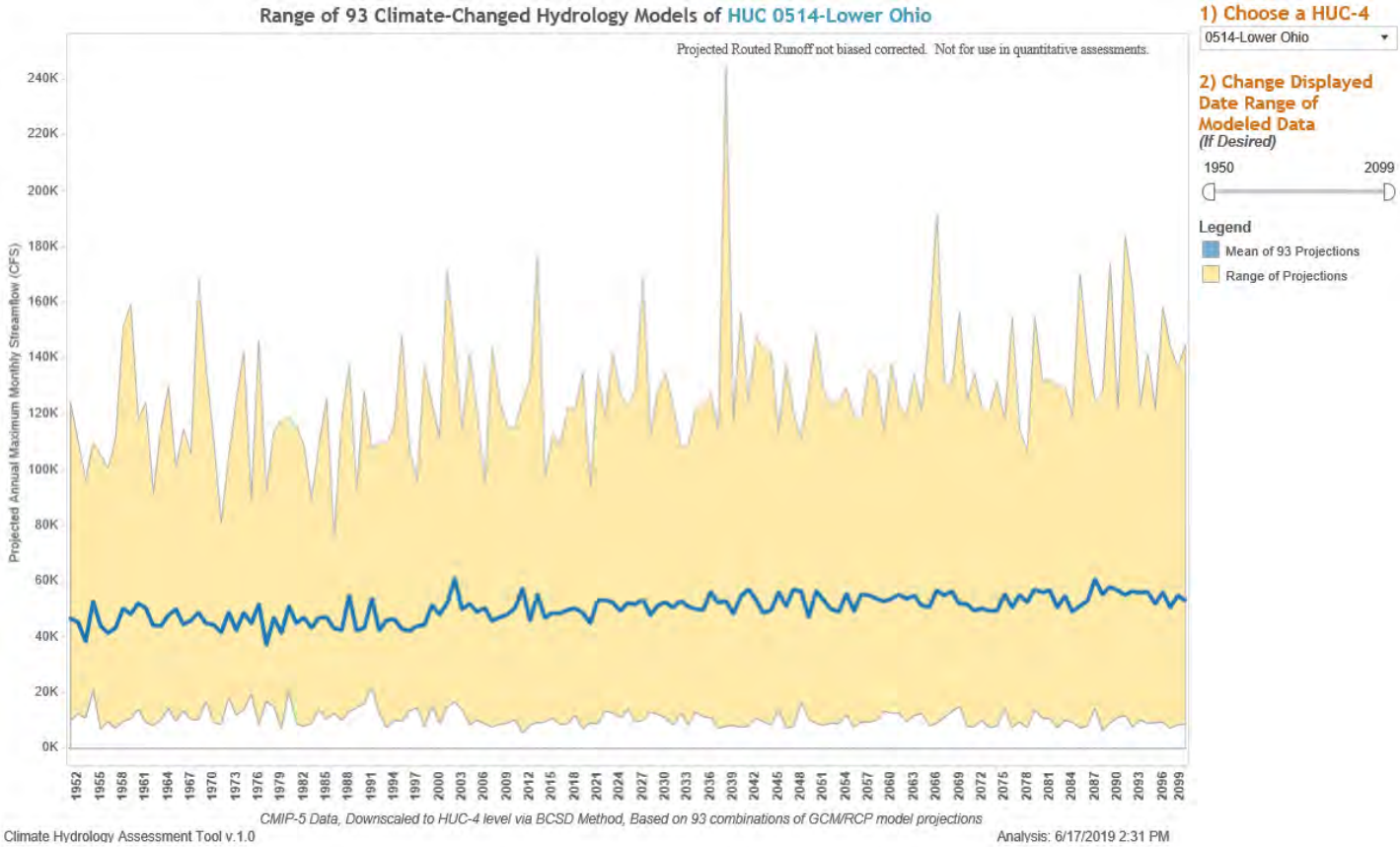

Figure 9-26. Range of GCM/RCP projections for the Lower Ohio, HUC-0514.

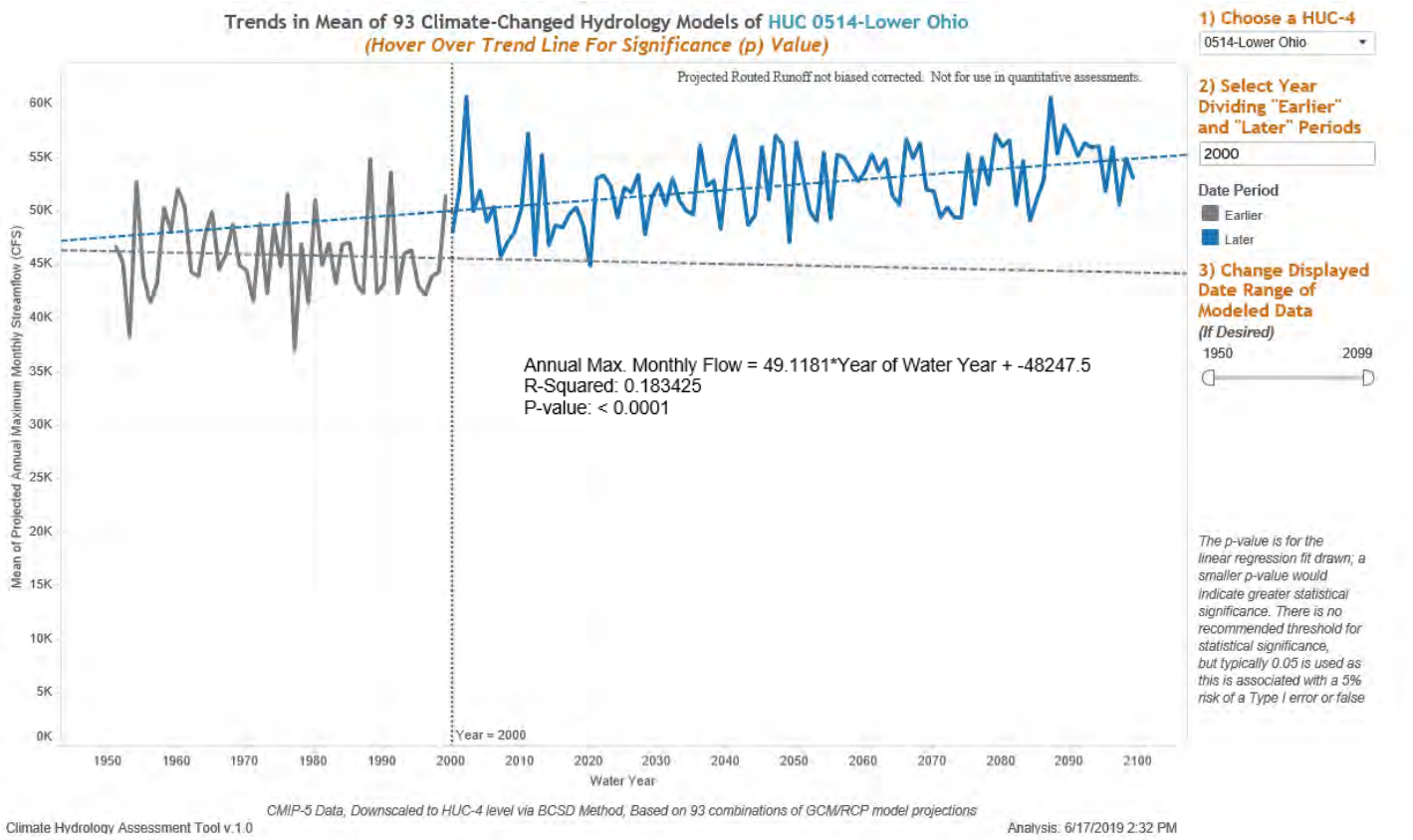

Figure 9-27. Mean of GCM/RCP projections for the Lower Ohio, HUC-0514.
Mean of Projections Regression: [Q = 49.1181*(Water Year) – 48247.5] [R^2 = 0.183425] [P-value = <0.0001]

9.3.3. Vulnerability Assessment

The USACE Watershed Climate Vulnerability Assessment Tool (VA Tool) facilitates a screening level, comparative assessment of how vulnerable a given HUC-4 watershed is to the impacts of climate change relative to the other 202 HUC-4 watersheds within the continental United States (CONUS). The tool can be used to assess the vulnerability of a specific USACE business line such as "Flood Risk Reduction" or "Navigation" to projected climate change impacts. Assessments using this tool help to identify and characterize specific climate threats and particular sensitivities or vulnerabilities, at least in a relative sense, across regions and business lines. The tool uses the Weighted Ordered Weighted Average (WOWA) method to represent a composite index of how vulnerable a given HUC-4 watershed (Vulnerability Score) is to climate change specific to a given business line. The HUC-4 watersheds with the top 20% of WOWA scores are flagged as being vulnerable.

Flood Risk Reduction (Management) and Emergency Management are the two most relevant business lines to the Louisville Metro Flood Protection System Feasibility Study and are the primary business lines analyzed with the USACE Climate Vulnerability Assessment Tool. While only the flood risk reduction and emergency management business lines are discussed in detail, all business lines available within the VA tool were examined for outstanding vulnerability, and none was found. Business lines included in the VA tool include: ecosystem restoration, emergency management, flood risk reduction, hydropower, navigation, recreation, regulatory, and water supply.

When assessing future risk projected by climate change, the USACE Climate Vulnerability Assessment Tool makes an assessment for two 30-year epochs of analysis centered at 2050 and 2085. These two periods were selected to be consistent with many of the other national and international analyses. The Vulnerability tool assesses how vulnerable a given HUC-4 watershed is to the impacts of climate change for a given business line using climate hydrology based on a combination of projected climate outputs from the general circulation models (GCMs) and representative concentration pathway (RCPs) resulting in 100 traces per watershed per time period. The top 50% of the traces is called "wet" and the bottom 50% of the traces is called "dry." Meteorological data projected by the GCMs is translated into runoff using the Variable Infiltration Capacity (VIC) macro-scale hydrologic model. For this assessment, the default National Standards Settings are used to carry out the vulnerability assessment.

For Flood Risk and Emergency Management, the Ohio River Basin (HUC 0514) is not within the top 20% of vulnerable watersheds within the CONUS for any of the four scenarios, which is not to say that vulnerability to future climate change does not exist within the basin. Table 9-6 displays the overall vulnerability scores for the two business lines relevant to this study under both wet and dry scenarios and under both time epochs. The indicators driving the residual vulnerability for the flood risk management and emergency management business lines are shown in Figure 9-28 and Figure 9-29, respectively. Table 9-7 and Table 9-8display the indicators contributing to vulnerability within the Lower Ohio Basin for the flood risk reduction and emergency management business lines; the tables are generally sorted from largest to smallest average indicator contribution to vulnerability. Additionally, the tables display the indicator code, name, and a brief description of the indicator's meaning.

Regarding the Flood Risk Reduction business line, the primary indicators driving vulnerability within the watershed are the flood magnification factor (indicators 568C and 568L) and the large elasticity between rainfall and runoff (indicator 277). The flood magnification factor represents how the monthly flow exceeded 10% of the time is predicted to change in the future; a value greater than 1 indicates flood flow is predicted to increase, which is true for the Lower Ohio Basin. The rainfall/runoff elasticity (277) measures the tendency for small changes in precipitation to result in large changes in runoff. Additional information regarding indicators can be found within the Vulnerability Assessment Tool Users Guide (U.S. Army Corps of Engineers, 2016).

Regarding the Emergency Management business line, the primary indicators driving vulnerability within the watershed include the low flow reduction factor (indicators 700C and 700L). This low flow factor is less than 1 for all epochs and scenarios within HUC 0514, indicating that the monthly flow exceeded 90% of the time is predicted to decrease in the future, thereby increasing stresses on water supply. Emergency management vulnerability is further increased by the relatively high number of people within the watershed living with a disability (indicator 447) and the number of people living below the poverty line (indicator 443). Statistically, both of these socioeconomic groups are disproportionately impacted by natural disasters and often have limited access to essential goods and services in the event of an emergency. Another indicator driving emergency management vulnerability is the population living within the 500-yr floodplain.

Note that some of the indicators contain a suffix of "L" (local) or "C" (cumulative). Indicators with an "L" suffix reflect flow generated within only one HUC-4 watershed, whereas indicators with a "C" suffix reflect flow generated within a HUC-4 watershed and any upstream watersheds. In the case of the Lower Ohio River (HUC 0514), there is a substantial drainage area upstream of the 4-digit HUC.
It is important to note the variability displayed in the VA tool's results (Table 9-6, Table 9-7, and Table 9-8) highlights some of the uncertainty associated with the projected climate change data used as an input to the VA tool. Because the wet and dry scenarios each represent an average of 50% of the GCM outputs, the variability between the wet and dry scenarios underestimates the larger variability between all the underlying projected climate changed hydrology estimates. This variability can also be seen between the 2050 and 2085 epochs, as well as various other analysis within this report, such as output from the CHAT (Figure 9-26).

Table 9-6. Overall Vulnerability Scores for all Epochs and Scenarios

	Flood Risk Reduction		**Emergency Management**	
Epoch	**2050**	**2085**	**2050**	**2085**
Dry	46.34	44.74	64.928	64.928
Wet	49.36	52.21	63.698	64.928

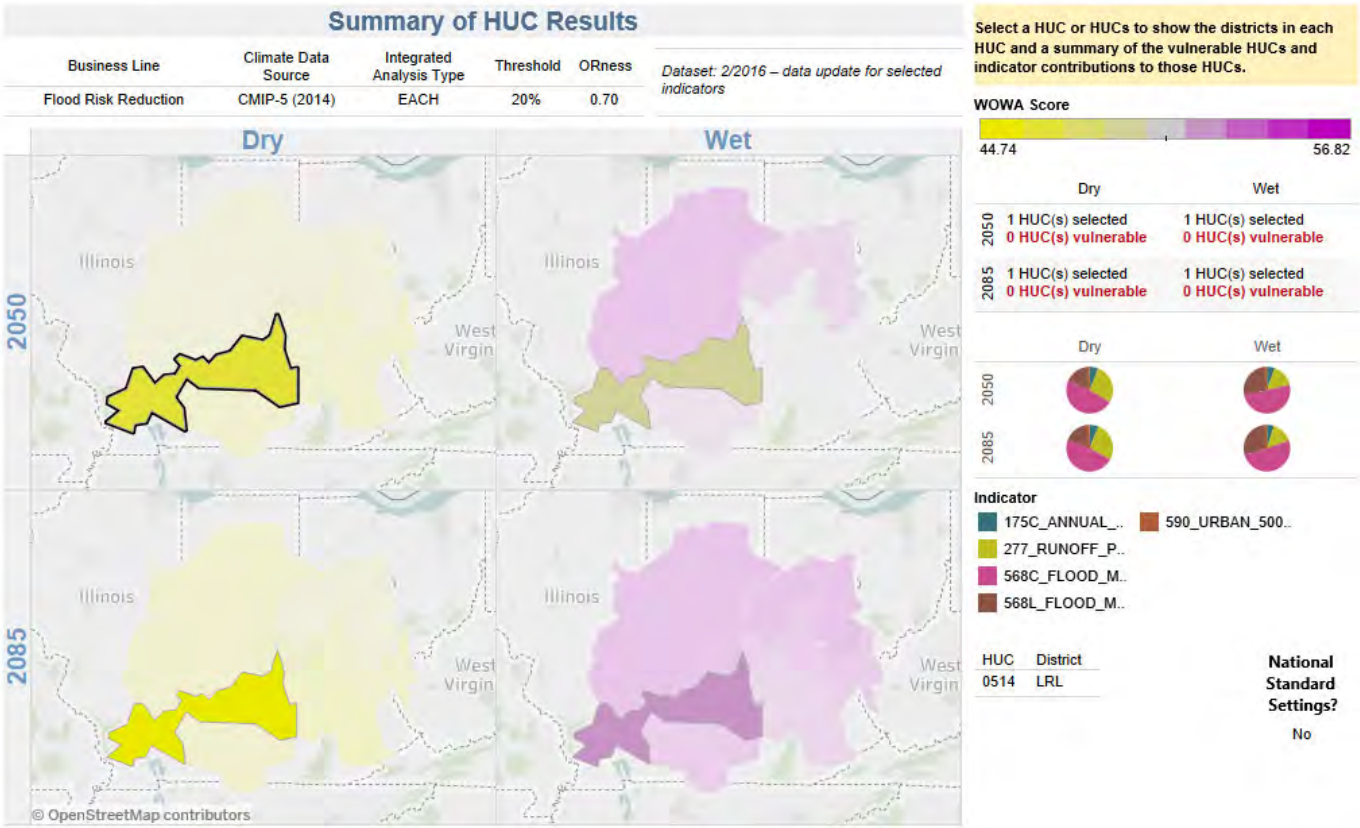

Figure 9-28. VA Tool Summary of HUC Results for Flood Risk Reduction Business Line

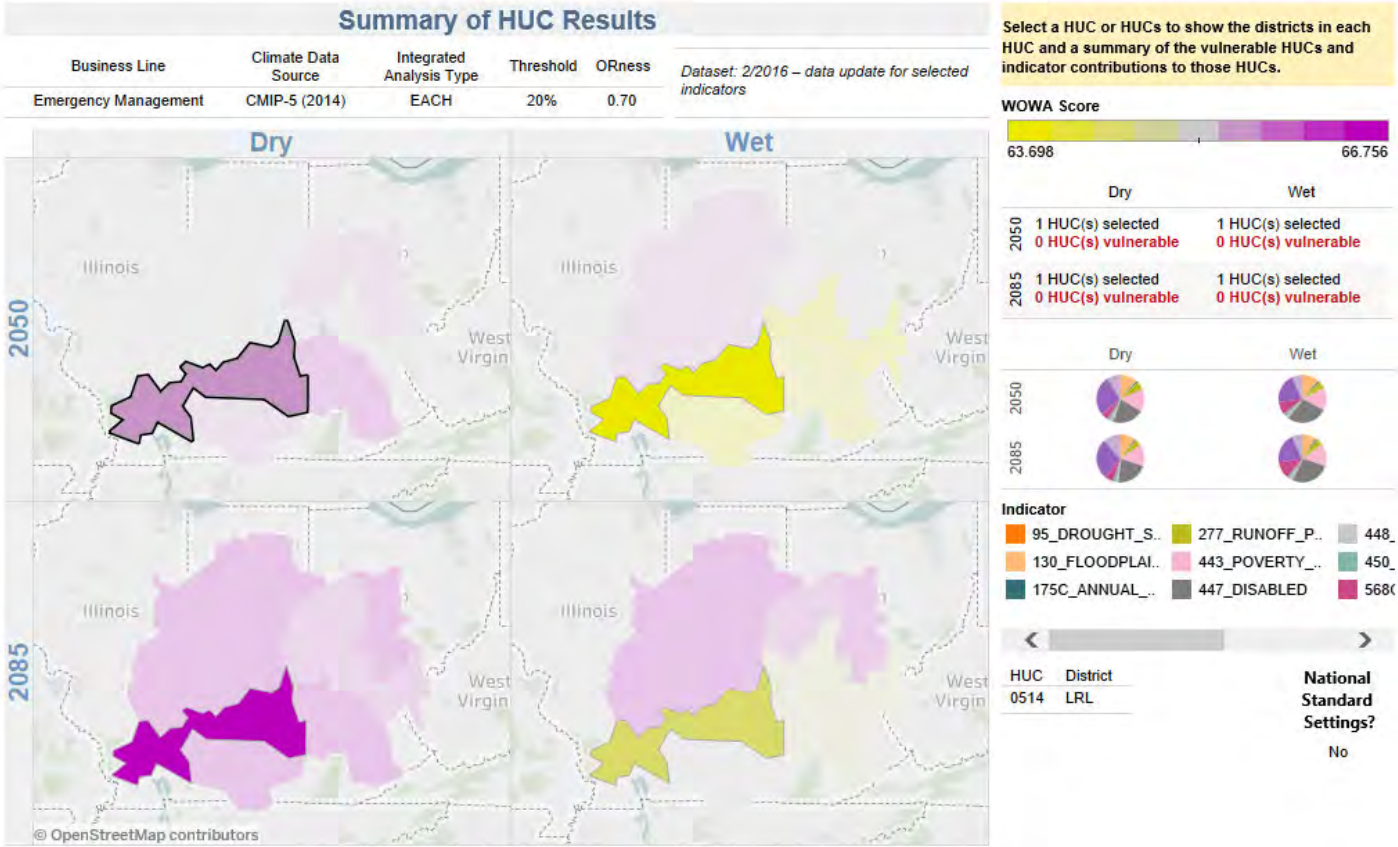

Figure 9-29. VA Tool Summary of HUC Results for Emergency Management Business Line

Table 9-7. Vulnerability Indicators for Flood Risk Reduction Business Line. Sorted by highest to lowest indicator contribution to vulnerability.

Flood Risk Reduction Business Line			2050	2050	2085	2085
Indicator Code	**Indicator Name**	**Description**	**Dry**	**Wet**	**Dry**	**Wet**
568C	Cumulative Flood Magnification Factor	Change in flood runoff: ratio of indicator 571C (monthly runoff exceeded 10% of the time, including upstream freshwater inputs) to 571C in base period.	47.76%	50.41%	47.81%	50.76%
277	Percent Change in Runoff Divided by the Percent Change in Precipitation	Median of: deviation of runoff from monthly mean times average monthly runoff divided by deviation of precipitation from monthly mean times average monthly precipitation.	27.54%	15.87%	26.80%	14.73%
568L	Local Food Magnification Factor	Change in flood runoff: Ratio of indicator 571L (monthly runoff exceeded 10% of the time, excluding upstream freshwater inputs) to 571L in base period.	16.78%	26.56%	16.92%	27.71%
175C	Cumulative Annual Covariance of Unregulated Runoff	Long-term variability in hydrology: ratio of the standard deviation of annual runoff to the annual runoff mean. Includes upstream freshwater inputs (cumulative).	5.99%	5.38%	6.16%	4.86%
590	Acres of Urban Area Within 500-Year Floodplain	Acres of urban area within the 500-year floodplain.	1.93%	1.77%	2.31%	1.93%

Table 9-8. Vulnerability Indicators for Emergency Management Business Line. Sorted by highest to lowest indicator contribution to vulnerability.

Emergency Management			2050	2050	2085	2085
Indicator Code	**Indicator Name**	**Description**	**Dry**	**Wet**	**Dry**	**Wet**
700C	Cumulative Low Flow Reduction Factor	Change in low runoff: ratio of indicator 570C (monthly runoff exceeded 90% of the time, including upstream freshwater inputs) to 570C in base period.	27.30%	20.45%	27.97%	20.80%
447	Percent of People Disabled	Percent of people who are disabled.	21.84%	27.79%	21.66%	27.44%
443	Number of People Below the Poverty Line	Number of people living below the poverty line.	14.98%	15.31%	14.53%	14.79%
130	Population in 500-Year Floodplain	Population within the 500-year floodplain.	11.11%	11.35%	8.62%	8.78%
700L	Local Low Flow Reduction Factor	Change in low runoff: ratio of indicator 570L (monthly runoff exceeded 90% of the time, excluding upstream freshwater inputs) to 570L in base period.	8.74%	6.61%	11.18%	6.70%
277	Percent Change in Runoff Divided by the Percent Change in Precipitation	Median of: deviation of runoff from monthly mean times average monthly runoff divided by deviation of precipitation from monthly mean times average monthly precipitation.	6.02%	4.79%	4.51%	4.64%
568C	Cumulative Flood Magnification Factor	Change in flood runoff: ratio of indicator 571C (monthly runoff exceeded 10% of the time, including upstream freshwater inputs) to 571C in base period.	4.79%	8.74%	5.72%	11.44%
450	Number of Communities With Flood Insurance	Number of communities enrolled in the National Flood Insurance Program (NFIP).	2.13%	2.18%	2.11%	2.15%
448	Disaster Resilience Due to Experience	Number of declared disasters.	1.43%	1.46%	1.14%	1.44%
175C	Cumulative Annual Covariance of Unregulated Runoff	Long-term variability in hydrology: ratio of the standard deviation of annual runoff to the annual runoff mean. Includes upstream freshwater inputs (cumulative).	1.12%	1.12%	0.89%	1.06%
95	Drought Severity Index	Greatest precipitation deficit: The most negative value calculated by subtracting potential evapotranspiration from precipitation over any 1-, 3-, 6-, or 12-month period.	0.55%	0.21%	1.69%	0.75%

9.4.Summary and Conclusions

The Louisville Metro Flood Protection System and this related Feasibility Study operate to reduce the risks and associated damages of flooding for the City of Louisville. Based on the literature review observed trends as well as an analysis of locally observed data, statistically significant and increasing trends in temperature and precipitation have been detected. These findings are further supported by analysis performed under MSD direction by CH2M Hill to perform an update of precipitation frequency estimates for the City of Louisville. These increases in precipitation are likely related to anthropogenic climate change, but cannot be distinguished from similar shifts driven by natural variation at this time. An assessment of observed peak annual streamflow by the CHAT and NSD tools has revealed statistically significant increasing trends and strong nonstationarities on multiple streams located within the City of Louisville, however these trends were not present on the Ohio River or on reference "pristine" streams located outside of the city's urban center. For these reasons, the increasing trends in streamflow detected on Beargrass Creek and Pond Creek are attributed to the substantial change in land use, population growth, and urbanization of Louisville, particularly in the mid-1950s. It is very difficult to separate the potential influence of climate change from these factors, but the lack of apparent climate driven change on the Floyds Fork gage supports the finding of little climate driven change on streamflow.

Regarding projected future trends, there is generally a consensus of increasing temperatures, precipitation, and streamflow. These changes will likely vary seasonally, with greater increases in the winter and spring months. Additionally, the frequency of intense storms and rainfall is projected to increase. It should be noted that substantial uncertainty exists within future climate projections, this uncertainty is effectively illustrated by the range of GCM peak annual streamflow projections shown in Figure 9-26. At this time, each of the 93 climate projections included in this figure's range can be considered equally likely to occur.

All of these trends in observed and projected streamflow and precipitation are driving vulnerability within the HUC-4 region and for the Louisville Metro Flood Protection System. This system includes miles of levee and floodwall to protect the interior area from flooding induced by the Ohio River. While some residual risk exists regarding these flood walls and levees, these features are largely resilient to the impacts of climate change. This is due to the conservative, and therefore resilient, design of these features which were sized based upon the 1937 flood plus 3 feet of freeboard, as well as substantial upstream construction of flood risk management reservoirs which has occurred since the flood protection system's inception. Due to the upstream reservoir construction alone, flow frequency estimates are assumed to have dropped since the flood protection system was constructed. This combination of circumstances has produced a rather robust levee system from a hydraulic adequacy perspective.

Other features of the system, such as flood pump stations, are more vulnerable to the potential impacts of climate change. Increased frequency and intensity of rainfall on interior areas translates to increased frequency of use on the pump stations. The combination of urbanization, observed increasing streamflows, and potential for more frequent future rainfall increases the stress on these pump stations. For this reason, as well as others included throughout this appendix and Appendix B (H&H), the 90% upper confidence limit (UCL) of the Atlas 14 precipitation frequency estimate was selected as the basis of design. This provides some conservatism in design as opposed to the standard usage of the median Atlas 14 values, accounting for a portion of the hydrologic uncertainty associated with this project. Selection of the UCL values constitutes risk informed decision making accounting for uncertainty and does not constitute a quantitative analysis of climate change as defined by ECB 2018-14. A quantitative analysis could involve utilization of outputs from projected global circulation models, such as CH2M Hill's SimCLIM models, as a basis of project design.

Using these Atlas 14 UCL values as a basis of hydrologic design did not result in pump capacity increases being justified; see Appendix B – Hydraulics and Hydrology. However it is possible that in the future as more data becomes available or as further development of the watershed occurs, there may be a need for capacity increase. The findings of this assessment indicate the Louisville Metro Flood Protection System will be able to accommodate future climatic and hydrologic changes without a substantial need to alter its operations or increase its capacity in the future, assuming required O&M occurs. Because of the robust nature of the levee system and the degree of flexibility incorporated into pumping station operation, future rainfall and streamflow would have to increase significantly in order to warrant substantial changes to the project. While the Louisville Metro Flood Protection System operates to reduce flood risk and will continue to do so into the future, it is possible that more frequent intense storms and larger volumes of flood-season runoff due to climate change could become operationally significant and result in more frequent flood damages.

Potential resilience measures which could be implemented to reduce future flood risks associated with climate change may include structural modifications to individual pump stations, acquisition of additional real estate to facilitate increased flood storage and remove flood prone structures, and changes to existing operation procedures (such as opening flood gates when the interior elevation exceeds the exterior). It is recommended that inflow-frequency, stage-frequency, and precipitation-frequency be reevaluated periodically in the future to determine how projected trends manifest themselves in future observations. Depending on the results of these future analyses, additional flood risk reduction measures may be required. Currently the findings of this report do not impact the numerical results discussed in Appendix B – Hydraulics and Hydrology.

Table 9-9 displays the residual risk table required by ECB 2018-14. This table lists potential climatic triggers, hazards, harms, and approximate qualitative likelihood of occurrence. The table is primarily focused on the business line of interest, flood risk reduction, however that is not to say that other USACE business lines will not be impacted by climate change. Because this qualitative analysis is focused on the Louisville Metro Flood Protection System as a whole, only generic project features have been identified within the table.

Based on this assessment, it is recommended that the potential, future effects of climate change be treated as occurring within the uncertainty range calculated for the current hydrologic analysis. If this assumption proves to be inadequate when future observations or more refined projections become available, then a quantitative evaluation and revision of these results may be required.

Table 9-9. Residual Risk Table for the Louisville Metro Feasibility Study

Feature of Measure	Trigger	Hazard	Harm	Qualitative Likelihood
Flood Risk Reduction – Pump Stations	Minor increase in precipitation volume from larger or more frequent storms	Increased precipitation will result in more frequent use of flood pump stations and potential for increase flood damages	Increased flood damages would lead to increased economic harm. Additional pump capacity or changes in pump operation could potentially mitigate these effects.	Likely
Floodwater storage area	Increased urbanization	Increased urbanization leads to further development of flood prone areas	Increased development increases flood damages and frequency of flooding.	Likely
Flood Risk Reduction – Pump Stations	Change in seasonality of runoff	Increased runoff occurring in the winter-time flood season	Increased runoff in the winter flood season would lead to increased economic harm. Additional pump capacity or changes in pump operation could potentially mitigate these effects.	Likely
Flood Risk Reduction – Flood Wall / Levee	Increase in flow-frequency or stage-frequency or stage-duration behavior of the Ohio River	These changes would result in increased loading to the levee / floodwall and increased percent of time that flood pump station gates are closed.	Increased levee loading increases the probability of levee failure and associated damages and loss of life.	Not Likely
Flood Risk Reduction – Pump Stations	Substantial increase in precipitation volume from larger or more frequent storms	Large increase in precipitation frequency could render existing pump station infrastructure insufficient	Large increases in precipitation frequency would lead to increased economic harm. Structural changes and improvements to pump stations to increase capacity may be deemed as necessary.	Not Likely

9.5. References

Drum, R. G., J. Noel, J. Kovatch, L. Yeghiazarian, H. Stone, J. Stark, P. Kirshen, E. Best, E. Emery, J. Trimboli, J. Arnold, and D. Raff (2017), Ohio River Basin–Formulating Climate Change Mitigation/Adaptation Strategies Through Regional Collaboration with the ORB Alliance, Civil Works Technical Report, CWTS 2017-01, U.S. Army Corps of Engineers, Institute for Water Resources. May 2017.

Fourth National Climate Assessment, Volume II, Chapter 2, National Topics: Our Changing Climate, 2018.

Fourth National Climate Assessment, Volume II, Chapter 3, National Topics: Water, 2018.

Fourth National Climate Assessment, Volume II, Chapter 24, Southeast Region, 2018.

Laughlin S, Loechle J, Buckler J. CH2M Hill. (2015) Analysis of Historical Precipitation Intensity-Duration Frequency for Jefferson County, Kentucky.

Laughlin S, Loechle J, Buckler J. CH2M Hill. (2015) Analysis of Projected Changes in Precipitation IDF Values Based on Climate Change Projections.

U.S. Army Corps of Engineers, Climate Hydrology Assessment Tool (CHAT). Issued 2016.

U.S. Army Corps of Engineers, Climate Preparedness and Resilience (CPR) Community of Practice (CoP) Applications Portal. https://maps.crrel.usace.army.mil/projects/rcc/portal.html

U.S. Army Corps of Engineers, Engineering and Construction Bulletin 2016-25 (Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects). Issued 16 September 2016.

U.S. Army Corps of Engineers, Engineering and Construction Bulletin 2018-14 (Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects). Issued 10 September 2018.

U.S. Army Corps of Engineers, Engineering Technical Letter (ETL) 1100-2-3. (Guidance for Detection of Nonstationarities in Annual Maximum Discharges.) Issued 28 April 2017.

U.S. Army Corps of Engineers, Nonstationarity Detection (NSD) Tool and User Guide. Version 1.2. Issued May 2016, updated September 2018.

U.S. Army Corps of Engineers, Vulnerability Assessment (VA) Tool and User Guide. Version 1.1. Issued November 2016.

U.S. Army Corps of Engineers, Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions, Ohio Region 05. January 2015.

U.S. Army Corps of Engineers, Time Series Toolbox, Trend Analysis and Nonstationarity Detection. 2018.

U.S. Army Corps of Engineers website with climate impact analysis tools: https://maps.crrel.usace.army.mil/projects/rcc/portal.html

U.S. Army Corps of Engineers Louisville District, Qualitative Assessment of Climate Change Impacts on the Willamette River Basin, Oregon. 2019.

U.S. Census Bureau, Decennial Census, Population for Louisville Kentucky. 2019.

White K, Arnold J, CDM Smith (2015) Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions – Ohio Region 05.

APPENDIX J - Cost Engineering
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1. Appendix J – Cost Engineering

This appendix lists and describes the current working cost estimate as part of the feasibility study. Included within are details regarding the development of the cost estimate including the scope of work, major assumptions, markups, and contingency development utilizing the Cost and Schedule Risk Analysis (CSRA).

1.1. Scope of Work

The scope of work included in the cost estimate was derived from Table 1.1 in Appendix A of this Volume 2, and utilized design drawings including Civil, Structural, Mechanical, and Electrical disciplines that are also part of this feasibility study report. The cost estimator also used satellite imagery and limited knowledge of site conditions. Assumed means and methods of construction, construction access, temporary laydown areas, acquisition strategy, PED, construction management, similar project conditions experienced in the Paducah Flood Pump Station project, schedule, and risks were discussed with the project team and applied to the cost estimate.

1.2. Cost Estimate

1.2.1 General Information

Structure
The estimate is organized per the Civil Works Work Breakdown Structure (WBS) guideline/template.

Acquisition Strategy
Due to the size of the project (>$20M), it is assumed that this will be advertised as a Full and Open/Unrestricted project. Per conversations with PDT members and leadership, typically projects over $15-20M would be put out as Unrestricted, with all projects smaller than that typically going to MATOCs. The current working estimate assumes one contract.

Contractor Hierarchy
This estimator assumed this project to have a Prime Contractor subcontracting the work to multiple subcontractors per disciplines of the work.

Project Mark-ups
- Cost Book Adjustment: 10.18%
- Escalation: (Estimated Award Date - October 2021, Project duration estimated to be 5 years, Midpoint of Construction - July 2022)
- Productivity 95%

Prime Contractor Mark-ups
- JOOH: 18%
- HOOH: 15%
- Profit: Profit Weighted Guidelines Wizard 8.9%
- Bond: 1.5%

Sub Contractor Mark-ups:
- SubJOOH: 18%
- SubHOOH: 7%

Profit: 10%

Sales Tax: 6.00% (Jefferson County, KY)

Contingency: 21% per the CSRA, 25% for Lands and Damages per LRL Real Estate Division.

1.2.2 **Pricing**

Pricing for replacement/rebuild of pumps was derived from recent pricing received for a similar project, the Ohio River Shoreline project in Paducah, KY. Pricing from the similar project was analyzed to determine cost patterns based on pump sizing. These patterns were then used to apply costs to this project based on the sizes of the pumps. Repair of pump motors, and replacement of electrical gear, controls, and electrical service transformers was established with pricing received from vendors and the local electrical service provider, LG&E. Pricing was spot-checked for accuracy with Louisville MSD historical costs for pump repair/replacement work.

All pricing for pumps and motor refurbishment or replacement considered the location, pump characteristics, motor size, assumed crew sizes, and productivities for pump and motor removal and installation. Due to limited access and/or confined maneuvering conditions at the various pump stations the estimator assumed the use of lifting equipment as necessary to perform the removal, moving, loading, unloading, and installation work.

Pricing to modify existing levee and closure structures were created mainly from developing a work breakdown structure for each scope of work and applying appropriate M2 Cost Book CSI tasks with quantities and appropriate markups.

Cost sources
Used the 2016 Cost Book - English. Revised material costs, per quotes received and or production rates as appropriate per estimator's judgment.

Wage Rates
The cost estimate includes labor rates per Heavy & Highway decision no. KY20190072 02/01/2019, and Building decision no. KY190093 dated 02/01/2019 for Jefferson, KY.

Equipment
2016 MII Equipment 2016 Region 02 library Region 2.

Material
2016 Cost Book – English. Revised material costs, per quotes received for the major and/or various item s as noted in the estimate costs items.

All costs identified Feature 01 - Lands and Damages are total costs to owner including contingency, provided by LRL Real Estate Division. No contractor assigned.

Project PED was discussed with the PDT. PED, including support during construction, was estimated at $13,625,730, plus contingency.

Construction Management (S&A) was discussed with the PDT and estimated at 5% of construction costs, plus contingency.

1.3. Schedule

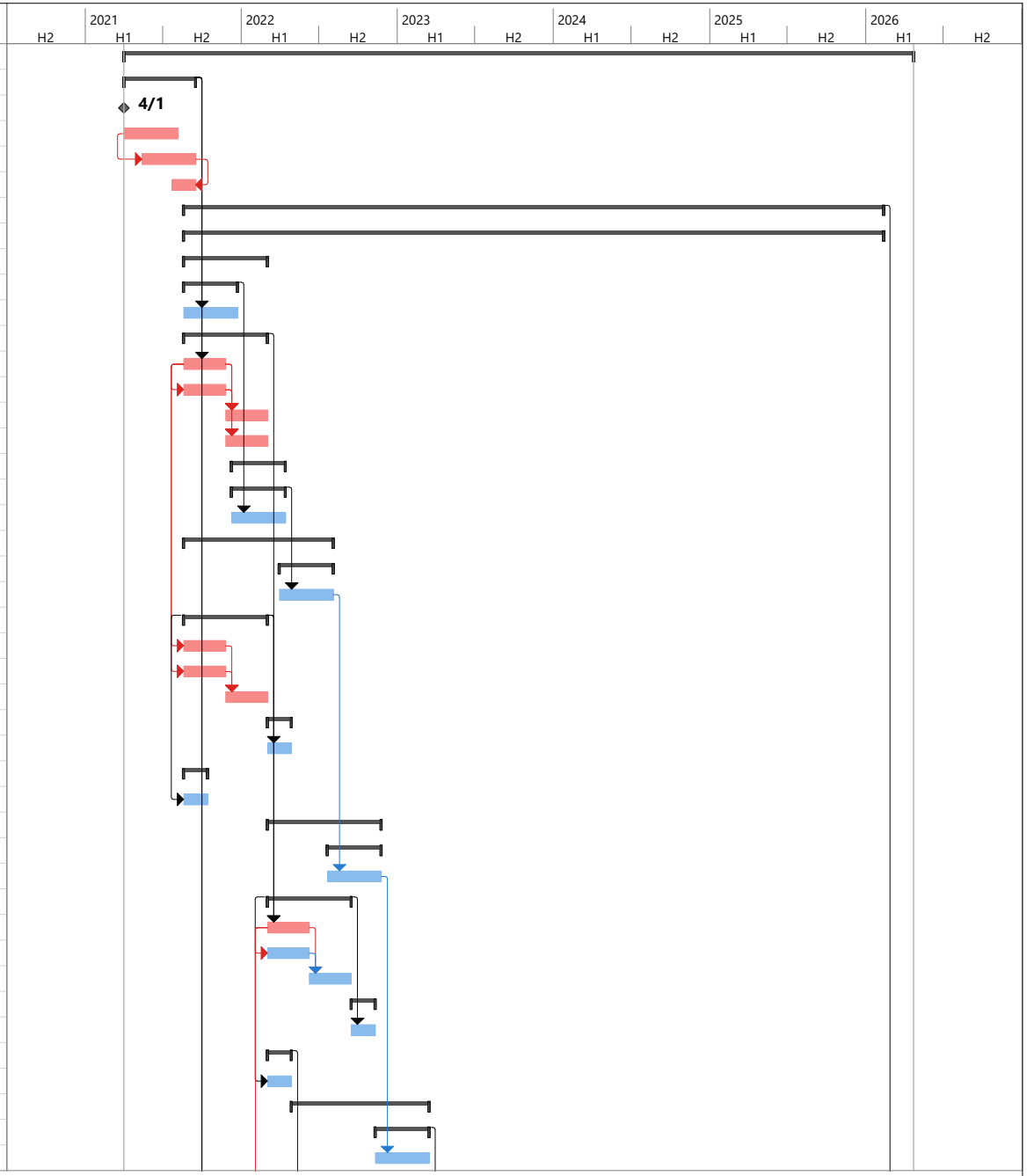
The construction schedule assumes that work, specifically to the pump stations, will be staggered to accommodate requirements of operation during in, and off, flood season time periods. This, and the duration of the work to the pump stations, will cause the pump station work to be the critical path of the construction schedule. Coordination with Louisville MSD will be necessary to further develop a detailed construction schedule including station sequencing, number of pumps allowed to be out-of-service, etc.

Through discussions with the PDT it was determined that an assumed overall construction schedule of five (5) years should be assumed.

A detailed construction schedule was developed utilizing software such as Microsoft Project with the following project-specific assumptions:

- Two(2) pumps will be rebuilt at two(2) different pump station at a time.
- Electrical and Controls work will be performed in sequence by pump station, staggered by approximately two(2) weeks.
- Discharge pipe repair / replacement work will be performed in sequence by pump station, staggered by approximately two(2) weeks.
- Discharge pipe repair / replacement work will be performed following the start of pump rebuilds (Start-to-Start) at each station.
- Work to repair/replace/add lubrication will follow the completion of the pump rebuild work for each station.

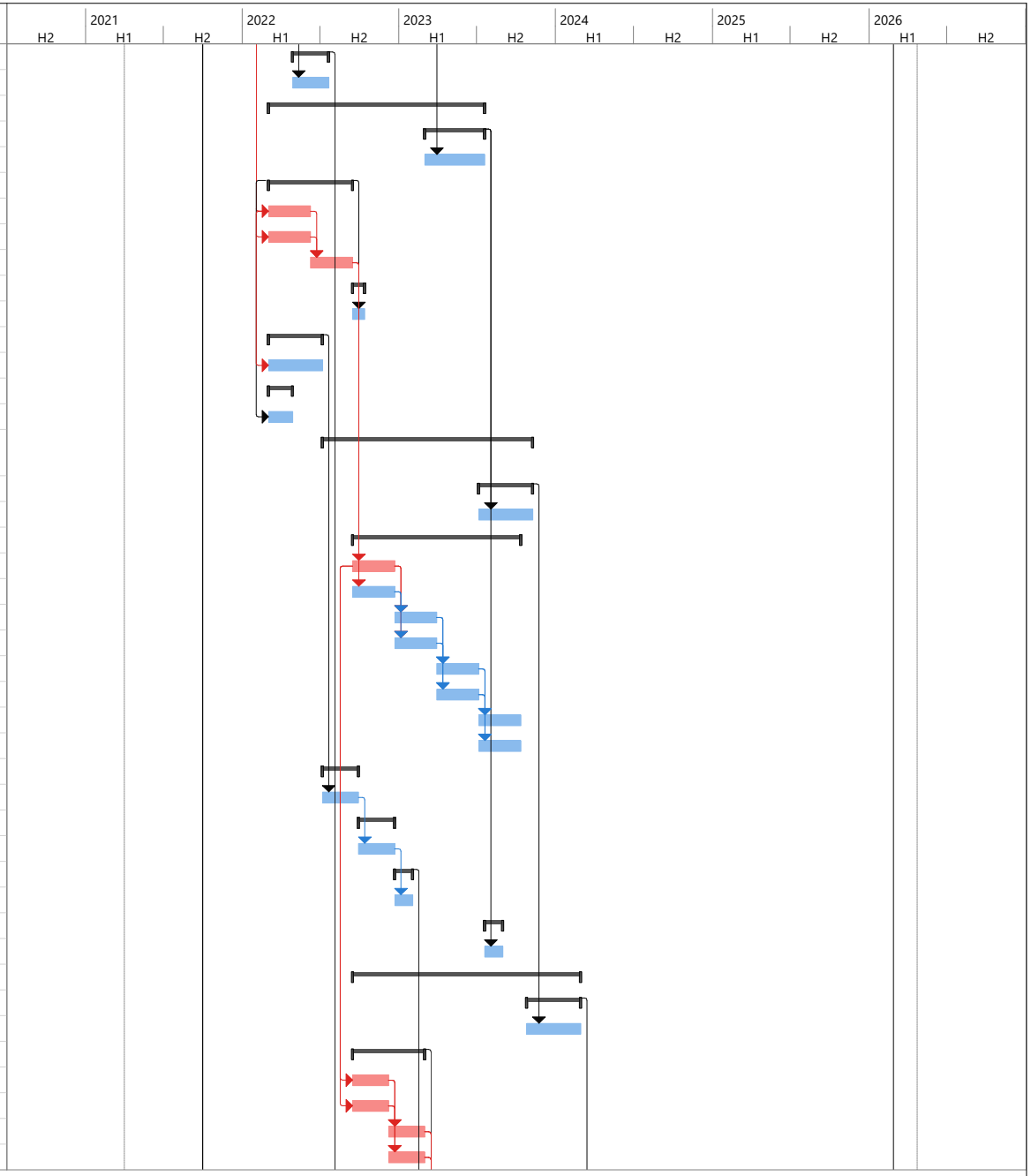
ID		Task Name	Duration	Start	Finish	Predecessors
1		**Construction Schedule**	**1320 days**	**Thu 4/1/21**	**Wed 4/22/26**	
2		**Preconstruction Phase**	**120 days**	**Thu 4/1/21**	**Wed 9/15/21**	
3		Notice to Proceed	0 days	Thu 4/1/21	Thu 4/1/21	
4		Generate Contractor Submi	90 days	Thu 4/1/21	Wed 8/4/21	
5		Review Submittals	90 days	Thu 5/13/21	Wed 9/15/21	4SS+30 days
6		Approve Submittals	40 days	Thu 7/22/21	Wed 9/15/21	5FF
7		**Construction Phase**	**1170 days**	**Thu 8/19/21**	**Wed 2/11/26**	
8		**Pump Stations**	**1170 days**	**Thu 8/19/21**	**Wed 2/11/26**	
9		**Starkey Pump Station**	**140 days**	**Thu 8/19/21**	**Wed 3/2/22**	
10		**Electrical and Control**	**90 days**	**Thu 8/19/21**	**Wed 12/22/2**	
11		Electrical and Contr	90 days	Thu 8/19/21	Wed 12/22/2	2FS-20 days
12		**Pump Rebuild**	**140 days**	**Thu 8/19/21**	**Wed 3/2/22**	
13		Pump 1 Rebuild	70 days	Thu 8/19/21	Wed 11/24/2	2FS-20 days
14		Pump 2 Rebuild	70 days	Thu 8/19/21	Wed 11/24/2	13SS
15		Pump 3 Rebuild	70 days	Thu 11/25/21	Wed 3/2/22	13,14
16		Pump 4 Rebuild	70 days	Thu 11/25/21	Wed 3/2/22	13,14
17		**Western Pump Station**	**90 days**	**Thu 12/9/21**	**Wed 4/13/22**	
18		**Electrical and Control**	**90 days**	**Thu 12/9/21**	**Wed 4/13/22**	
19		Electrical and Contr	90 days	Thu 12/9/21	Wed 4/13/22	10FS-10 days
20		**Upper Mill Pump Statior**	**250 days**	**Thu 8/19/21**	**Wed 8/3/22**	
21		**Electrical and Control**	**90 days**	**Thu 3/31/22**	**Wed 8/3/22**	
22		Electrical and Contr	90 days	Thu 3/31/22	Wed 8/3/22	18FS-10 days
23		**Pump Rebuild**	**140 days**	**Thu 8/19/21**	**Wed 3/2/22**	
24		Pump 1 Rebuild	70 days	Thu 8/19/21	Wed 11/24/2	13SS
25		Pump 2 Rebuild	70 days	Thu 8/19/21	Wed 11/24/2	13SS
26		Pump 3 Rebuild	70 days	Thu 11/25/21	Wed 3/2/22	24,25
27		**Lubrication System**	**40 days**	**Thu 3/3/22**	**Wed 4/27/22**	
28		Lubrication System	40 days	Thu 3/3/22	Wed 4/27/22	23
29		**Discharge Pipe Repair**	**40 days**	**Thu 8/19/21**	**Wed 10/13/2**	
30		Discharge Pipe Repa	40 days	Thu 8/19/21	Wed 10/13/2	23SS
31		**Lower Mill Pump Statior**	**190 days**	**Thu 3/3/22**	**Wed 11/23/2**	
32		**Electrical and Control**	**90 days**	**Thu 7/21/22**	**Wed 11/23/2**	
33		Electrical and Contr	90 days	Thu 7/21/22	Wed 11/23/2	2FS-10 days
34		**Pump Rebuild**	**140 days**	**Thu 3/3/22**	**Wed 9/14/22**	
35		Pump 1 Rebuild	70 days	Thu 3/3/22	Wed 6/8/22	23,12
36		Pump 2 Rebuild	70 days	Thu 3/3/22	Wed 6/8/22	35SS
37		Pump 3 Rebuild	70 days	Thu 6/9/22	Wed 9/14/22	35,36
38		**Lubrication System**	**40 days**	**Thu 9/15/22**	**Wed 11/9/22**	
39		Lubrication System	40 days	Thu 9/15/22	Wed 11/9/22	34
40		**Discharge Pipe Repair**	**40 days**	**Thu 3/3/22**	**Wed 4/27/22**	
41		Discharge Pipe Repa	40 days	Thu 3/3/22	Wed 4/27/22	34SS
42		**Riverport Pump Station**	**230 days**	**Thu 4/28/22**	**Wed 3/15/23**	
43		**Electrical and Control**	**90 days**	**Thu 11/10/2**	**Wed 3/15/23**	
44		Electrical and Contr	90 days	Thu 11/10/22	Wed 3/15/23	33FS-10 days



Project: Louisville Metro Feasib
Date: Tue 10/29/19

Task		Inactive Task		Manual Summary Rollup		External Milestone		Manual Progress	
Split		Inactive Milestone		Manual Summary		Deadline			
Milestone		Inactive Summary		Start-only		Critical			
Summary		Manual Task		Finish-only		Critical Split			
Project Summary		Duration-only		External Tasks		Progress			

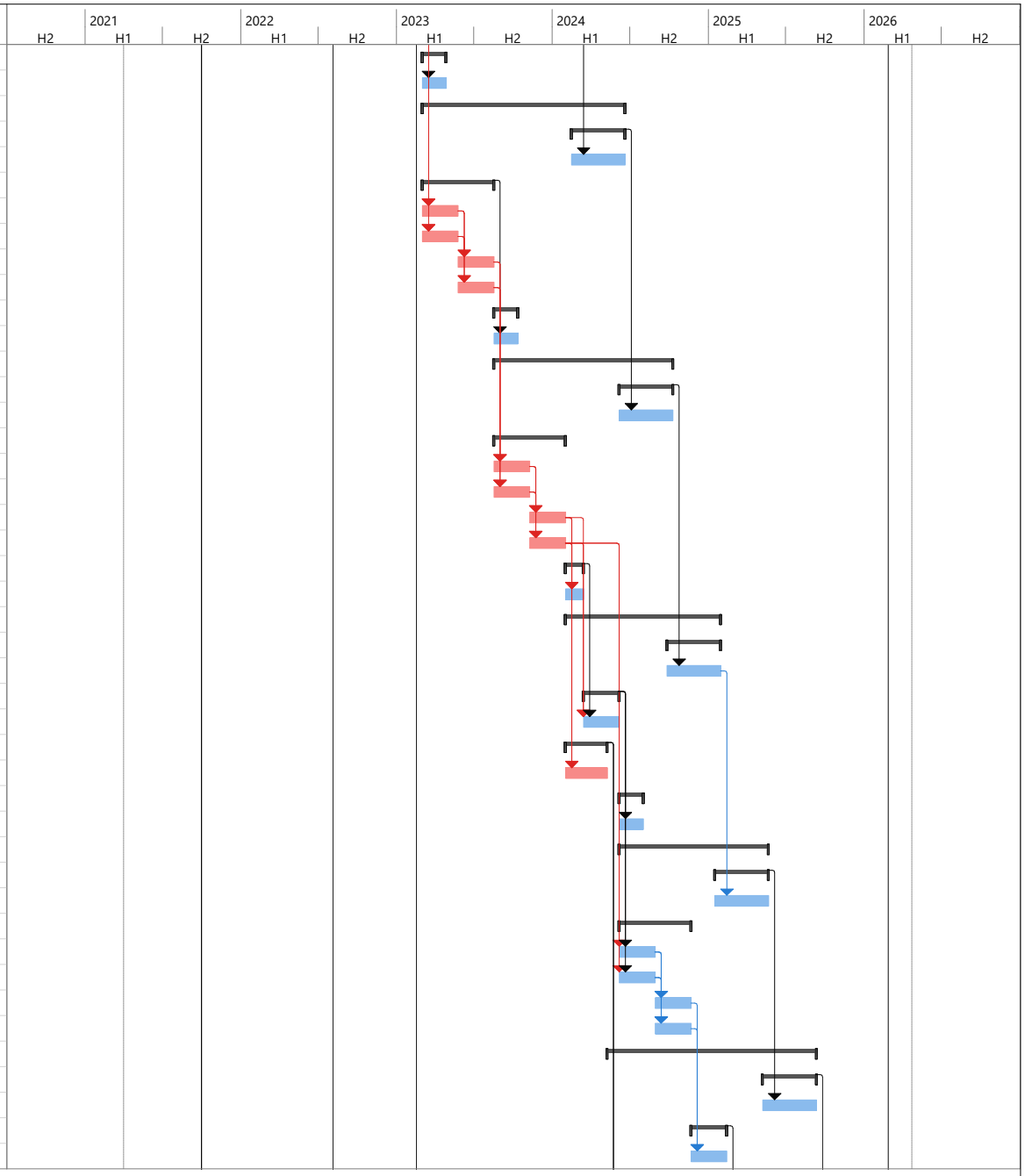
ID		Task Name	Duration	Start	Finish	Predecessors
45		**Discharge Pipe Repair**	**60 days**	**Thu 4/28/22**	**Wed 7/20/22**	
46		Discharge Pipe Repa	60 days	Thu 4/28/22	Wed 7/20/22	40
47		**Pond Creek Pump Statio**	**360 days**	**Thu 3/3/22**	**Wed 7/19/23**	
48		**Electrical and Control**	**100 days**	**Thu 3/2/23**	**Wed 7/19/23**	
49		Electrical and Contr	100 days	Thu 3/2/23	Wed 7/19/23	43FS-10 days
50		**Pump Rebuild**	**140 days**	**Thu 3/3/22**	**Wed 9/14/22**	
51		Pump 1 Rebuild	70 days	Thu 3/3/22	Wed 6/8/22	35SS
52		Pump 2 Rebuild	70 days	Thu 3/3/22	Wed 6/8/22	35SS
53		Pump 3 Rebuild	70 days	Thu 6/9/22	Wed 9/14/22	51,52
54		**Vibration Sensors**	**20 days**	**Thu 9/15/22**	**Wed 10/12/2**	
55		Vibration Sensors	20 days	Thu 9/15/22	Wed 10/12/2	50
56		**Formed Suction Intak**	**90 days**	**Thu 3/3/22**	**Wed 7/6/22**	
57		Formed Suction Int	90 days	Thu 3/3/22	Wed 7/6/22	51SS
58		**Repair Water Service**	**40 days**	**Thu 3/3/22**	**Wed 4/27/22**	
59		Repair Water Servic	40 days	Thu 3/3/22	Wed 4/27/22	50SS
60		**Beargrass Creek Pump Station**	**350 days**	**Thu 7/7/22**	**Wed 11/8/23**	
61		**Electrical and Control**	**90 days**	**Thu 7/6/23**	**Wed 11/8/23**	
62		Electrical and Contr	90 days	Thu 7/6/23	Wed 11/8/23	48FS-10 days
63		**Pump Rebuild**	**280 days**	**Thu 9/15/22**	**Wed 10/11/2**	
64		Pump 1 Rebuild	70 days	Thu 9/15/22	Wed 12/21/2	53
65		Pump 2 Rebuild	70 days	Thu 9/15/22	Wed 12/21/2	53
66		Pump 3 Rebuild	70 days	Thu 12/22/22	Wed 3/29/23	64,65
67		Pump 4 Rebuild	70 days	Thu 12/22/22	Wed 3/29/23	65,64
68		Pump 5 Rebuild	70 days	Thu 3/30/23	Wed 7/5/23	66,67
69		Pump 6 Rebuild	70 days	Thu 3/30/23	Wed 7/5/23	67,66
70		Pump 7 Rebuild	70 days	Thu 7/6/23	Wed 10/11/2	68,69
71		Pump 8 Rebuild	70 days	Thu 7/6/23	Wed 10/11/2	69,68
72		**Trash Rake**	**60 days**	**Thu 7/7/22**	**Wed 9/28/22**	
73		Trash Rake	60 days	Thu 7/7/22	Wed 9/28/22	56
74		**Gate Operation**	**60 days**	**Thu 9/29/22**	**Wed 12/21/2**	
75		Gate Operation	60 days	Thu 9/29/22	Wed 12/21/2	73
76		**New Stairs**	**30 days**	**Thu 12/22/2**	**Wed 2/1/23**	
77		New Stairs	30 days	Thu 12/22/22	Wed 2/1/23	75
78		**New Transducers**	**30 days**	**Thu 7/20/23**	**Wed 8/30/23**	
79		New Transducers	30 days	Thu 7/20/23	Wed 8/30/23	48
80		**5th Street Pump Station**	**380 days**	**Thu 9/15/22**	**Wed 2/28/24**	
81		**Electrical and Control**	**90 days**	**Thu 10/26/2**	**Wed 2/28/24**	
82		Electrical and Contr	90 days	Thu 10/26/2	Wed 2/28/24	61FS-10 days
83		**New Submersible Pun**	**120 days**	**Thu 9/15/22**	**Wed 3/1/23**	
84		New Submersible P	60 days	Thu 9/15/22	Wed 12/7/22	64SS
85		New Submersible P	60 days	Thu 9/15/22	Wed 12/7/22	64SS
86		New Submersible P	60 days	Thu 12/8/22	Wed 3/1/23	84,85
87		New Submersible P	60 days	Thu 12/8/22	Wed 3/1/23	85,84



Project: Louisville Metro Feasib
Date: Tue 10/29/19

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Critical | Critical Split | Progress | Manual Progress

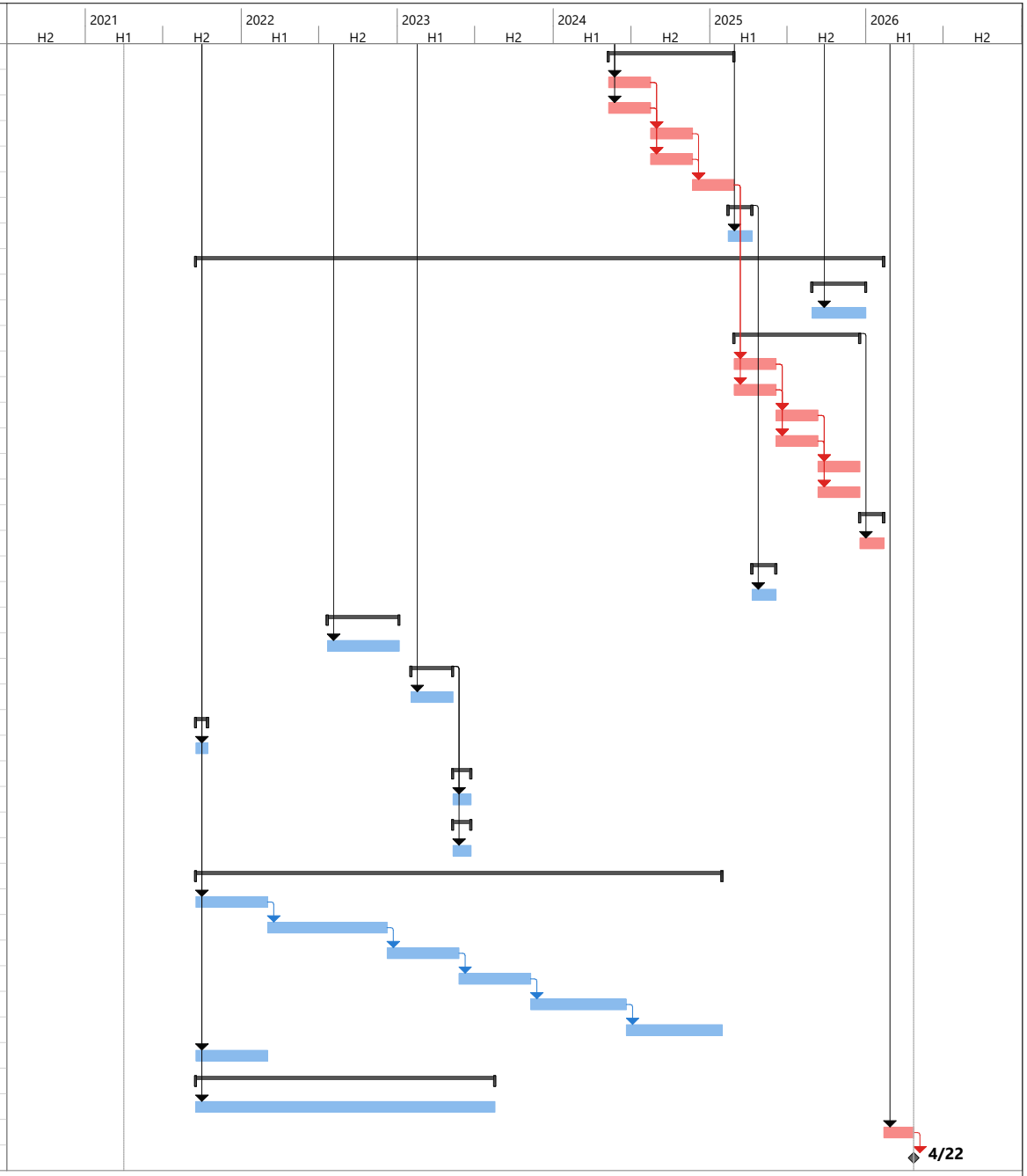
ID	Task Name	Duration	Start	Finish	Predecessors
88	**Piping and Valves**	**40 days**	**Thu 3/2/23**	**Wed 4/26/23**	
89	Piping and Valves	40 days	Thu 3/2/23	Wed 4/26/23	83
90	**10th Street Pump Statio**	**340 days**	**Thu 3/2/23**	**Wed 6/19/24**	
91	**Electrical and Control**	**90 days**	**Thu 2/15/24**	**Wed 6/19/24**	
92	Electrical and Contr	90 days	Thu 2/15/24	Wed 6/19/24	81FS-10 days
93	**New Submersible Pun**	**120 days**	**Thu 3/2/23**	**Wed 8/16/23**	
94	New Submersible P	60 days	Thu 3/2/23	Wed 5/24/23	87,86
95	New Submersible P	60 days	Thu 3/2/23	Wed 5/24/23	87,86
96	New Submersible P	60 days	Thu 5/25/23	Wed 8/16/23	94,95
97	New Submersible P	60 days	Thu 5/25/23	Wed 8/16/23	95,94
98	**Piping and Valves**	**40 days**	**Thu 8/17/23**	**Wed 10/11/2**	
99	Piping and Valves	40 days	Thu 8/17/23	Wed 10/11/23	93
100	**17th Street Pump Statio**	**300 days**	**Thu 8/17/23**	**Wed 10/9/24**	
101	**Electrical and Control**	**90 days**	**Thu 6/6/24**	**Wed 10/9/24**	
102	Electrical and Contr	90 days	Thu 6/6/24	Wed 10/9/24	91FS-10 days
103	**New Submersible Pun**	**120 days**	**Thu 8/17/23**	**Wed 1/31/24**	
104	New Submersible P	60 days	Thu 8/17/23	Wed 11/8/23	96,97
105	New Submersible P	60 days	Thu 8/17/23	Wed 11/8/23	96,97
106	New Submersible P	60 days	Thu 11/9/23	Wed 1/31/24	104,105
107	New Submersible P	60 days	Thu 11/9/23	Wed 1/31/24	104,105
108	**New Sump Pump**	**30 days**	**Thu 2/1/24**	**Wed 3/13/24**	
109	New Sump Pump	30 days	Thu 2/1/24	Wed 3/13/24	106,107
110	**27th Street Pump Statio**	**260 days**	**Thu 2/1/24**	**Wed 1/29/25**	
111	**Electrical and Control**	**90 days**	**Thu 9/26/24**	**Wed 1/29/25**	
112	Electrical and Contr	90 days	Thu 9/26/24	Wed 1/29/25	101FS-10 days
113	**New Submersible Pun**	**60 days**	**Thu 3/14/24**	**Wed 6/5/24**	
114	New Submersible P	60 days	Thu 3/14/24	Wed 6/5/24	106,107,108
115	**Pump Rebuild**	**70 days**	**Thu 2/1/24**	**Wed 5/8/24**	
116	Pump 1 Rebuild	70 days	Thu 2/1/24	Wed 5/8/24	106,107
117	**Piping and Valves**	**40 days**	**Thu 6/6/24**	**Wed 7/31/24**	
118	Piping and Valves	40 days	Thu 6/6/24	Wed 7/31/24	113
119	**34th Street Pump Statio**	**250 days**	**Thu 6/6/24**	**Wed 5/21/25**	
120	**Electrical and Control**	**90 days**	**Thu 1/16/25**	**Wed 5/21/25**	
121	Electrical and Contr	90 days	Thu 1/16/25	Wed 5/21/25	112FS-10 days
122	**New Submersible Pun**	**120 days**	**Thu 6/6/24**	**Wed 11/20/2**	
123	New Submersible P	60 days	Thu 6/6/24	Wed 8/28/24	113,107
124	New Submersible P	60 days	Thu 6/6/24	Wed 8/28/24	113,107
125	New Submersible P	60 days	Thu 8/29/24	Wed 11/20/2	123,124
126	New Submersible P	60 days	Thu 8/29/24	Wed 11/20/2	123,124
127	**Shawnee Pump Station**	**350 days**	**Thu 5/9/24**	**Wed 9/10/25**	
128	**Electrical and Control**	**90 days**	**Thu 5/8/25**	**Wed 9/10/25**	
129	Electrical and Contr	90 days	Thu 5/8/25	Wed 9/10/25	120FS-10 days
130	**New Submersible Pun**	**60 days**	**Thu 11/21/2**	**Wed 2/12/25**	
131	New Submersible P	60 days	Thu 11/21/2	Wed 2/12/25	125,126



Project: Louisville Metro Feasib
Date: Tue 10/29/19

Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Critical
Critical Split
Progress
Manual Progress

ID	Task Name	Duration	Start	Finish	Predecessors
132	**Pump Rebuild**	**210 days**	**Thu 5/9/24**	**Wed 2/26/25**	
133	Pump 1 Rebuild	70 days	Thu 5/9/24	Wed 8/14/24	115
134	Pump 2 Rebuild	70 days	Thu 5/9/24	Wed 8/14/24	115
135	Pump 3 Rebuild	70 days	Thu 8/15/24	Wed 11/20/2	133,134
136	Pump 4 Rebuild	70 days	Thu 8/15/24	Wed 11/20/2	133,134
137	Pump 5 Rebuild	70 days	Thu 11/21/24	Wed 2/26/25	135,136
138	**Piping and Valves**	**40 days**	**Thu 2/13/25**	**Wed 4/9/25**	
139	Piping and Valves	40 days	Thu 2/13/25	Wed 4/9/25	130
140	**Paddy's Run Pump Static**	**1150 days**	**Thu 9/16/21**	**Wed 2/11/26**	
141	**Electrical and Control**	**90 days**	**Thu 8/28/25**	**Wed 12/31/2**	
142	Electrical and Contr	90 days	Thu 8/28/25	Wed 12/31/2	128FS-10 days
143	**Pump Rebuild**	**210 days**	**Thu 2/27/25**	**Wed 12/17/2**	
144	Pump 1 Rebuild	70 days	Thu 2/27/25	Wed 6/4/25	137
145	Pump 2 Rebuild	70 days	Thu 2/27/25	Wed 6/4/25	137
146	Pump 3 Rebuild	70 days	Thu 6/5/25	Wed 9/10/25	144,145
147	Pump 4 Rebuild	70 days	Thu 6/5/25	Wed 9/10/25	144,145
148	Pump 5 Rebuild	70 days	Thu 9/11/25	Wed 12/17/2	146,147
149	Pump 6 Rebuild	70 days	Thu 9/11/25	Wed 12/17/2	146,147
150	**Lubrication System**	**40 days**	**Thu 12/18/2**	**Wed 2/11/26**	
151	Lubrication System	40 days	Thu 12/18/25	Wed 2/11/26	143
152	**Trash Rake**	**40 days**	**Thu 4/10/25**	**Wed 6/4/25**	
153	Trash Rake	40 days	Thu 4/10/25	Wed 6/4/25	138
154	**Discharge Pipe Repair**	**120 days**	**Thu 7/21/22**	**Wed 1/4/23**	
155	Discharge Pipe Repa	120 days	Thu 7/21/22	Wed 1/4/23	45
156	**Structural Repairs**	**70 days**	**Thu 2/2/23**	**Wed 5/10/23**	
157	Structural Repairs	70 days	Thu 2/2/23	Wed 5/10/23	76
158	**Roof Repairs**	**20 days**	**Thu 9/16/21**	**Wed 10/13/2**	
159	Roof Repairs	20 days	Thu 9/16/21	Wed 10/13/2	2
160	**New Stairs**	**30 days**	**Thu 5/11/23**	**Wed 6/21/23**	
161	New Stairs	30 days	Thu 5/11/23	Wed 6/21/23	156
162	**Replace Bridge Crane**	**30 days**	**Thu 5/11/23**	**Wed 6/21/23**	
163	Replace Bridge Cran	30 days	Thu 5/11/23	Wed 6/21/23	156
164	**Levees and Floodwalls**	**880 days**	**Thu 9/16/21**	**Wed 1/29/25**	
165	Canal Station Floodwall	120 days	Thu 9/16/21	Wed 3/2/22	2
166	27th Street Closure	200 days	Thu 3/3/22	Wed 12/7/22	165
167	10th Street Concrete Clo	120 days	Thu 12/8/22	Wed 5/24/23	166
168	Pond Creek Wall	120 days	Thu 5/25/23	Wed 11/8/23	167
169	Butchertown T Wall	160 days	Thu 11/9/23	Wed 6/19/24	168
170	Johnsontown Road Closu	160 days	Thu 6/20/24	Wed 1/29/25	169
171	Repair Waterstops	120 days	Thu 9/16/21	Wed 3/2/22	2
172	**Sluice Gates**	**500 days**	**Thu 9/16/21**	**Wed 8/16/23**	
173	Sluice Gates	500 days	Thu 9/16/21	Wed 8/16/23	2
174	Project Closeout	50 days	Thu 2/12/26	Wed 4/22/26	7
175	Project Complete	0 days	Wed 4/22/26	Wed 4/22/26	174



Project: Louisville Metro Feasib
Date: Tue 10/29/19

Task		Inactive Task		Manual Summary Rollup		External Milestone		Manual Progress	
Split		Inactive Milestone		Manual Summary		Deadline			
Milestone		Inactive Summary		Start-only		Critical			
Summary		Manual Task		Finish-only		Critical Split			
Project Summary		Duration-only		External Tasks		Progress			

1.4. Total Project Cost Summary (TPCS)

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **Louisville Metro**
PROJECT NO: **456975**
LOCATION: **Jefferson County, KY**

DISTRICT: **LRL**
PREPARED: **10/29/2019**
POC: **CHIEF, COST ENGINEERING, Jim Vermillion**

This Estimate reflects the scope and schedule in report; Report Name and date

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
							Program Year (Budget EC):			2020					
							Effective Price Level Date:			1-Oct- 19					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	REMAINING COST ($K)	Spent Thru: 1-Oct-15 ($K)	TOTAL FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
11	LEVEES & FLOODWALLS	$20,783	$4,364	21%	$25,147		$20,783	$4,364	$25,147		$25,147	8.8%	$22,610	$4,748	$27,358
13	PUMPING PLANT	$100,538	$21,113	21%	$121,651		$100,538	$21,113	$121,651		$121,651	8.8%	$109,374	$22,969	$132,343
18	CULTURAL RESOURCE PRESERVATION	$100	$21	21%	$121		$100	$21	$121		$121	3.0%	$103	$22	$125
			-			-						-			
	CONSTRUCTION ESTIMATE TOTALS:	$121,421	$25,498		$146,919		$121,421	$25,498	$146,919		$146,919	8.8%	$132,087	$27,738	$159,825
01	LANDS AND DAMAGES	$104	$26	25%	$130		$104	$26	$130		$130	3.0%	$107	$27	$134
30	PLANNING, ENGINEERING & DESIGN	$11,031	$2,317	21%	$13,348		$11,031	$2,317	$13,348		$13,348	7.6%	$11,873	$2,493	$14,366
31	CONSTRUCTION MANAGEMENT	$6,071	$1,275	21%	$7,346		$6,071	$1,275	$7,346		$7,346	18.7%	$7,209	$1,514	$8,723
	PROJECT COST TOTALS:	$138,627	$29,116	21%	$167,743		$138,627	$29,116	$167,743		**$167,743**	9.1%	$151,275	$31,772	$183,048

CHIEF, COST ENGINEERING, Jim Vermillion

PROJECT MANAGER, Wil Ailstock & Nate Moulder

CHIEF, REAL ESTATE, Veronica Hiriams

CHIEF, PLANNING, Amy Babey

CHIEF, ENGINEERING, John Bock

CHIEF, OPERATIONS, Tim Fudge

CHIEF, CONSTRUCTION, Kevin Jefferson

CHIEF, CONTRACTING, Denise Bush

CHIEF, RM, Vicki Vasquez

CHIEF, DPM, Linda Murphy

ESTIMATED TOTAL PROJECT COST:		**$183,048**
ESTIMATED FEDERAL COST:	65%	$118,981
ESTIMATED NON-FEDERAL COST:	35%	$64,067
22 - FEASIBILITY STUDY:		**$2,072**
ESTIMATED FEDERAL COST:	50%	$1,036
ESTIMATED NON-FEDERAL COST:	50%	$1,036
ESTIMATED FEDERAL COST OF PROJECT		**$120,017**

Filename: CAP Example TPCS Sep 2017 r1.xlsx
TPCS

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: Louisville Metro
LOCATION: Jefferson County, KY
This Estimate reflects the scope and schedule in report; Report Name and date

DISTRICT: LRL
POC: CHIEF, COST ENGINEERING, Jim Vermillion
PREPARED: 10/29/2019

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			6-May-16	Program Year (Budget EC):			2020					
		Estimate Price Level:			1-Oct-19	Effective Price Level Date:			1 -Oct-19					
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 1 or CONTRACT 1													
11	LEVEES & FLOODWALLS	$20,783	$4,364	21.0%	$25,147		$20,783	$4,364	$25,147	2024Q2	8.8%	$22,610	$4,748	$27,358
13	PUMPING PLANTS	$100,538	$21,113	21.0%	$121,651		$100,538	$21,113	$121,651	2024Q2	8.8%	$109,374	$22,969	$132,343
18	CULTURAL RESOURCE PRESERVATION	$100	$21	21.0%	$121		$100	$21	$121	2021Q3	3.0%	$103	$22	$125
	CONSTRUCTION ESTIMATE TOTALS:	$121,421	$25,498	21.0%	$146,919		$121,421	$25,498	$146,919			$132,087	$27,738	$159,825
01	LANDS AND DAMAGES	$104	$26	25.0%	$130		$104	$26	$130	2021Q3	3.0%	$107	$27	$134
30	PLANNING, ENGINEERING & DESIGN													
3.0%	Project Management	$792	$166	21.0%	$958		$792	$166	$958	2021Q1	4.1%	$825	$173	$998
1.0%	Planning & Environmental Compliance			21.0%										
15.0%	Engineering & Design	$6,327	$1,329	21.0%	$7,656		$6,327	$1,329	$7,656	2021Q1	4.1%	$6,588	$1,383	$7,971
1.0%	Reviews, ATRs, IEPRs, VE	$238	$50	21.0%	$288		$238	$50	$288	2021Q1	4.1%	$248	$52	$300
1.0%	Life Cycle Updates (cost, schedule, risks)			21.0%										
1.0%	Contracting & Reprographics			21.0%										
3.0%	Engineering During Construction	$2,645	$555	21.0%	$3,200		$2,645	$555	$3,200	2024Q2	18.7%	$3,141	$660	$3,800
2.0%	Planning During Construction	$1,029	$216	21.0%	$1,245		$1,029	$216	$1,245	2021Q1	4.1%	$1,071	$225	$1,296
3.0%	Adaptive Management & Monitoring			21.0%										
1.0%	Project Operations			21.0%										
31	CONSTRUCTION MANAGEMENT													
5.0%	Construction Management	$6,071	$1,275	21.0%	$7,346		$6,071	$1,275	$7,346	2024Q2	18.7%	$7,209	$1,514	$8,723
	Project Operation:			21.0%										
	Project Management			21.0%										
	CONTRACT COST TOTALS:	$138,627	$29,116		$167,743		$138,627	$29,116	**$167,743**			$151,275	$31,772	**$183,048**

1.5. Cost and Schedule Risk Analysis

Project Development Stage/Alternative: Feasibility (Alternatives) - For Milestone #1

Risk Category: Low Risk: Simple Project-No Life Safety

Meeting Date: 7/22/2019

Schedule Duration: Aug-2021 (From (Month/Year)) – Sep-2021 (From (Month/Year)) **Schedule Duration:** 60.0 Months; 0% Schedule Contingency

80% Finish Date: Sep-2021

	CWWBS	Feature of Work	Contract Cost	% Contingency	$ Contingency	Total
	Risk Not included within CSRA Model					
	01 LANDS AND DAMAGES	Real Estate	$ 104,000	25%	$ 26,000	$ 130,000
	Risk included within CSRA Model					
1	13 PUMPING PLANT	Starkey FPS	$ 4,451,239.00	21%	$ 934,760	$ 5,385,999
2	13 PUMPING PLANT	Western FPS	$ 1,504,493.00	21%	$ 315,944	$ 1,820,437
3	13 PUMPING PLANT	Upper Mill FPS	$ 9,723,367.00	21%	$ 2,041,907	$ 11,765,274
4	13 PUMPING PLANT	Lower Mill FPS	$ 4,425,872.00	21%	$ 929,433	$ 5,355,305
5	13 PUMPING PLANT	Riverport FPS	$ 1,726,883.00	21%	$ 362,645	$ 2,089,528
6	13 PUMPING PLANT	Pond Creek FPS	$ 19,623,926.00	21%	$ 4,121,024	$ 23,744,950
7	13 PUMPING PLANT	Beargrass Creek FPS	$ 20,354,721.00	21%	$ 4,274,491	$ 24,629,212
8	13 PUMPING PLANT	Fourth Street FPS	$ -	0%	$ -	$ -
9	13 PUMPING PLANT	Fifth Street FPS	$ 1,784,861.00	21%	$ 374,821	$ 2,159,682
10	13 PUMPING PLANT	Tenth Street FPS	$ 2,709,678.00	21%	$ 569,032	$ 3,278,710
11	13 PUMPING PLANT	Seventeenth Street FPS	$ 1,739,866.00	21%	$ 365,372	$ 2,105,238
12	13 PUMPING PLANT	Twenty Seventh Street FPS	$ 4,706,064.00	21%	$ 988,273	$ 5,694,337
13	13 PUMPING PLANT	Thirty Fourth Street FPS	$ 2,323,848.00	21%	$ 488,008	$ 2,811,856
14	13 PUMPING PLANT	Shawnee Park FPS	$ 9,958,754.00	21%	$ 2,091,338	$ 12,050,092
15	13 PUMPING PLANT	Paddy's Run FPS Remodel	$ 15,504,552.00	21%	$ 3,255,956	$ 18,760,508
16	11 LEVEES AND FLOODWALLS	Canal Station Floodwall	$ 1,195,112.00	21%	$ 250,974	$ 1,446,086
17	11 LEVEES AND FLOODWALLS	27th Street Closure	$ 443,473.00	21%	$ 93,129	$ 536,602
18	11 LEVEES AND FLOODWALLS	10th St. Swing Gate Concrete Closure	$ 181,278.00	21%	$ 38,068	$ 219,346
19	11 LEVEES AND FLOODWALLS	Pond Creek Wall	$ 349,768.00	21%	$ 73,451	$ 423,219
20	11 LEVEES AND FLOODWALLS	Butchertown T Wall	$ 928,479.00	21%	$ 194,981	$ 1,123,460
21	11 LEVEES AND FLOODWALLS	Johnsontown Road Closure	$ 61,151.00	21%	$ 12,842	$ 73,993
22	11 LEVEES AND FLOODWALLS	Repair Waterstops	$ 581,720.00	21%	$ 122,161	$ 703,881
23	11 LEVEES AND FLOODWALLS	Sluice Gates	$ 17,041,687.00	21%	$ 3,578,754	$ 20,620,441
24	18 CULTURAL RESOURCE PRESERVATION	Mitigation	$ 100,000	21%	$ 21,000	$ 121,000
25	All Other	Remaining Construction Items	$ -	0%	$ -	$ -
26	30 PLANNING, ENGINEERING, AND DESIGN	Planning, Engineering, & Design	$ 11,030,730	21%	$ 2,316,453	$ 13,347,183
27	31 CONSTRUCTION MANAGEMENT	Construction Management	$ 6,071,000	21%	$ 1,274,910	$ 7,345,910
XX	FIXED DOLLAR RISK ADD (EQUALLY DISPERSED TO ALL, MUST INCLUDE JUSTIFICATION SEE BELOW)				$ -	

Totals					
Real Estate	$ 104,000	25%	$ 26,000	$ 130,000.00
Total Construction Estimate	$ 121,420,792	21%	$ 25,498,366	$ 146,919,158
Total Planning, Engineering & Design	$ 11,030,730	21%	$ 2,316,454	$ 13,347,184
Total Construction Management	$ 6,071,000	21%	$ 1,274,910	$ 7,345,910
Fixed Dollar Risk Equally Distributed	$ -	0%	$ -	$ -
Total	$ 138,626,522	21%	$ 29,115,730	$ 167,742,252

RISK RAGE ASSUMPTION DEVELOPMENT

Risk Matrix

Likelihood of Occurrence	Impact or Consequence of Occurrence: Negligible	Marginal	Moderate	Significant	Critical
Certain	RELOOK AT BASIS OF ESTIMATE				
Very Likely	Low	Medium	High	High	High
Likely	Low	Medium	Medium	High	High
Possible	Low	Low	Medium	Medium	High
Unlikely	Low	Low	Low	Medium	Medium

Likelihood of Occurrence Table

Any changes to these assumptions will change the assumptions in the models.

Likelihood	Low % Occurrence	High % Occurrence
Very Likely	70%	100%
Likely	30%	70%
Possible	5%	30%
Unlikely	0%	5%
Unrated		

Percent's above are based on 10 events, and are considered approximate, judgment should be used for final grouping dependent on # of occurrences, project size, flexibility and complexity.

If event occurrence	then it's likelihood is thought to be between…
Certain	Relook at Basis of Estimate
Very Likely	70% and 100%
Likely	30% and 70%
Possible	5% and 30%
Unlikely	0% and 5%

Likelihood of Occurrence Tables.

If an event is

Certain: implies the event has a 100% chance of occurrenc Relook at Basis of estimate.

Very Likely: implies the event has a 70% to 100% chance of occurrence.

Likely: implies the event has a 30% to 70% chance of occurrence.

Possible: implies the event has a 5% to 30% chance of occurrence.

Unlikely: implies the event has a 0% to 5% chance of occurrence.

Impact or Consequence of Occurrence

Any changes to these assumptions will change the assumptions in the models.

	% of Project Cost or Schedule Change	
	per Cost Event Exceeds	per Schedule Event Exceeds
Negligible	0.000%	2.000%
Marginal	0.500%	5.000%
Moderate	2.000%	10.000%
Significant	3.000%	15.000%
Critical	5.000%	20.000%

Percent's above are based on 10 events, and are considered approximate, judgment should be used for final grouping dependent on # of occurrences, project size, flexibility and complexity.

If event occurrence	then it's Impact to total project cost is thought to be between…
Negligible	0% and .5%
Marginal	.5% and 2%
Moderate	2% and 3.%
Significant	3.% and 5%
Critical	over 5%

Impact or Consequence of Occurrence

If an event is classified as....

Negligible: implies the event has a 0% to .5 impact to project cost..

Marginal: implies the event has a .5% to 2 impact to project cost.

Moderate: implies the event has a 2.% to 3 impact to project cost.

Significant: implies the event has a 3.% to 5 impact to project cost.

Critical: implies the event has a greater than 5% to impact to project cost.

Cost and Schedule Risk Analysis **LOUISVILLE METRO FPS**

Risk Facilitator Jay Thomas, USACE LRL

Risk Register Meeting

Date: 7/22/19 - 7/23/19

Attendance	Name	Office	Representing
Full	Tyler Canfield	USACE-LRL	Cost Engineering
Full	Wolfe Mill	Louisville MSD	Engineering
Full	Matthew Whelan	USACE-LRL	Geotechnical
Full	Nate Moulder	USACE-LRL	Planning
Full	Roger Dale Setters	USACE-LRL	Project Management / Planning
Full	Jake Allgeier	USACE-LRL	Hydraulics
Full	Jeff Timbas	USACE-LRL	Electrical Engineering
Full	BJ Evans	USACE-LRL	Structural Engineering
Full	Keenan Burns	USACE-LRL	Mechanical Engineering
Full	Richard Morrison	USACE-LRL	Electrical Engineering
Full	Barry Schueler	USACE-LRL	Project Management / Planning
Full	Josh Dickerson	Louisville MSD	Engineering
Full	Marc Thomas	Louisville MSD	Operations
7/22 Only	Dane Anderson	Louisville MSD	FPS Operations
Full	Will Ailstock	USACE-LRL	Project Management / Planning
Full	Junette Toe	USACE-LRL	Project Management
7/23 Only	Stephanie Lauglin	Louisville MSD	Engineering

Follow-Up Discussions - Individual or group discussions

Date: **through**

Attendance	Name	Office	Representing

Follow-Up Meeting Notes

PDT members supplied additional data based on the questions from the CSRA with regards to the following:

				Project Cost			Project Schedule			Other Information					Cost Model			Schedule Model			Cost due to Schedule Risk							
															COST			Schedule Model			Cost From Schedule			TOTAL Cost		TOTAL Schedule		
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood (I)	Impact (I)	Risk Level (I)	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Responsibility/ POC	Affected Project Component	Low Variance (Min)	Likely (C)	High Variance (80%H)	Low Variance (S) (Min)	Likely (S)	High Variance (S) (80%H)	Low Variance (CS) (Min)	Likely Added Cost (CS)	High Variance (CS) (80%H)	Event Prob (PC)	Simulated Cost (C) + (CS)	Event Prob (PS)	Simulated Sched (S)	Risk Quantification Discussions	Risk Mitigation Measures
Lands and Damages (LD)																												
LD1	Additional Easements may be needed.	Additional easement acquisition may be needed to perform work.	MSD does not possess easements on all closures. Additional easement acquisition may be necessary to perform work, or so that future O&M can be performed.	Unlikely	Marginal	Low	Certain	Negligible	Rebock at Basis of Schedule	Triangular				$0	$0	$500,000							100%	$0	100%	0 Mo	MSD does not possess easements on all closures. Additional easement acquisition may be necessary to perform work, or so that future O&M can be performed. Minimum assumed costs would be $0 with no easements needed, and maximum of $500MM. Likely that only 0.5% of maximum will be needed.	
Environmental and Regulatory																												
Contract Acquisition (CA)																												
CA1	Best value contract award	Current direction is for low-bid procurement. Possible other procurement methods may be utilized including best value / trade off approach.	Could impact the overall construction costs by 5-10%	Possible	Critical	High	Possible	Moderate	Medium	Triangular			Project Cost & Schedule	$0	$0	$10,000,000							100%	$0	100%	0 Mo	Current direction is for low-bid procurement. Possible other procurement methods may be utilized including best value / trade off approach. The team determined that approximately 5%, or $10MM, could be added to cost with a best value approach.	
Project & Program Management (PM)																												
PM1				Certain	Negligible	Rebock at Basis of Estimate	Certain	Negligible	Rebock at Basis of Schedule														100%	$0	100%	0 Mo		
Beargrass PS																												
BE1	Motor Refurbishment following inspection	Existing motors are >60year age and possibly could need refurbishment within the time period of this project.	Eight existing motors.	Very Likely	Significant	High	Very Likely	Marginal	Medium	Triangular			Project Cost & Schedule	$0	$0	$12,000,000							100%	$0	100%	0 Mo	Current Direction is to inspect motors during construction. It is anticipated that motor refurbishment will be needed following inspection. The possible minimal cost is $0 with no motors needed refurbishment, maximum is $12MM, with most likely that 4 out of 8 motors will need refurbishing at cost of $6MM.	
BE2	Motor inspection	Existing motors are >60year age and possibly could need refurbishment within the time period of this project. The PDT determined that the project cost estimate should include inspection of each motor.		Certain	Negligible	Rebock at Basis of Estimate	Certain	Negligible	Rebock at Basis of Schedule				Project Cost & Schedule										100%	$0	100%	0 Mo		
BE3	Pump Reverse Engineer	Existing pumps possibly could need refurbishment within the time period of this project. The unique make-up of the pumps and pump station would require reverse engineering efforts.	350000, may get 1, unlikely	Unlikely	Marginal	Low	Certain	Negligible	Rebock at Basis of Schedule	Triangular			Project Cost & Schedule	$0	$0	$350,000							100%	$0	100%	0 Mo	Current Direction is to inspect motors during construction. It is anticipated that motor refurbishment will be needed following inspection, also resulting in the need for reverse engineering. The possible minimal cost is $0 with no motors needed refurbishment, maximum is $350,000 for cost of reverse engineering. This will be yes/no assumption with 80% probability of yes.	
BE4	Gate repair/replace following inspection	Gate is >60year age and possibly could need refurbishment within the time period of this project.	Two existing gates	Very Likely	Moderate	High	Very Likely	Negligible	Low	Triangular			Project Cost & Schedule	$0	$0	$750,000							100%	$0	100%	0 Mo	Current Direction is to replace lifting mechanisms for the gate. PDT felt that with the age of the gate that following inspection multiple structural parts of the gate may need repair, and possibly the entire gate needs to be replaced. Minimum cost would be $0, with maximum of gate replacement at $750,000.	
BE5	Gate inspection included in PED	Existing Gate are >60year age and possibly could need refurbishment within the time period of this project. The PDT determined that the project cost estimate should include inspection of the two gates		Certain	Negligible	Rebock at Basis of Estimate	Very Likely	Negligible	Low				Project Cost & Schedule										100%	$0	100%	0 Mo		
Starkey PS																												
ST1	Motor Refurbishment following inspection	Existing motors and pumps possibly could need refurbishment within the time period of this project.	Four existing motors currently experience frequent cycling use with sanitary flow, resulting in decreased life cycles. Possible replacement of all four pumps may be needed following inspection.	Very Likely	Moderate	High	Very Likely	Marginal	Medium	Triangular			Project Cost & Schedule	$0	$0	$2,000,000							100%	$0	100%	0 Mo	Current Direction is to inspect motors during construction. It is anticipated that motor refurbishment will be needed following inspection. The possible minimal cost is $0 with no motors needed refurbishment, maximum is $2MM, with most likely that 2 of the 4motors will need refurbishing at cost of $1MM.	
ST2	Motor inspection	Existing motors are >60year age and possibly could need refurbishment within the time period of this project. The PDT determined that the project cost estimate should include inspection of each motor.		Certain	Negligible	Rebock at Basis of Estimate	Certain	Negligible	Rebock at Basis of Schedule				Project Cost & Schedule										100%	$0	100%	0 Mo		
Paddy's Run FPS																												
PR1	Relocate power lines underground	Existing power lines are installed overhead. MSD suggested during the CSRA meeting that the lines be relocated underground due to access to the building and service reliability.	Likelihood is likely, and cost impact is negligible due to maximum cost estimated at $300k	Likely	Negligible	Low	Likely	Negligible	Low	Triangular			Project Cost & Schedule	$0	$0	$300,000							100%	$0	100%	0 Mo	Likelihood is likely, and cost impact is negligible due to maximum cost estimated at $300k. Likely variance is estimated at 50% of maximum.	
PR2	Structural Refurbishment	The current cost estimate includes costs for scope of structural refurbishment of the FPS. It's possible that additional structural refurbishment will be needed once further investigation takes place.	The current cost estimate includes costs for scope of structural refurbishment of the FPS. It's possible that additional structural refurbishment will be needed once further investigation takes place.	Likely	Marginal	Medium	Certain	Negligible	Rebock at Basis of Schedule	Triangular			Project Cost & Schedule	$0	$0	$1,000,000							100%	$0	100%	0 Mo	Likelihood is likely, and cost impact is marginal due to maximum cost estimated at $1MM. Likely variance is estimated at 25% of maximum.	
Riverport FPS																												
RP1	Motor Refurbishment following inspection	Existing motors and pumps possibly could need refurbishment within the time period of this project.	Three existing motors are old, but rarely used. Possible replacement of all three pumps may be needed following inspection.	Very Likely	Moderate	High	Very Likely	Marginal	Medium	Triangular			Project Cost & Schedule	$0	$0	$500,000							100%	$0	100%	0 Mo	Current Direction is to inspect motors during construction. It is anticipated that motor refurbishment will be needed following inspection. The possible minimal cost is $0 with no motors needed refurbishment, maximum is $500M, with most likely that 1 of the 3 motors will need refurbishing at cost of $165M.	
RP2	Motor inspection	Existing motors are >60year age and possibly could need refurbishment within the time period of this project. The PDT determined that the project cost estimate should include inspection of each motor.		Certain	Negligible	Rebock at Basis of Estimate	Certain	Negligible	Rebock at Basis of Schedule				Project Cost & Schedule										100%	$0	100%	0 Mo		
Lower Mill PS																												
LM1	Motor Refurbishment following inspection	Existing motors and pumps possibly could need refurbishment within the time period of this project.	Three existing motors are old. Possible replacement of all three pumps may be needed following inspection.	Very Likely	Moderate	High	Very Likely	Marginal	Medium	Triangular			Project Cost & Schedule	$0	$0	$1,200,000							100%	$0	100%	0 Mo	Current Direction is to inspect motors during construction. It is anticipated that motor refurbishment will be needed following inspection. The possible minimal cost is $0 with no motors needed refurbishment, maximum is $1.2MM, with most likely that 1 of the 3 motors will need refurbishing at cost of $400M.	
LM2	Motor inspection	Existing motors are >60year age and possibly could need refurbishment within the time period of this project. The PDT determined that the project cost estimate should include inspection of each motor.		Certain	Negligible	Rebock at Basis of Estimate	Certain	Negligible	Rebock at Basis of Schedule				Project Cost & Schedule										100%	$0	100%	0 Mo		
17th Street																												
SV1	Replacement of MCC's with new pumps/motors	Current scope includes replacing existing pumps with submersible column pumps. The existing MCC's may need to be replaced to run the new column pumps.		Certain	Negligible	Rebock at Basis of Estimate	Certain	Negligible	Rebock at Basis of Schedule				Project Cost & Schedule										100%	$0	100%	0 Mo		
Upper Mill PS																												
UM1	Motor Refurbishment not needed following inspection	Current estimate includes motor refurbishment. Existing motor may not need refurbishment within the time period of this project.	Current estimate includes motor refurbishment. Existing motor may not need refurbishment within the time period of this project.	Possible	Moderate	Medium	Possible	Moderate	Medium	Triangular			Project Cost & Schedule	-$400,000	$0	$0							100%	$0	100%	0 Mo	Current Direction is to inspect motors during construction and to replace one(1) motor. It is possible that motor refurbishment will not be needed following inspection. The possible minimal cost is $-400MM with no motors needed refurbishment, maximum is $0, with most likely that it will need refurbishing at cost of $400M.	
UM2	Motor inspection	Existing motors are >60year age and possibly could need refurbishment within the time period of this project. The PDT determined that the project cost estimate should include inspection of each motor.		Certain	Negligible	Rebock at Basis of Estimate	Certain	Negligible	Rebock at Basis of Schedule				Project Cost & Schedule										100%	$0	100%	0 Mo		
Western FPS																												
WE1	Add VRD's	MSD requested that operation of Western FPS be reviewed and possibly add VFD's to mitigate over-cycling of pumps.	MSD requested that operation of Western FPS be reviewed and possibly add VFD's to mitigate over-cycling of pumps. Likelihood is likely, and cost could reach $2MM, therefore moderate impact.	Likely	Moderate	Medium	Possible	Moderate	Medium	Triangular			Project Cost & Schedule	$0	$0	$2,000,000							100%	$0	100%	0 Mo	MSD requested that operation of Western FPS be reviewed and possibly add VFD's to mitigate over-cycling of pumps. Likelihood is likely, and cost could reach $2MM, therefore moderate impact. Likely variance is approx. $1.5MM, or 75% of the maximum.	

				Project Cost			Project Schedule			Other Information				Cost Model			Schedule Model			Cost due to Schedule Risk									
														COST			Schedule Model			Cost From Schedule			TOTAL Cost		TOTAL Schedule			
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood ©	Impact ©	Risk Level ©	Likelihood (R)	Impact (R)	Risk Level (R)	Cost Variance Distribution	Schedule Variance Distribution	Responsibility/ POC	Affected Project Component	Low Variance (Min)	Likely (C)	High Variance (80%H)	Low Variance (S) (Min)	Likely (S)	High Variance (S) (80%H)	Low Variance (CS) (Min)	Likely Added Cost (CS)	High Variance (CS) (80%H)	Event Prob (PC)	Simulated Cost (C) + (CS)	Event Prob (PS)	Simulated Sched (S)	Risk Quantification Discussions	Risk Mitigation Measures
WE2	Revise wetwell hydraulics	MSD requested that operation of Western FPS be reviewed and possibly improve the hydraulics inside the wetwell.	Current estimate does not include any work to the wetwell. MSD MSD requested that operation of Western FPS be reviewed and possibly improve the hydraulics inside the wetwell. Likelihood is likely, and cost could reach $2MM, therefore moderate impact.	Likely	Moderate	Medium	Possible	Moderate	Medium	Triangular			Project Cost & Schedule	$0	$0	$2,000,000							100%	$0	100%	0 Mo	Current estimate does not include any work to the wetwell. MSD MSD requested that operation of Western FPS be reviewed and possibly improve the hydraulics inside the wetwell. Likelihood is likely, and cost could reach $2MM, therefore moderate impact. Likely variance is approx. $500M, or 25% of the maximum.	
Levees and Floodwalls																													
LF1	10th Street closure may receive political pushback on closure	Current cost estimate includes the alternative to permanently close 10th street closure. Political pushback may require the alternative for a swing gate.	Current cost estimate includes the alternative to permanently close 10th street closure. Political pushback may require the alternative for a swing gate. Likelihood was deemed to be approx. 50/50, therefore "likely". Cost variance is $500M so marginal impact.	Likely	Marginal	Medium	Possible	Marginal	Low	Triangular			Project Cost & Schedule	$0	$0	$500,000							100%	$0	100%	0 Mo	Current cost estimate includes the alternative to permanently close 10th street closure. Political pushback may require the alternative for a swing gate. The swing gate alternate is approximately $500M increase from the permanent closure. Therefore minimum variance is $0, maximum is $500M. Likely is that some modification to the design will be needed per political pushback resulting in approximately 20% of maximum cost.	
Overall																													
OA1	Existing facility cranes may need replacing	Existing Cranes at new submersible stations may need replacing.	Due to possible weight increase of new replacement pumps. >4% increase would require structural analysis of supports. Some risk possibly mitigated by load testing of cranes during PED.	Possible	Moderate	Medium	Possible	Marginal	Low	Triangular			Project Cost & Schedule	$0	$0	$1,500,000							100%	$0	100%	0 Mo	Due to possible weight increase of new replacement pumps. >4% increase would require structural analysis of supports. Some risk possibly mitigated by load testing of cranes during PED. Affected stations include 8th, 10th, 17th, 27th, and 34th street PS's. Minimum is $0 with no cranes being replaced, maximum with all PS's replacement cranes is $1.5MM, with likely being one crane needing replacement at $300MM.	
OA2	Existing facility cranes may need work	Existing Cranes at Pumps to be rebuilt stations may need repairs.	Unlikely due to current MSD procedures to test the existing cranes, but possible due to MSD's experience. Some risk possibly mitigated by load testing of cranes during PED. Larger stations have larger impact to the cost and schedule.	Unlikely	Marginal	Low	Possible	Marginal	Low	Triangular			Project Cost & Schedule	$0	$0	$500,000							100%	$0	100%	0 Mo		

Contingency on Base Estimate	80% Confidence Project Cost	
Base Construction Estimate	$121,420,792	
Baseline Estimate Cost Contingency Amount ->	$25,498,366	21%
Baseline Estimate Construction Cost (80% Confidence) ->	$146,919,158	

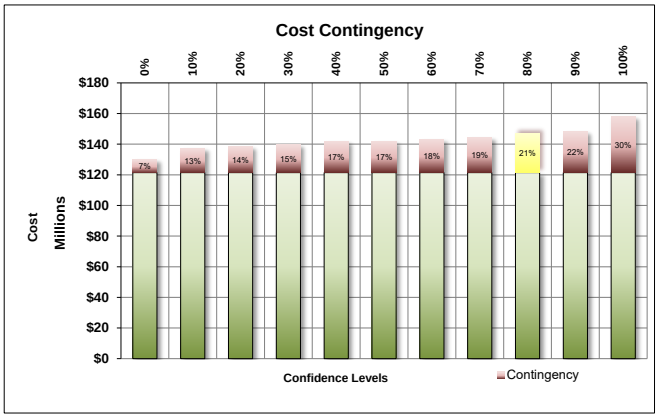
Contingency on Schedule	80% Confidence Project Schedule	
Project Base Schedule Duration ->	60.0 Months	
Schedule Contingency Duration ->	0.0 Months	0%
Project Schedule Duration (80% Confidence) ->	60.0 Months	

LOUISVILLE METRO FPS
22-Jul-19

- PROJECT CONTINGENCY DEVELOPMENT -

INITIAL CONSTRUCTION
Contingency Analysis

Base Case Estimate (Excluding 01)	$121,420,792	
Confidence Level	Contingency Value	Contingency
0%	8,499,455	7%
10%	15,784,703	13%
20%	16,998,911	14%
30%	18,213,119	15%
40%	20,641,535	17%
50%	20,641,535	17%
60%	21,855,743	18%
70%	23,069,950	19%
80%	25,498,366	21%
90%	26,712,574	22%
100%	36,426,238	30%

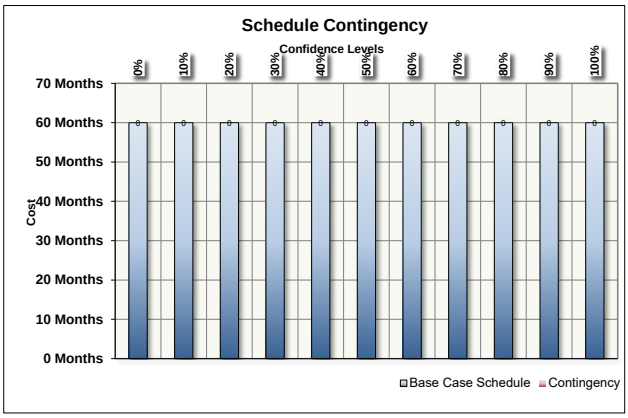


LOUISVILLE METRO FPS
22-Jul-19

- SCHEDULE CONTINGENCY (DURATION) DEVELOPMENT -

Contingency Analysis

Base Case Schedule	60.0 Months	
Confidence Level	Contingency Value	Contingency
0%	0 Months	0%
10%	0 Months	0%
20%	0 Months	0%
30%	0 Months	0%
40%	0 Months	0%
50%	0 Months	0%
60%	0 Months	0%
70%	0 Months	0%
80%	0 Months	0%
90%	0 Months	0%
100%	0 Months	0%



1.6. MII Cost Estimate Summary

Estimated by	Jay Thomas, LRL-ED-M-C
Designed by	
Prepared by	Jay Thomas, LRL-ED-M-C
Preparation Date	10/29/2019
Effective Date of Pricing	10/29/2019
Estimated Construction Time	1,825 Days

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Description	ContractCost	Contingency	ProjectCost
Summary Level	138,626,519.50	29,115,729.10	167,742,248.60
Low Range	138,626,519.50	29,115,729.10	167,742,248.60
01 LANDS AND DAMAGES	104,000.00	26,000.00	130,000.00
11 LEVEES AND FLOODWALLS	20,782,666.16	4,364,359.89	25,147,026.06
Floodwall and Closures	3,740,979.68	785,605.73	4,526,585.41
Canal Station Floodwall	1,195,111.62	250,973.44	1,446,085.06
27th Street Closure	443,472.69	93,129.26	536,601.95
10th St. Swing Gate Concrete Closure	181,276.80	38,068.13	219,344.92
Pond Creek Wall	349,768.48	73,451.38	423,219.86
Butchertown T Wall	928,479.13	194,980.62	1,123,459.75
Johnsontown Road Closure	61,150.78	12,841.66	73,992.45
Repair Waterstops	581,720.17	122,161.24	703,881.41
Sluice Gates	17,041,686.49	3,578,754.16	20,620,440.65
13 PUMPING PLANT	100,538,123.34	21,113,005.90	121,651,129.24
Flood PS Remodel	100,538,123.34	21,113,005.90	121,651,129.24
Starkey FPS	4,451,239.29	934,760.25	5,385,999.55
Western FPS	1,504,492.49	315,943.42	1,820,435.91
Upper Mill FPS	9,723,367.22	2,041,907.12	11,765,274.33
Lower Mill FPS	4,425,871.64	929,433.04	5,355,304.69
Riverport FPS	1,726,882.81	362,645.39	2,089,528.20
Pond Creek FPS	19,623,925.65	4,121,024.39	23,744,950.04
Beargrass Creek FPS	20,354,721.05	4,274,491.42	24,629,212.47
Fifth Street FPS	1,784,861.10	374,820.83	2,159,681.93
Tenth Street FPS	2,709,678.62	569,032.51	3,278,711.13
Seventeenth Street FPS	1,739,865.90	365,371.84	2,105,237.74
Twenty Seventh Street FPS	4,706,063.97	988,273.43	5,694,337.40
Thirty Fourth Street FPS	2,323,847.70	488,008.02	2,811,855.72
Shawnee Park FPS	9,958,753.98	2,091,338.34	12,050,092.31
Paddy's Run FPS Remodel	15,504,551.92	3,255,955.90	18,760,507.83
30 PED	11,030,730.00	2,316,453.30	13,347,183.30
Design	7,356,530.00	1,544,871.30	8,901,401.30
Construction Support	3,674,200.00	771,582.00	4,445,782.00
31 CONSTRUCTION MANAGEMENT	6,071,000.00	1,274,910.00	7,345,910.00
06 CULTURAL RESOURCE PRESERVATION	100,000.00	21,000.00	121,000.00

US Army Corps of Engineers®

LOUISVILLE METRO LEVEE SYSTEM FEASIBILITY STUDY

P2# 145626

LOUISVILLE, KY

CONCEPT SUBMITTAL

VOLUME 3

CONTRACT NUMBER: WXXXXX-XX-X-XXX
SOLICITATION NUMBER: XXXXX-XX-X-XXX
AUGUST 2019

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXX-XX-X-XXX
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DRAWING CODE:

DESIGNED BY: J. TOE
DRAWN BY: J. TOE
CHECKED BY: J SINKHORN
SUBMITTED BY: J. TOE
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

TITLE SHEET

SHEET ID
G-001

SHEET ID	SHEET TITLE
GENERAL	
G-001	COVER SHEET
G-002	DRAWING INDEX
G-003	STANDARD SYMBOLS
G-004	STANDARD ABBREVIATIONS
G-005	LOCATION AND VICINITY MAPS
G-006	AERIAL PHOTOGRAPH
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REAL ESTATE	
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BEARGRASS CREEK PUMP STATION	
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BG-S-106	BEARGRASS CREEK EXTERIOR WALKWAY - ALTERNATE 2
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BG-E-102	BEARGRASS CREEK PS ROLLERGATE DECK ELECTRICAL PLA
BG-E-103	BEARGRASS CREEK PS SUBSTATION PLAN
STARKEY PUMP STATION	
CIVIL	
ST-C-101	STARKEY PS SITE PLAN
REAL ESTATE	
ST-R-101	STARKEY PS RIGHT OF WAY PLAN
MECHANICAL	
ST-M-101	STARKEY PS MECHANICAL PLAN
ELECTRICAL	
ST-E-101	STARKEY PS ELECTRICAL PLAN
ST-E-102	STARKEY PS SUBSTATION PLAN
ST-E-601	STARKEY PS EXISTING POWER ONE LINE (1 OF2)
ST-E-602	STARKEY PS EXISTING POWER ONE LINE (2 OF2)
BUTCHERTOWN	
CIVIL	
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BT-C-102	BUTCHERTOWN I-WALL STABILIZATION SITE PLAN 2 OF 2
REAL ESTATE	
BT-R-101	BUTCHERTOWN I-WALL STABILIZATION RW PLAN 1 OF 2
BT-R-102	BUTCHERTOWN I-WALL STABILIZATION RW PLAN 2 OF 2
STRUCTURAL	
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CIVIL	
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REAL ESTATE	
4-R-101	4TH STREET PS RIGHT OF WAY PLAN
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CIVIL	
5-C-101	5TH STREET PS SITE PLAN
REAL ESTATE	
5-R-101	5TH STREET PS RIGHT OF WAY PLAN
MECHANICAL	
5TH-M-101	5TH STREET PS MECHANICAL PLANS
ELECTRICAL	
5TH-E-101	FIFTH STREET PS ELECTRICAL PLAN
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CIVIL	
10-C-101	10TH STREET PS SITE PLAN
REAL ESTATE	
10-R-101	10TH STREET PS RIGHT OF WAY PLAN

SHEET ID	SHEET TITLE
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10-S-301-ALT2	TENTH STREET GATE SECTION - ALTERNATE 2
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CIVIL	
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REAL ESTATE	
10-R-101	10TH STREET PS RIGHT OF WAY PLAN
MECHANICAL	
10-M-101	TENTH STREET PS MECHANICAL PLANS
ELECTRICAL	
10-E-101	TENTH ST PS ELECTRIAL PLAN
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CIVIL	
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REAL ESTATE	
17-R-101	17TH STREET PS RIGHT OF WAY PLAN
MECHANICAL	
17-M-101	SEVENTEENTH STREET PS MECHANICAL PLANS
ELECTRICAL	
17-E-101	SEVENTEENTH ST PS ELECTRICAL PLAN
17-E-102	SEVENTEENTH ST PS SUBSTATION PLAN
17-E-601	SEVENTEENTH ST PS EXISTING POWER ONE LINE
CANAL STATION	
CIVIL	
CN-C-101	CANAL STATION SITE PLAN
REAL ESTATE	
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STRUCTURAL	
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CIVIL	
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27-E-102	TWENTY SEVENTH ST PS SUBSTATION PLAN
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MR-R-101	MCALPINE ACCESS ROAD RW PLAN 1 OF 2
MR-R-102	MCALPINE ACCESS ROAD RW PLAN 2 OF 2
THIRTY FOURTH STREET PUMP STATION	
CIVIL	
34-C-101	34TH STREET PS SITE PLAN
REAL ESTATE	
34-R-101	34TH STREET PS RIGHT OF WAY PLAN
MECHANICAL	
34-M-101	THIRTY FOURTH PS MECHANICAL PLANS
ELECTRICAL	
34-E-101	THIRTY FOURTH ST PS ELECTRICAL PLAN
34-E-102	THIRTY FOURTH ST PS SUBSTATION PLAN
SHAWNEE PARK PUMP STATION	
CIVIL	
SH-C-101	SHAWNEE PARK PS SITE PLAN
REAL ESTATE	
SH-R-101	SHAWNEE PARK PS RIGHT OF WAY PLAN
MECHANICAL	
SH-M-101	SHAWNEE PS MECHANICAL PLANS
ELECTRICAL	
SH-E-101	SHAWNEE PS ELECTRICAL PLAN
SH-E-102	SHAWNEE PS SUBSTATION PLAN
SH-E-601	SHAWNEE PS EXISTING POWER ONE LINE

SHEET ID	SHEET TITLE
WESTERN PARKWAY PUMP STATION	
CIVIL	
W-C-101	WESTERN FPS SITE PLAN
REAL ESTATE	
W-R-101	WESTERN FPS RIGHT OF WAY PLAN
ELECTRICAL	
W-E-101	WESTERN FPS ELECTRICAL PLAN
W-E-102	WESTERN FPS SUBSTATION PLAN
PADDY'S RUN PUMP STATION	
CIVIL	
PR-C-101	PADDY'S RUN PUMP STATION SITE PLAN
PR-C-102	PADDY'S RUN PUMP STATION ALTERNATIVE SITE PLAN
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PR-S-103-ALT2	PADDY'S RUN ROOF FRAMING PLAN - ALTERNATE 2
PR-S-104-ALT2	PADDY'S RUN WALKWAY PLAN - ALTERNATE 2
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PR-S-202-ALT2	PADDY'S RUN EXTERIOR ELEVATIONS - ALTERNATE 2
PD-S-203-ALT2	PADDY'S RUN EXTERIOR ELEVATIONS - ALTERNATE 2
PD-S-204-ALT2	PADDY'S RUN EXTERIOR ELEVATIONS - ALTERNATE 2
PD-S-301-ALT2	PADDY'S RUN INTERIOR SECTIONS - ALTERNATE 2
PD-S-302-ALT2	PADDY'S RUN INTERIOR ELEVATIONS - ALTERNATE 2
MECHANICAL	
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ELECTRICAL	
PR-E-101	PADDY'S RUN PS ELECTRICAL PLAN
PR-E-102	PADDY'S RUN PS SUBSTATION PLAN
PR-E-601	PADDY'S RUN PS EXISTING POWER ONE LINE
UPPER MILL CREEK PUMP STATION	
CIVIL	
UC-C-101	UPPER MILL CREEK PUMP STATION SITE PLAN
UC-C-201	UPPER MILL CREEK PUMP STATION DETAIL SHEET
REAL ESTATE	
UC-R-101	LOWER MILL CREEK PUMP STATION RIGHT OF WAY PLAN
MECHANICAL	
UMC-M-101	UPPER MILL CREEK PS MECHANICAL PLANS
ELECTRICAL	
UMC-E-101	UPPER MILL CREEK PS ELECTRICAL PLAN
UMC-E-102	UPPER MILL CREEK PS SUBSTATION PLAN
UMC-E-601	UPPER MILL CREEK PUMP STATION EXISTING ONE LINE DIAGR
RIVERPORT PUMP STATION	
CIVIL	
RP-C-101	RIVERPORT PUMP STATION SITE PLAN
RP-C-201	RIVERPORT PUMP STATION DETAIL SHEET
REAL ESTATE	
RP-R-101	RIVERPORT PUMP STATION RIGHT OF WAY PLAN
ELECTRICAL	
RP-E-101	RIVERPORT PS ELECTRICAL PLAN
RP-E-102	RIVERPORT PS SUBSTATION PLAN
RP-E-601	RIVERPORT PS EXISTING POWER ONE LINE
JOHNSONTOWN ROAD CLOSURE	
CIVIL	
JT-C-101	JOHNSONTOWN CLOSURE VAULT SITE PLAN
REAL ESTATE	
JT-R-101	JOHNSONTOWN CLOSURE VAULT RIGHT OF WAY PLAN
STRUCTURAL	
JT-S-101	JOHNSONTOWN RD CLOSURE VAULT PLANS
LOWER MILL CREEK PUMP STATION	
CIVIL	
LC-C-101	LOWER MILL CREEK PS SITE PLAN
LC-C-201	LOWER MILL CREEK PS DETAIL SHEET
REAL ESTATE	
LC-R-101	LOWER MILL CREEK PS RIGHT OF WAY PLAN
MECHANICAL	
LMC-M-101	LOWER MILL CREEK PS MECHANICAL PLANS
ELECTRICAL	
LMC-E-101	LOWER MILL CREEK PS ELECTRICAL PLAN
LMC-E-102	LOWER MILL CREEK PS SUBSTATION PLAN
LMC-E-601	LOWER MILL CREEK PS EXISTING POWER ONE LINE

SHEET ID	SHEET TITLE
POND CREEK PUMP STATION	
CIVIL	
PC-C-101	POND CREEK PUMP STATION SITE PLAN 1 OF 2
PC-C-102	POND CREEK PUMP STATION SITE PLAN 2 OF 2
REAL ESTATE	
PC-R-101	POND CREEK PUMP STATION RW PLAN 1 OF 2
PC-R-102	POND CREEK PUMP STATION RW PLAN 2 OF 2
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PC-S-102	POND CREEK I-WALL REPAIR
MECHANICAL	
PC-M-101	POND CREEK PS MECHANICAL PLANS
PC-M-102	POND CREEK PS MECHANICAL SECTION
PC-M-103	POND CREEK PS FORMED SUCTION INTAKE
ELECTRICAL	
PC-E-101	POND CREEK PS ELECTRICAL PLAN
PC-E-102	POND CREEK PS SUBSTATION PLAN
PC-E-601	POND CREEK PUMP STATION EXISTING ONE LINE DIAGRAM

A1 DRAWING INDEX
SCALE: NTS

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

DESIGNED BY: J. TOE
DRAWN BY: J. TOE
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OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

DRAWING INDEX

SHEET ID
G-002

CONCEPT SUBMITTAL

TOPOGRAPHIC SYMBOLS

GAS LINE — G
LOW PRESSURE GAS — G(LP)
MEDIUM PRESSURE GAS — G(MP)
HIGH PRESSURE GAS — G(HP)
INDUSTRIAL WASTE — IW
POWER LINE - AERIAL — P
POWER LINE - UNDERGROUND — UP
POWER LINES DUCTS — ED (3-4")
SANITARY SEWER LINE — SS
FORCE MAIN — FM
STEAM LINE — S
STORM DRAINAGE LINE — SD
TELEPHONE LINE - UNDERGROUND — TU
TELEPHONE LINE - AERIAL — T
TELEPHONE DUCTS — TD (2-4")
TELEPHONE AND POWER - AERIAL — PT
WATER LINE — W
FIRE MAIN — F
EDGE OF GRAVEL
SUBDRAIN — SD
CLEANOUT — C.O.
FIRE HYDRANT — FH
CATCH BASIN — CB
LIFT STATION — LS
MANHOLE W/DESIGNATION — MH-1
POST INDICATOR VALVE — PIV
POWER POLE
POWER POLE WITH GUY
SPIGOT
VALVE
CONTOUR — 555
BENCHMARK
RIPRAP
SPOT ELEVATION — 555
CONTRACTOR WORK LIMITS
CHAIN LINK FENCE
FLOW DIRECTION — FLOW
BORING
HEADWALL
CUT & SLOPE INDICATORS

HEATING, VENTILATING AND AIR CONDITIONING

FANS, HEATERS AND VENTILATORS

CENTRIFUGAL ROOF EXHAUST FAN W/DESIGNATION — EF-1
CENTRIFUGAL WALL EXHAUST FAN W/DESIGNATION — EF-2
PROPELLER TYPE WALL MOUNTED FAN W/DESIGNATION — EF-3
FAN COIL UNIT W/DESIGNATION — FC-1
UNIT HEATER-HORIZONTAL W/DESIGNATION — UH-2
CONVECTOR W/DESIGNATION — CV-1
UNIT HEATER - VERTICAL W/DESIGNATION — UH-3
UNIT VENTILATOR
CENTRIFUGAL CEILING EXHAUST FAN W/DESIGNATION — EF-4

DUCT WORK

DIRECTION OF FLOW
DUCT-FIRST FIGURE IS SIDE SHOWN — 250/150
FLEXIBLE DUCT
EXHAUST INLET
RETURN INLET
SUPPLY OUTLET
CHANGE IN ELEVATION RISE (R) OR DROP (D) — D
CEILING DIFFUSER RECTANGULAR OR SQUARE, ARROWS INDICATE THROW — CD 250/150 175
CEILING RETURN REGISTER (RR) OR RETURN GRILLE (RG) — RR 250/150 175
THERMOSTAT — T
CEILING DIFFUSER - ROUND — CD 250 175
SUPPLY REGISTER (SR) OR SUPPLY GRILLE (SG) - SIDE WALL — SR 250/150 175
OUTSIDE AIR INTAKE LOUVER — 250/150 175
EXHAUST (E) OR RETURN (R) DUCT SECTION — E 150/250
OUTSIDE AIR DUCT SECTION — O A 150/250
FLEXIBLE CONNECTIONS
AIR DEFLECTOR
TURNING VANES
AUTOMATIC DAMPERS - MOTOR OPERATED — M M.O.
FIRE DAMPER — FD
MODULATING CONTROL DAMPER — MCD
SMOKE DAMPER — SD
VOLUME CONTROL DAMPER (MANUAL) — VD

VALVES

CONNECTION TYPES:
FLANGED — SCREWED — BELL & SPIGOT — WELDED — SOLDERED

NOTES:
SCREWED END REPRESENTATION MAY BE USED FOR ALL TYPES OF CONNECTIONS PROVIDED THE TYPE OF CONNECTION IS COVERED BY DRAWING LEGEND, NOTE OR SPECIFICATIONS.

ANGLE GATE
AIR OUTLET — A
BACK PRESSURE
BALANCING
CHECK
DIAPHRAGM
GATE
GATE STOP W/HOSE BIBB — HB
GLOBE
MOTOR OPERATED VALVE W/DESIGNATION — M MV-1
PRESSURE REDUCING W/DESIGNATION — P PRV-1
REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTER
RELIEF (R) OR SAFETY (S)
THREE WAY

PIPE FITTINGS AND SPECIALTIES

CONNECTION TYPES:
FLANGED — SCREWED — BELL & SPIGOT — WELDED — SOLDERED — SOLVENT CEMENT

NOTES:
SCREWED END REPRESENTATION MAY BE USED FOR ALL TYPES OF CONNECTIONS PROVIDED THE TYPE OF CONNECTION IS COVERED BY DRAWING LEGEND, NOTE OR SPECIFICATIONS.

PIPE FITTINGS:
BASE ELBOW
CLEANOUT — C.O.
CLEANOUT — C.O.
CROSS
DOUBLE BRANCH ELBOW
ELBOW - 45 DEGREES
ELBOW - 90 DEGREES
ELBOW - LONG RADIUS
ELBOW - TURNED DOWN
ELBOW - TURNED UP
FLEXIBLE CONNECTOR
FLOOR DRAIN (FD) OR SIGHT DRAIN (SD) — FD
HOSE OR LAWN FAUCET, WALL HYDRANT AND DESIGNATION — HB
INCREASER - CONCENTRIC
INCREASER - ECCENTRIC
LATERAL
REDUCER - CONCENTRIC
REDUCER - ECCENTRIC
REDUCING ELBOW — 2 4
REDUCING FLANGE
SIDE OUTLET ELBOW OUTLET - DOWN
SIDE OUTLET ELBOW OUTLET - UP
SIDE OUTLET TEE OUTLET - DOWN
SIDE OUTLET TEE OUTLET - UP
SINGLE SWEEP TEE
SLEEVE
SPRINKLER HEAD
STRAINER
TEE
TEE OUTLET - DOWN
TEE OUTLET - UP
UNION - FLANGED
UNION SCREWED
WATER HAMMER ARRESTER — W.H.A.

ARCHITECTURAL SYMBOLS

ARCHITECTURAL REPRESENTATIONS

BATHTUB
CENTER LINE
COLUMN CENTERLINE DESIGNATION — 1 A
DIAMETER
DOOR DESIGNATION — 000
DRINKING FOUNTAIN (WALL TYPE)
ELECTRIC WATER COOLER (EWC) — OR
EYE WASH/DELUGE SHOWER
ELEVATION TARGET
FIRE EXTINGUISHER CABINET — OR FEC FEC
FOLDING PARTITION
HAND DRYER
HANDICAP EWC
HANDICAP RAIL — OR
HANDICAP SHOWER
HANDICAP SINK
HANDICAP URINAL
SIGNAGE MARKER — X
LAVATORY — OR OR
PARTITION TYPE — X
PLATE
ROOM DESIGNATION — 000
SERVICE SINK — S OR S
SHOWER HEAD
SHOWER STALL
SINK (COUNTER TOP OR FLUSH RIM) — OR
SPECIAL ITEMS — X
SQUARE
URINAL (WALL TYPE) — OR
UTILITY SINK
VACUUM OUTLET
WATER CLOSET (PEDIATRIC)
WATER CLOSET (WALL MOUNT TYPE) — OR
WATER CLOSET (TANK TYPE)
WINDOW DESIGNATION — A

MATERIAL SYMBOLS

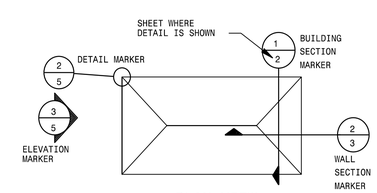
WOOD - ROUGH
WOOD - FINISHED
PLYWOOD
STEEL
CERAMIC TILE
MINERAL WOOL (FIRESTOP MATERIAL)
RIGID INSULATION
BLANKET, BATT OR LOOSE FILL INSULATION
SPRAY APPLIED FIREPROOFING
GRANULAR/GRAVEL FILL/ CAPILLARY WATER BARRIER
BRICK OR CAST IRON
CMU
ORIGINAL EARTH
FILL EARTH/FINISHED GRADE
CONCRETE
GROUT/GYP. BD.
ROCK
GMU
GLASS BLOCK
BRONZE, BRASS OR COPPER
ALUMINUM
CAST STONE

BUILDING PIPING

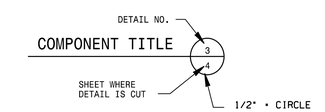
NOTE:
WHENEVER SYMBOLICAL REPRESENTATION IS NECESSARY TO DISTINGUISH BETWEEN SERVICES, THE FOLLOWING SYMBOLS SHALL BE USED EXCEPT THAT THE PRINCIPAL SYSTEM ON ANY PIPING DRAWING MAY BE INDICATED BY A SOLID LINE IF DESIRED WHEN SUCH INDICATION WILL NOT CAUSE CONFLICT.

CHILLED WATER RETURN — CWR
CHILLED WATER SUPPLY — CWS
COLD WATER
COMPRESSED AIR — A
CONDENSER WATER SUPPLY — C
CONDENSER WATER RETURN — CR
GAS — G
HIGH PRESSURE RETURN — HPR
HIGH PRESSURE STEAM — HPS
HOT WATER
HOT WATER RETURN OR RECIRCULATING
HOT WATER RETURN — HWR
HOT WATER SUPPLY — HWS
LOW PRESSURE RETURN — LPR
LOW PRESSURE STEAM — LPS
MEDIUM PRESSURE RETURN — MPR
MEDIUM PRESSURE STEAM — MPS
PIPE ANCHOR — A
PUMPED CONDENSATE — PC
ROOF DRAIN — RD
SANITARY SEWER — SS
STORM DRAIN — SD
VACUUM (AIR) — VAC
VENT — V
WASTE LINE (ABOVE & BELOW GRADE)
WASTE ANTIFREEZE — WA
WASTE OIL LINE — WO

CROSS REFERENCING



PLAN VIEW



DETAIL, SECTION, OR ELEVATION VIEW

GENERAL NOTES:

1. EXISTING CONDITIONS WILL BE SHOWN LIGHT AND NEW WORK SHOWN HEAVY.
2. WHEN ADDITIONAL SYMBOLS ARE NECESSARY, A LEGEND WILL BE LOCATED ON THE RESPECTIVE DRAWINGS.

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U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

STANDARD SYMBOLS

SHEET ID
G-003

CONCEPT SUBMITTAL

ABBREVIATIONS

&	AND
@	AT
AB	ANCHOR BOLT
ABSW	AIR BREAK SWITCH
ABV	ABOVE
A/C	AIR CONDITIONING
ACST	ACOUSTIC
ACU	AIR CONDITIONING UNIT
ADDL	ADDITIONAL
ADJ	ADJACENT, ADJUSTABLE
AFB	AIR FORCE BASE
A.F.F.	ABOVE FINISHED FLOOR
AFFF	AQUEOS FILM FORMING FOAM
AGGR	AGGREGATE
AHR	ANCHOR
AHU	AIR HANDLING UNIT
AL	ALUMINUM
ALTN	ALTERNATE
AMP	AMPERE
AP	ACCESS PANEL
APPROX	APPROXIMATELY
APVD	APPROVED
ARCH	ARCHITECTURE,ARCHITECTURAL
ASPH	ASPHALT
ASSY	ASSEMBLY
ASTM	AMERICAN SOCIETY FOR TESTING MATERIALS
ATC	ACOUSTICAL TILE CEILING
ATTEN	ATTENUATE, ATTENUATION
AUTO	AUTOMATIC
AUX	AUXILIARY
AVG	AVERAGE
AWG	AMERICAN WIRE GAGE
BCCMP	BITUMINOUS COATED CORRUGATED METAL PIPE
BD	BOARD
BEJ	BRICK EXPANSION JOINT
BG	BUMPER GUARD
BLDG	BUILDING
BLK	BLOCK
BLKG	BLOCKING
BM	BEAM, BENCH MARK
BOT	BOTTOM
BRG	BEARING
BRK	BRICK
BSMT	BASEMENT
BTU	BRITISH THERMAL UNIT
BUR	BUILT - UP ROOF
CL	CENTERLINE
C	CONVERTOR
CAP	CAPACITY, CAPACITOR
CAV	CAVITY
CC	COOLING COIL
C-C	CENTER TO CENTER
CEM	CEMENT
CFCI	CONTRACTOR FURNISHED,CONTRACTOR INSTALLED
CFGI	CONTRACTOR FURNISHED,GOVERNMENT INSTALLED
CFH	CUBIC FEET PER HOUR
CFM	CUBIC FEET PER MINUTE
CG	CORNER GUARD
CHAN	CHANNEL
CHG	CHARGE
CHW	CHILLED WATER
CI	CAST IRON
CIP	CAST IRON PIPE
CJ	CONTROL JOINT
CKT	CIRCUIT
CLG	CEILING
CLO	CLOSET
CLR	CLEAR
CLWG	CLEAR WATER GLASS
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CND	CONDUIT
CNDS	CONDENSATE
CO	CLEANOUT
CLWG	CLEAR WIRE GLASS
CW	COLD WATER
COL	COLUMN
CONC	CONCRETE
COND	CONDUCTOR, CONDENSER
CONN	CONNECTION
CONSTR	CONSTRUCTION
CONT	CONTINUOUS, CONTROL
CONTD	CONTINUED
CONV	CONVERTER
COP	COPPER
CORR	CORRUGATE
CP	CIRCULATING PUMP
CPE	CHLORINATED POLYETHYLENE
CPLG	COUPLING
CR	COLD ROLLED
CSPE	CHLOROSULFONATED POLYETHYLENE
CSK	COUNTERSINK
CT	CERAMIC TILE
CTR	CENTER
CU	CUBIC
CU FT	CUBIC FEET
CU YD	CUBIC YARD
CUR	CURRENT
CV	CHECK VALVE
D	DEEP
DA	DRIP ASSEMBLY
DB	DRY BULB
DET	DETAIL
DF	DRINKING FOUNTAIN
DIA	DIAMETER
DIM	DIMENSION
DIP	DUCTILE IRON PIPE
DISC	DISCONNECT
DISCH	DISCHARGE
DIST	DISTANCE
DISTR	DISTRIBUTION
DK	DECK
DL	DEAD LOAD
DN	DOWN
DOD	DEPARTMENT OF DEFENSE
DP	DEPTH
DPNL	DISTRIBUTION PANEL
DR	DOOR
DS	DOWNSPOUT
DWP	DRINKING WATER DISPENSER
DWG	DRAWING
DWH	DOMESTIC WATER HEATER
E	EAST
EA	EACH
EF	EACH FACE, EXHAUST FAN
EJ	EXPANSION JOINT
EL	ELEVATION, EXHAUST LOUVER
ELEC	ELECTRIC
ELEV	ELEVATE, ELEVATOR
EMER	EMERGENCY
EMT	ELECTRICAL METALLIC TUBING
ENGR	ENGINEER,ENGINEERING
ENTR	ENTRANCE
EPDM	ETHELENE PROPOLENE DIANENE MONOMER
EQ,EQL	EQUAL
EQPT	EQUIPMENT
ER	EXHAUST REGISTER
ESV	EXTRUDED SHEET VINYL WALL COVERING
EW	EACH WAY
EWC	ELECTRIC WATER COOLER
EXH	EXHAUST
EXST	EXISTING
EXP	EXPANSION
EXT	EXTERIOR
F	FAHRENHEIT, FACE
F.B.	FLAT BRACKET
FB	FIELD BOLTED
FC	FLEXIBLE CONNECTION
FD	FLOOR DRAIN
FDN	FOUNDATION
FDR	FEEDER
FEC	FIRE EXTINGUISHER CABINET
FE	FIRE EXTINGUISHER
FF	FINISH FLOOR, FACTORY FINISHED
FFE	FINISH FLOOR ELEVATION
FHC	FIRE HOSE CABINET
FH	FIRE HYDRANT
FIG	FIGURE
FL	FLOOR
FLA	FULL - LOAD AMPERES
FLEX	FLEXIBLE
FLL	FLOW LINE
FLMB	FLAMMABLE
FLUOR	FLUORESCENT
FNSH	FINISH
FR	FRAME
FRP	FIBERGLASS REINFORCED POLYESTER
FRT	FIRE RETARDENT TREATMENT
FS	FULL SIZE, FLOOR SINK
FT	FORT, FOOT, FEET, FLASH TANK
FTG	FOOTING
FU	FUSE
GA	GAGE
GAL	GALLON
GALV	GALVANIZED
GFGI	GOVERNMENT FURNISHED,GOVERNMENT INSTALLED
GFRP	GLASS-FIBER REINFORCED POLYMER
GL	GLASS
GMU	GLAZED MASONRY UNITS
GND	GROUND
GP	GUARD POST
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GR	GRADE
GSU	GLAZED STRUCTURAL UNIT
GV	GATE VALVE, GLOBE VALVE
GWB	GYPSUM WALL BOARD
GYP	GYPSUM
HB	HOSE BIB
HC	HEATING COIL,HANDICAPPED
HDND	HARDENED
HDW	HARDWARE
HDWL	HEADWALL
HGT	HEIGHT
H.I.D.	HIGH INTENSITY DISCHARGE
HM	HOLLOW METAL
HORIZ	HORIZONTAL
HP	HORSEPOWER, HIGH PRESSURE
HR	HOUR
HSS	HOLLOW STRUCTURAL SECTIONS
HTG	HEATING
HTR	HEATER
HW	HOT WATER
HVY	HEAVY
IAW	IN ACCORDANCE WITH
ID	INSIDE DIAMETER
IDENT	IDENTIFICATION
IL	INTAKE LOUVER
IN	INCH
INCAND	INCANDESCENT
INSUL	INSULATION
INTR	INTERIOR
JT	JOINT
J,JST	JOIST
JB	JUNCTION BOX
JC	JANITOR CLOSET
JCT	JUNCTION
KCP	KEENE'S CEMENT PLASTER
KG	KILOGRAM
KIT	KITCHEN
KO	KNOCK OUT
KV	KILOVOLT
KVA	KILOVOLT - AMPERE
KW	KILOWATT
LA	LIGHTNING ARRESTOR
LAV	LAVATORY
LB	POUND
LG	LENGTH, LONG
LIQ	LIQUID
LP	LOW PRESSURE
LTG	LIGHTING
LV	LOW VOLTAGE
LVR	LOUVER
LVRD	LOUVERED
M	METER
mm	MILLIMETER
MACH	MACHINE
MAINT	MAINTENANCE
MAN	MANUAL
MFD	MANUFACTURED
MFG	MANUFACTURING
MFR	MANUFACTURER
MATL	MATERIAL
MAX	MAXIMUM
MBH	THOUSAND BTU PER HOUR
MECH	MECHANICAL
MET	METAL
MH	MANHOLE
MIN	MINIMUM, MINUTE
MISC	MISCELLANEOUS
MK	MARK
MN	MAIN
MO	MOTOR-OPERATED, MASONRY OPENING, MONTH
MOD	MODEL (FOR GENERAL USE ONLY), MODIFY, MOTOR OPERATED DAMPER
MP	MEDIUM PRESSURE
MT	MOUNT
MTD	MOUNTED
MTG	MOUNTING
MTL	METAL
MKA	MAKE UP AIR UNIT
MSRY	MASONRY
N	NORTH
N.B.P.	NITRILE THERMOPLASTIC (FOR FUTURE FIRE RATING)
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRIC CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NEUT	NEUTRAL
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN, NUMBER
NOM	NOMINAL
NTS	NOT TO SCALE
OA	OUTSIDE AIR
OC	ON CENTER
OD	OUTSIDE DIAMETER
OFCE	OFFICE
OPN	OPERATION
OPNG	OPENING
OPP	OPPOSITE
OPP HND	OPPOSITE HAND
OVHD	OVERHEAD
PB	PULL BOX, PUSH BUTTON
PD	PUMP DISCHARGE
PH	PHASE
PI	POINT OF INTERSECTION
PIB	POLYISOBUTLENE
PIV	POST INDICATOR VALVE
PL	PLATE, PLASTIC LAMINATE
PLAS	PLASTER
PLSTC LAM	PLASTIC LAMINATE
PLD	PLATED
PLYWD	PLYWOOD
PNL	PANEL
PNT,P	PAINT
P.O.C.	POINT OF CONNECTION
POL	POLISH
PR	PAIR
PRELIM	PRELIMINARY
PRESS	PRESSURE
PRI	PRIMARY
PRV	PRESSURE REDUCING VALVE
PS	PULL SWITCH
PSF	POUND FORCE PER SQUARE FOOT
PSI	POUND FORCE PER SQUARE INCH
P.T.	PRESERVATIVE TREATMENT
PT	POINT,PRESERVATIVE TREATMENT
PTD	PAINTED
P.U.F.	POLYURETHANE FOAM
PVC	POINT OF VERTICAL CURVE, POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
PVT	POINT OF VERTICAL TANGENT
PVMT	PAVEMENT
QT	QUARRY TILE, QUART
QTY	QUANTITY
QTB	QUARRY TILE BASE
QUAL	QUALITY
R	RISER, RADIUS
R & R	REMOVE & REPLACE
RA	RETURN AIR
RAD	RADIUS
RCP	REINFORCED CONCRETE PIPE, RECIRCULATING PUMP
RCPT	RECEPTACLE
RD	ROAD, ROOF DRAIN
RDC	REDUCE
RDCN	REDUCTION
RECM	RECOMMEND, RECOMMENDATION
REF	REFERENCE
REINF	REINFORCE
REPL	REPLACE
REQD	REQUIRED
RESIL	RESILIENT
RET	RETAIN
REV	REVISION
RG	RETURN GRILLE
RM	ROOM
RO	ROUGH OPENING
RND	ROUND
RPM	REVOLUTIONS PER MINUTE
RWM	RECESSED WALK-OFF MAT
S	SOUTH
SAN	SANITARY
SATC	SUSPENDED ACOUSTICAL TILE CEILING
SC	SEALED CONCRETE
SCHED	SCHEDULE
SCRN	SCREEN
SD CFM	SUPPLY DIFFUSER (HVAC)
SECT	SECTION
SF	STORE FRONT
SVCE	SERVICE
SGL	SINGLE
SH	SHEET, SHOWER
SIM	SIMILAR
SLP	SLOPE
SMH	SANITARY MANHOLE
SOL	SOLENOID
SP	SINGLE POLE, SPACING, SPARE
SPEC	SPECIFICATION
SPR	SINGLE PLY ROOF
SPRT	SUPPORT
SQ	SQUARE
SQ FT	SQUARE FOOT
SR	SUPPLY REGISTER
SS	SERVICE SINK
SST	STAINLESS STEEL
ST	STEAM, STREET
STA	STATION
STD	STANDARD
STL	STEEL
STOR	STORAGE
ST PR	STATIC PRESSURE
STR	STRAIGHT, STRENGTH, STREAM, STRAINER
STRL	STRUCTURAL
SUSP	SUSPENDED
SYS	SYSTEM
SV	SEAMLESS VINYL
SW	SWITCH
T	TOILET
TAN	TANGENT
T & B	TOP AND BOTTOM
TBM	TEMPORARY BENCH MARK
TC	TOP OF CURB
TEL	TELEPHONE
TEMP	TEMPERATURE
TERM	TERMINAL
TG	TRANSFER GRILLE
THK	THICK
THR	THRESHOLD
THRU	THROUGH
TMPRD	TEMPERED
TOM	TOP OF MASONRY
TOS	TOP OF STEEL
TOW	TOP OF WALL
TSCT	THIN SET CEREMIC TILE
TYP	TYPICAL
U	UNION
UGND	UNDERGROUND
UL	UNDERWRITERS LABORATORY
UNO	UNLESS NOTED OTHERWISE
URN	URINAL
US	UNITED STATES
UTIL	UTILITY
V	VOLT, VALVE
VAC	VACUUM
VAR	VARIES
VC	VITRIFIED CLAY
VCB	VINYL COVE BASE
VCP	VITRIFIED CLAY PIPE
VCT	VINYL COMPOSITION TILE
VEL	VELOCITY
VENT	VENTILATION
VERT	VERTICAL
VEST	VESTIBULE
VOL	VOLUME
VR	VAPOR RETARDER
VS	VENT STACK
VTR	VENT THROUGH ROOF
VWC	VINYL WALL COVERING
W	WEST, WATT, WIDTH, WASTE
W/	WITH
W/O	WITHOUT
WC	WATER CLOSET
WD	WOOD, WINDOW DIMENSION
WDO	WINDOW
WHA	WATER HAMMER ARRESTOR
WI	WROUGHT IRON
WL	WATER LEVEL
WS	WASTE STACK, WATER SURFACE
WT	WEIGHT
WTHPRF	WEATHERPROOF
WTR	WATER
WWM	WELDED WIRE MESH
XBRA	CROSS BRACING
XFMR	TRANSFORMER
XSTR	EXTRA STRONG
YD	YARD
YR	YEAR

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MARK	DESCRIPTION	DATE

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SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
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DESIGNED BY: J. TOE
DRAWN BY: J. TOE
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

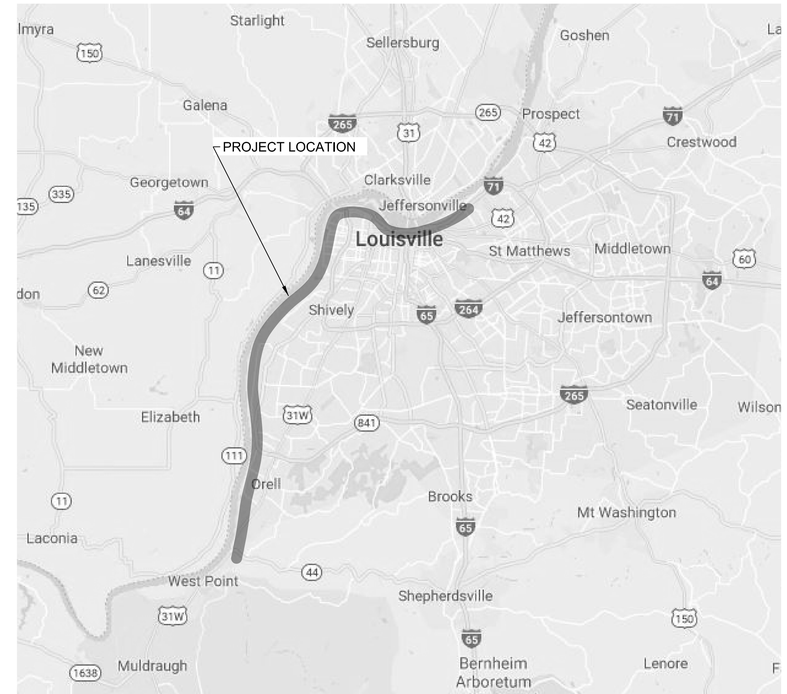
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

STANDARD ABBREVIATIONS

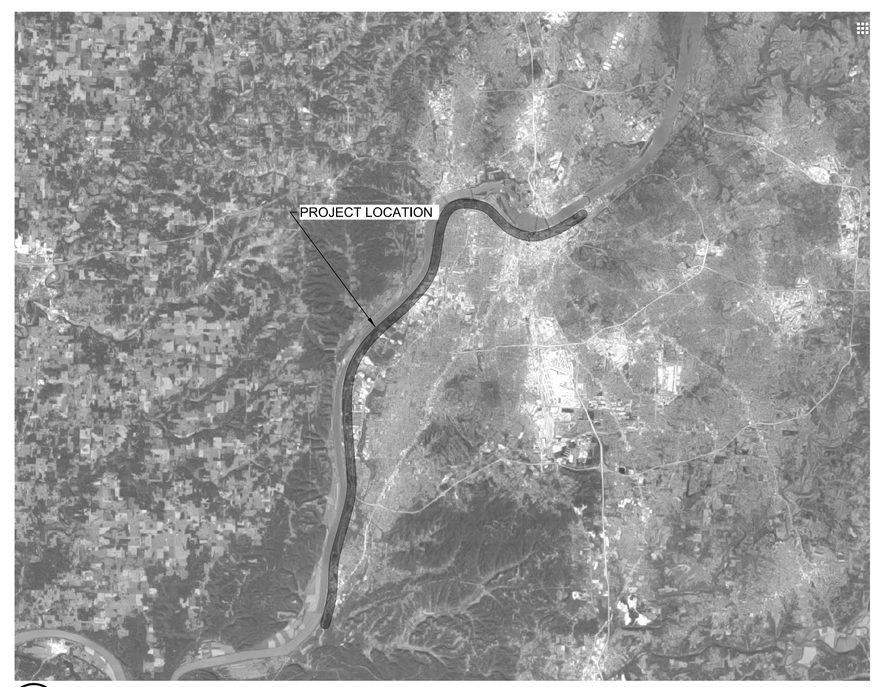
SHEET ID
G-004

CONCEPT SUBMITTAL

C1 AREA MAP
NTS



D6 VICINITY MAP
NTS



A6 LOCATION MAP
NTS

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600 DR. MARTIN LUTHER KING JR. PLACE
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LOCATION AND VICINITY MAPS

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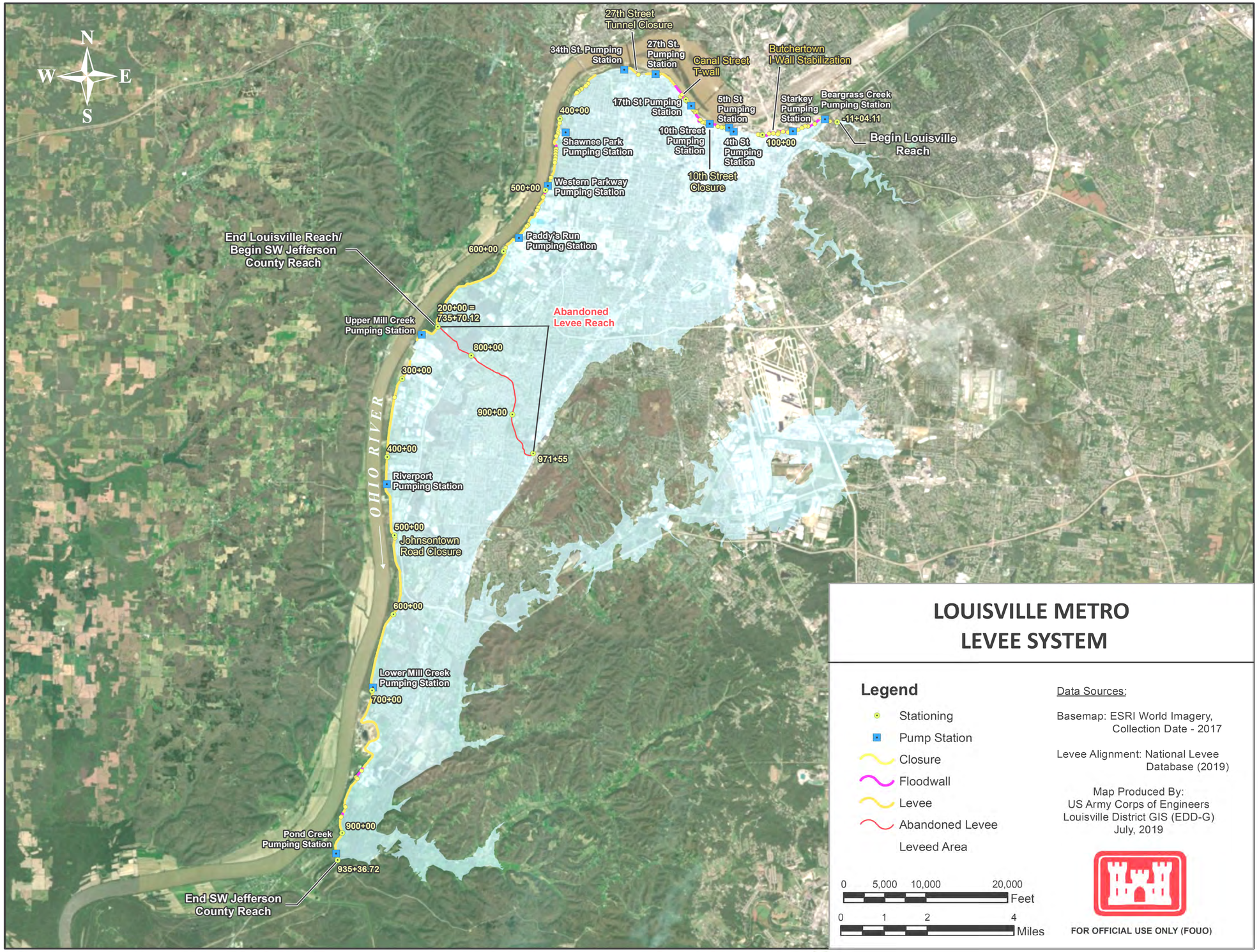
CONCEPT SUBMITTAL



LOUISVILLE METRO LEVEE SYSTEM

Legend

- Stationing
- Pump Station
- Closure
- Floodwall
- Levee
- Abandoned Levee
- Leveed Area

0 5,000 10,000 20,000 Feet

0 1 2 4 Miles

Data Sources:

Basemap: ESRI World Imagery, Collection Date - 2017

Levee Alignment: National Levee Database (2019)

Map Produced By:
US Army Corps of Engineers
Louisville District GIS (EDD-G)
July, 2019

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OHIO RIVER
LOUISVILLE LEVEE SYSTEM
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AERIAL PHOTOGRAPH

SHEET ID
G-006

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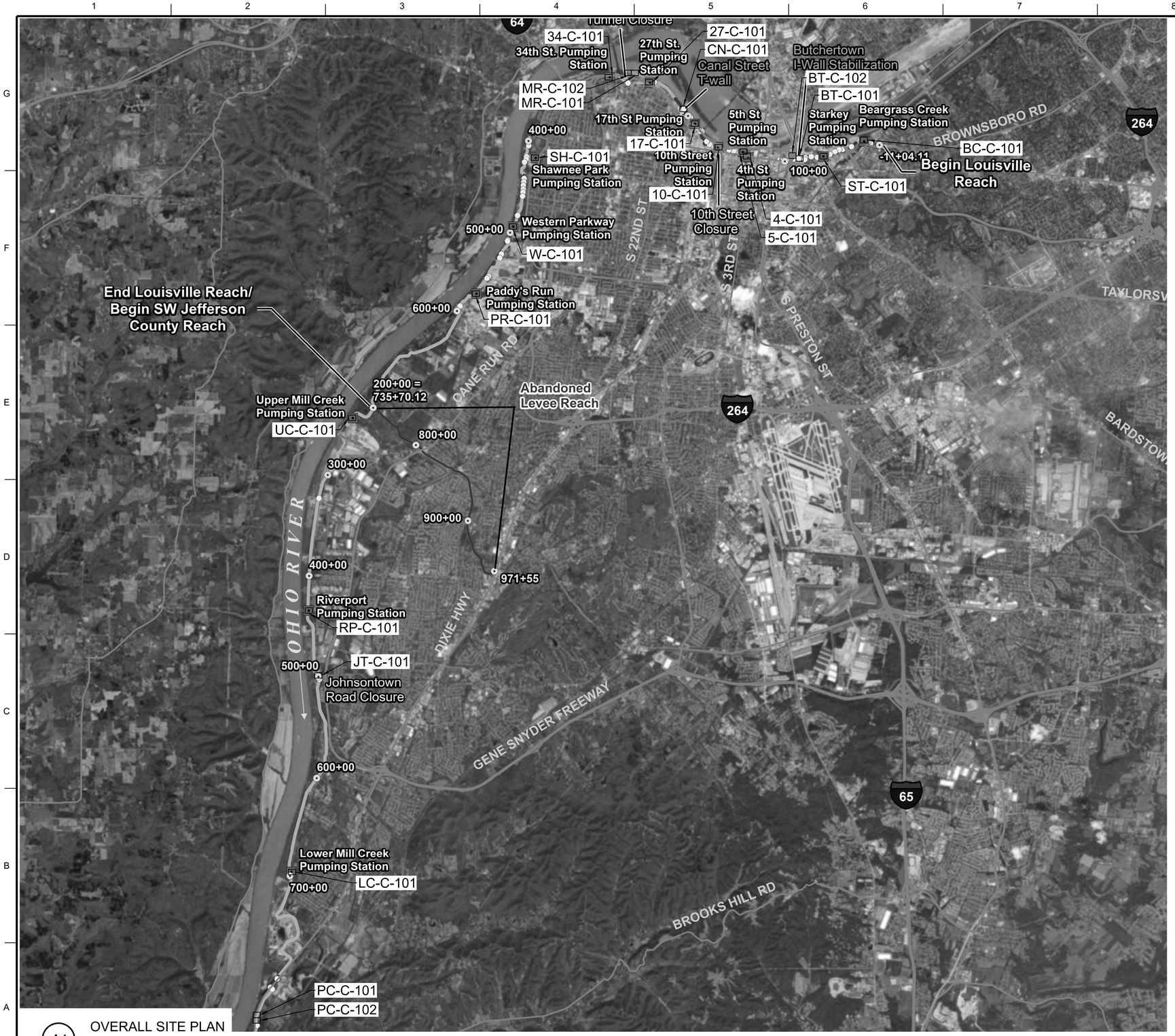

A1 OVERALL SITE PLAN

1"=600'

0 5000' 10000'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET, UNLESS INDICATED OTHERWISE.

LEGEND

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OHIO RIVER
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OVERALL SITE PLAN

SHEET ID
CS-C-101

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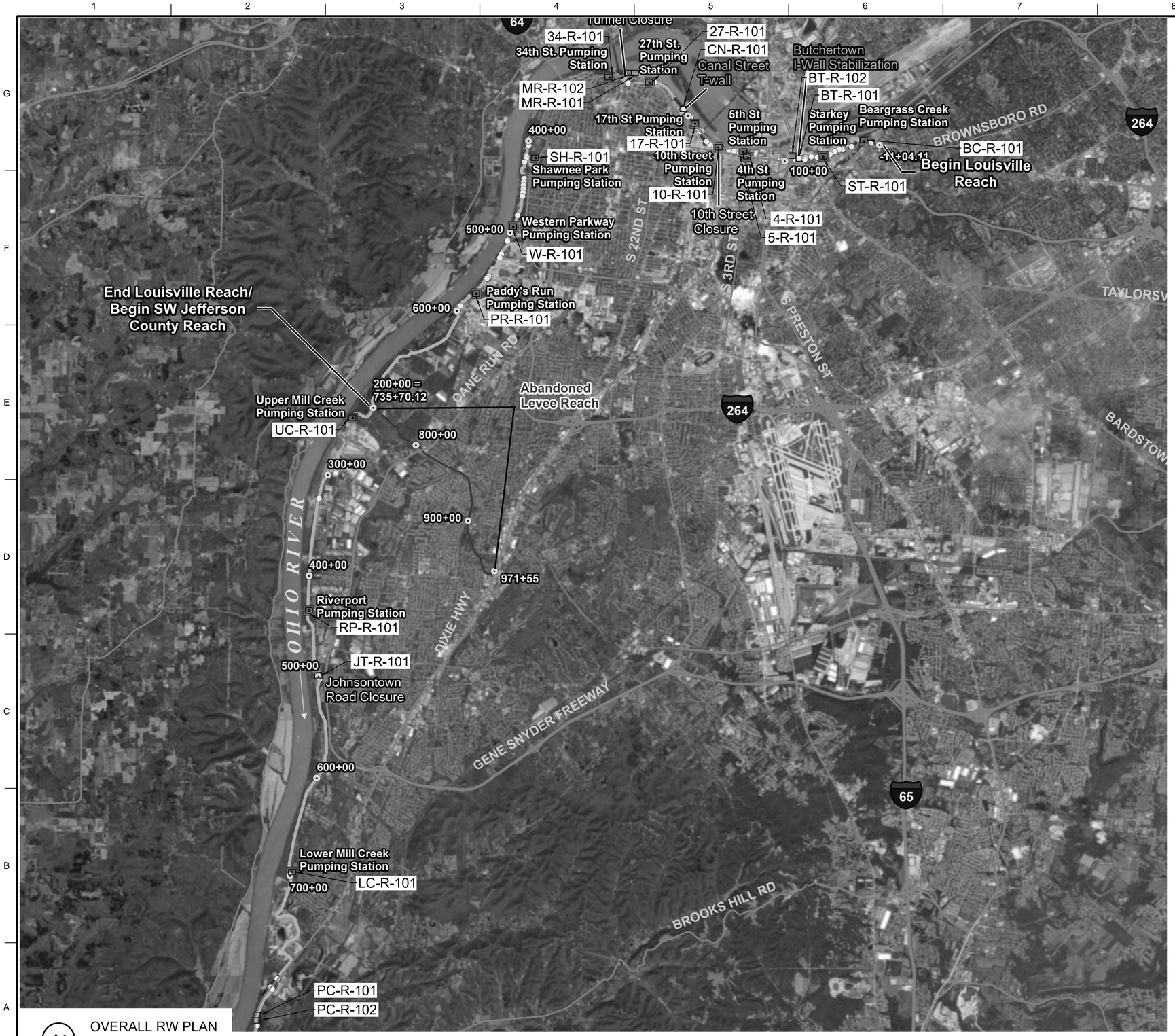

A1 OVERALL RW PLAN

1"=600'

0 5000' 10000'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET, UNLESS INDICATED OTHERWISE.

LEGEND

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OVERALL RIGHT OF WAY PLAN

SHEET ID
RW-R-101

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CONCEPT SUBMITTAL

A1 BEARGRASS CREEK PUMP STATION SITE PLAN
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

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BEARGRASS CREEK PS
SITE PLAN

SHEET ID
BG-C-101

CONCEPT SUBMITTAL

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A1 BEARGRASS CREEK PS RIGHT OF WAY PLAN
1"=50'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

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600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

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ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
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BEARGRASS CREEK PS
RIGHT OF WAY

SHEET ID
BG-R-101

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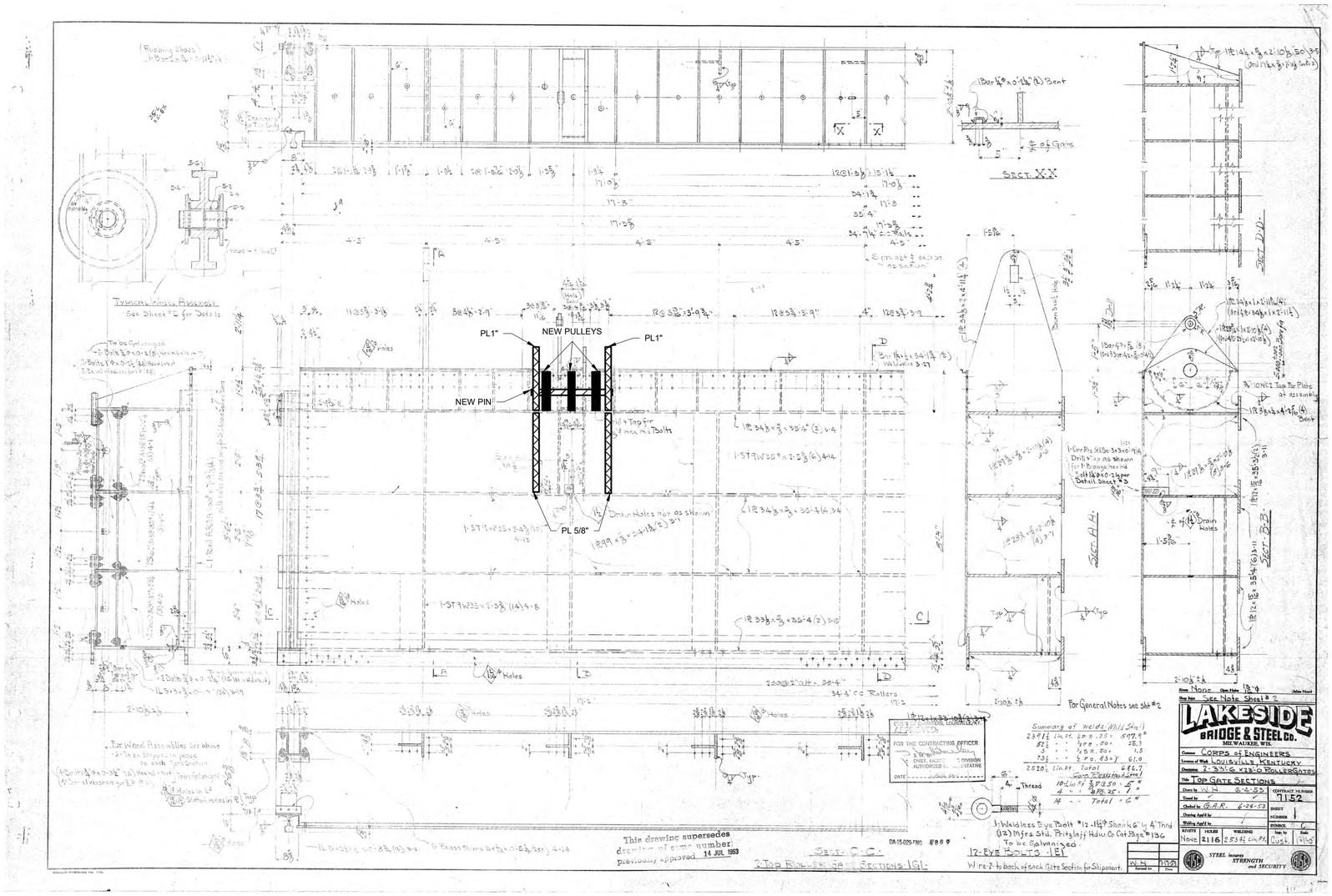
CONCEPT SUBMITTAL

NOTE:
1. ADD TWO PL1" OF SAME SIZE AND SHAPE AS EXISTING LIFTING PLATES.
2. ADD TWO PL 5/8" CONTINUITY PLATES OF THE SAME SIZE AND SHAPE AS EXISTING CONTINUITY PLATES
3. REPLACE PIN WITH LONGER PIN TO ACCOMMODATE A THIRD PULLEY.
4. GATE IS SYMMETRICAL, SECOND LIFTING POINT NOT SHOWN FOR CLARITY



1 TOP GATE SECTION
N.T.S.

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

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CHECKED BY: C. YOUNG
SUBMITTED BY:
CODE
SIZE
ANSI D

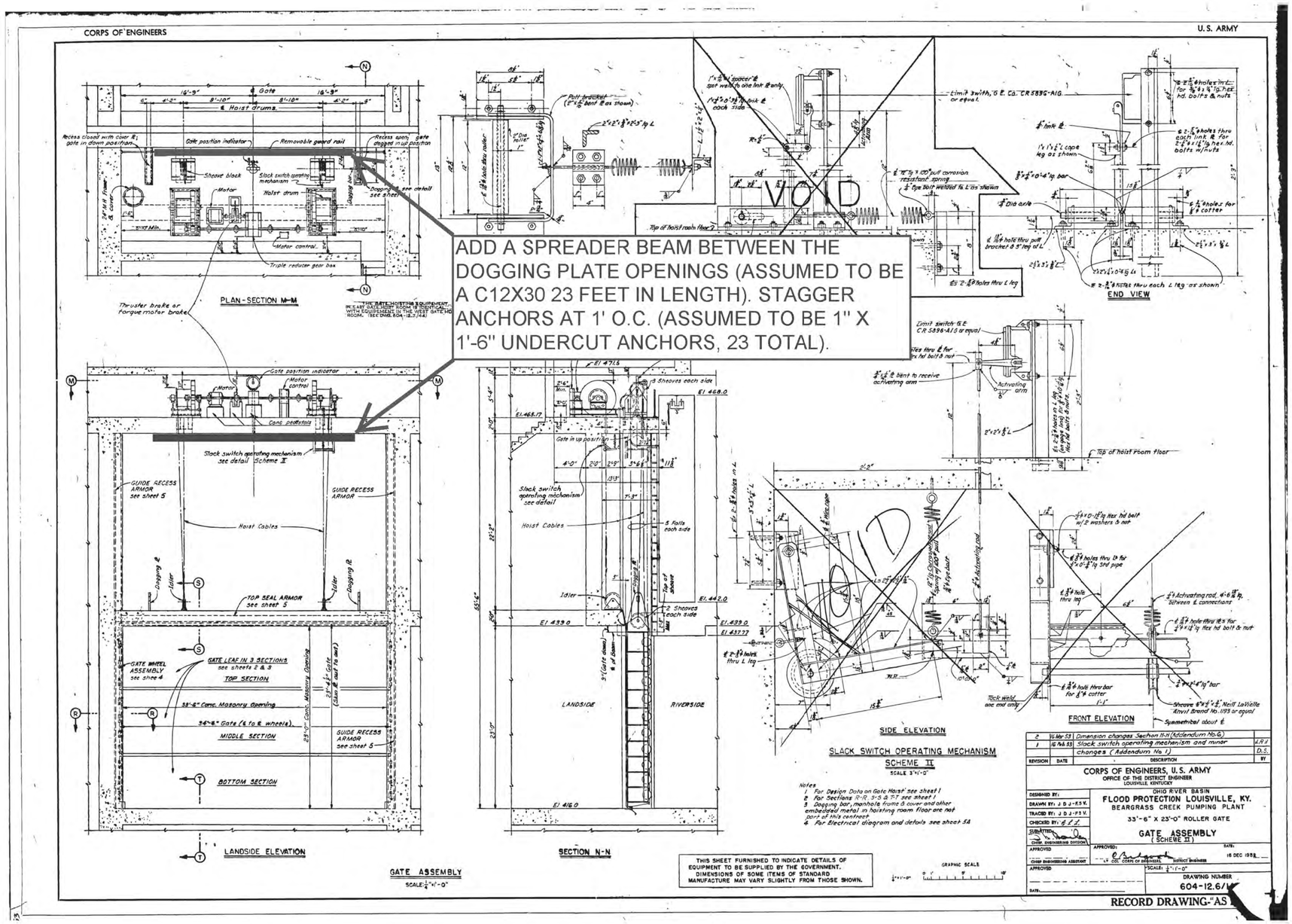
US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR MARTIN LUTHER KING JR PLACE

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

BEARGRASS CREEK TOP GATE SECTION

SHEET ID
BG-S-101

CONCEPT SUBMITTAL



1 SPREADER BEAM

N.T.S.

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

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DRAWN BY: B. EVANS	SOLICITATION NO.:
CHECKED BY: C. YOUNG	CONTRACT_NO.:
SUBMITTED BY: J. TYCE	DRAWING CODE:
SIZE: ANSI D	

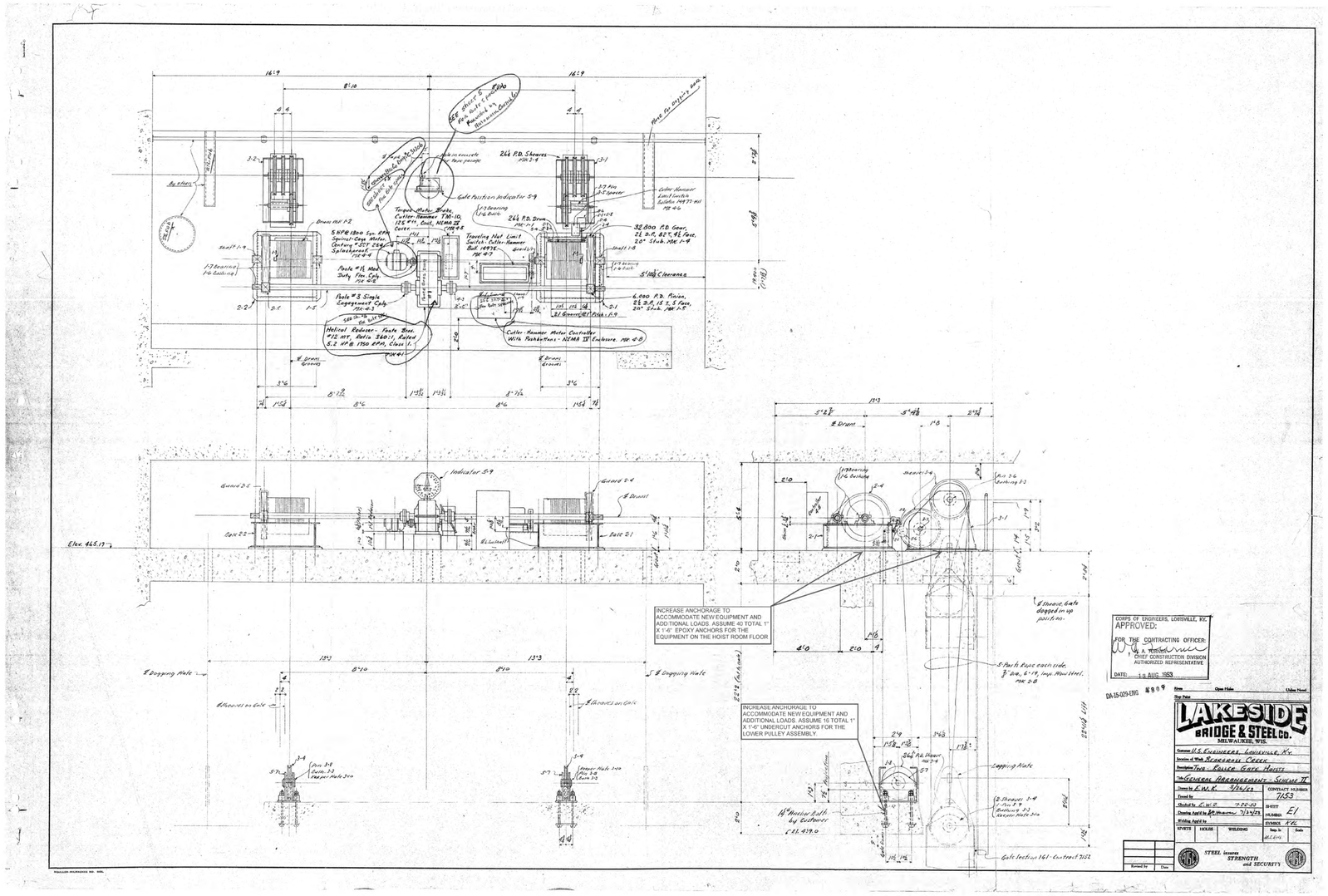
US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR MARTIN LUTHER KING JR PLACE

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

BEARGRASS CREEK SPREADER BEAM

SHEET ID

BG-S-102



1 ANCHORAGE
N.T.S.

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
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CHECKED BY: C. YOUNG
SUBMITTED BY:
SIZE: ANSI D
J. SIZE

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR MARTIN LUTHER KING JR PLACE

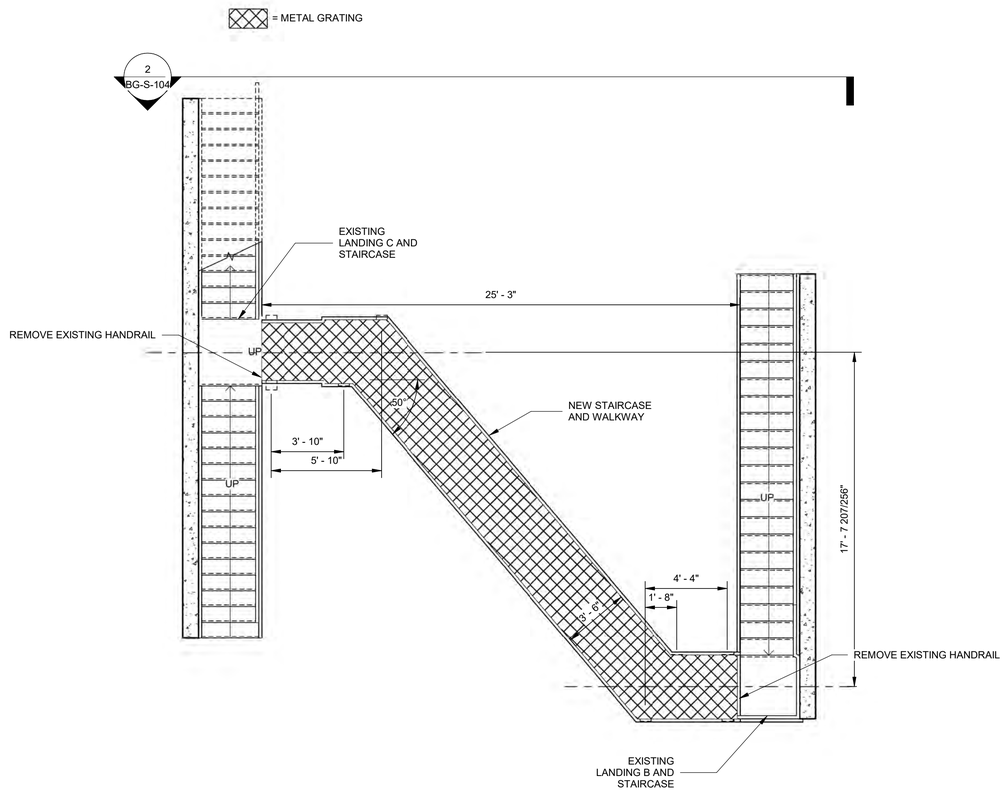
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

BEARGRASS CREEK ANCHORAGE PLAN

SHEET ID
BG-S-103

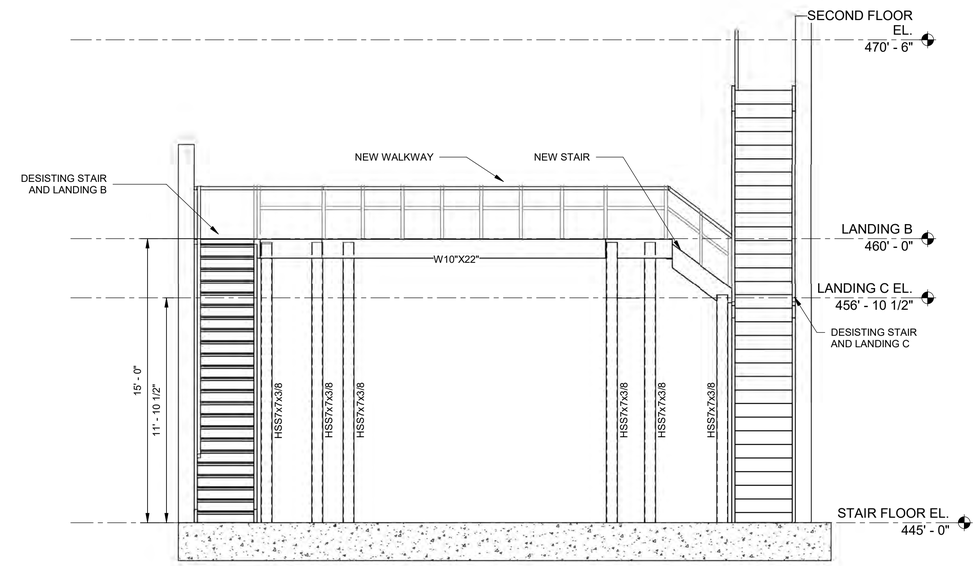
ALL DIMENSIONS AND ELEVATIONS ARE APPROXIMATE. FIELD VERIFY

MODIFY EXISTING RAILING AS NEEDED.



1 INTERIOR WALKWAY PLAN

1/4" = 1'-0"



2 BG-S-104 INTERIOR WALKWAY SECTION

1/4" = 1'-0"

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MARK	DESCRIPTION	DATE

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR MARTIN LUTHER KING JR PLACE

DESIGNED BY: B. EVANS
DRAWN BY: B. EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

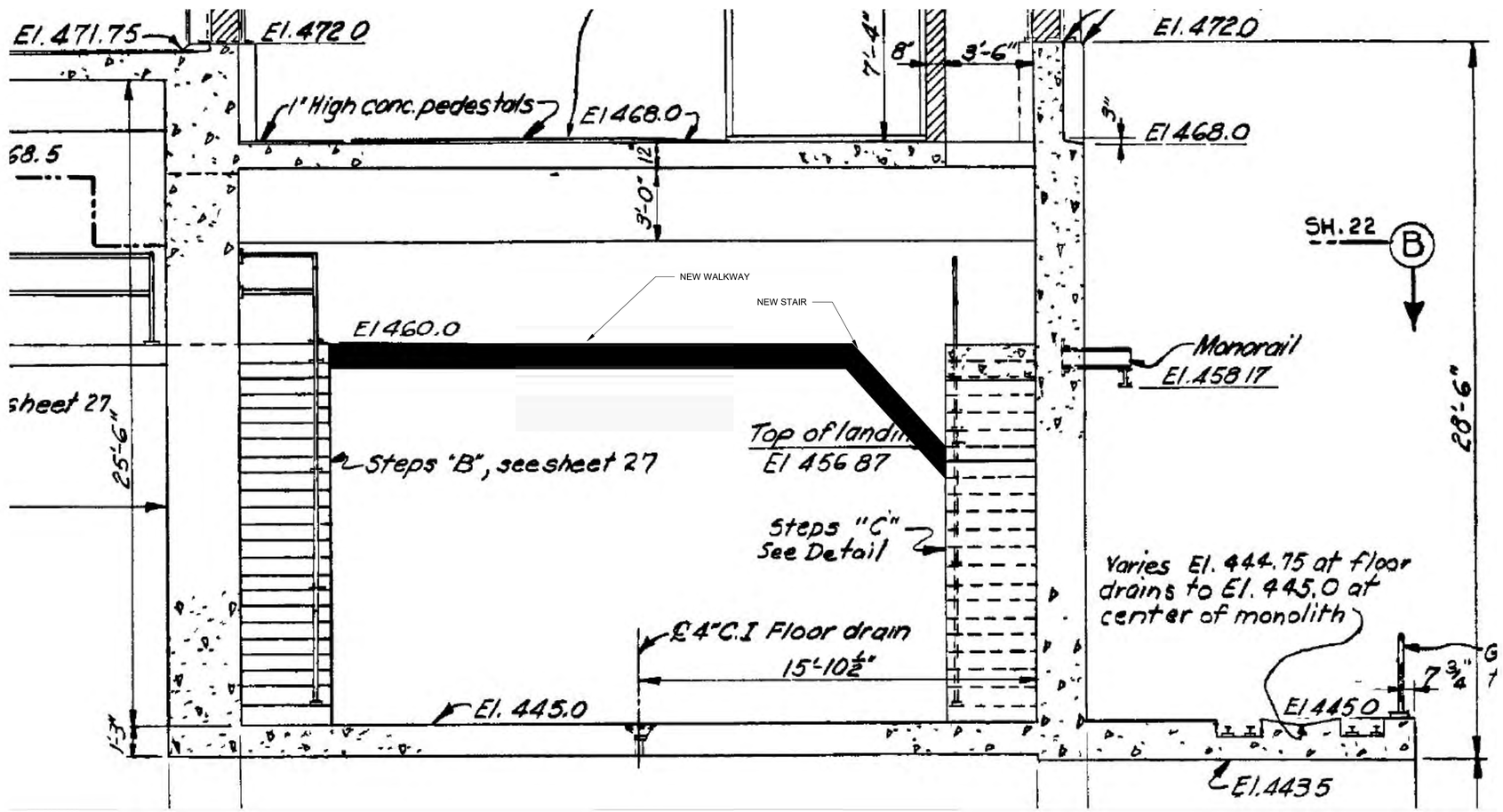
BEARGRASS CREEK INTERIOR WALKWAY-ALTERANTE 1

SHEET ID
ALT 1
BG-S-104

CONCEPT SUBMITTAL

NOTE: CRANE COVERAGE WILL BE LIMITED UNDER NEW WALKWAY; INSTALLATION OF AN ADDITIONAL CRANE OR A REMOVABLE SECTION OF WALKWAY WILL BE REQUIRED.

NOTE: WALKWAY COLUMNS NOT SHOWN FOR CLARITY



1 WALKWAY ELEVATION CONCEPT
N.T.S.

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR PLACE

DESIGNED BY: B. EVANS
DRAWN BY: B. EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TYDE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

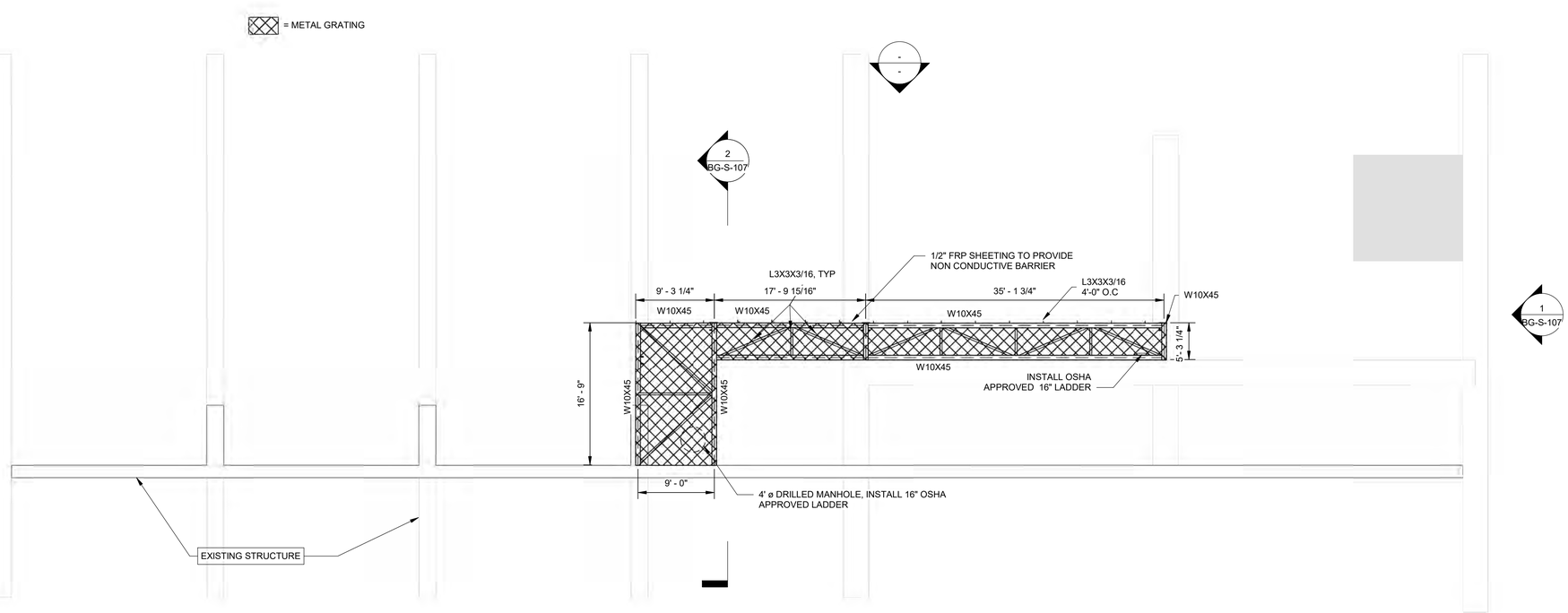
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

BEARGRASS CREEK INTERIOR WALKWAY NOTES-ALTERNATE 1

SHEET ID
ALT 1
BG-S-105

CONCEPT SUBMITTAL

ALL DIMENSIONS AND ELEVATIONS ARE APPROXIMATE



1 EXTERIOR WALKWAY
1/8" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

DESIGNED BY: B. EVANS
DRAWN BY: H.ESTES
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOTE
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR MARTIN LUTHER KING JR PLACE

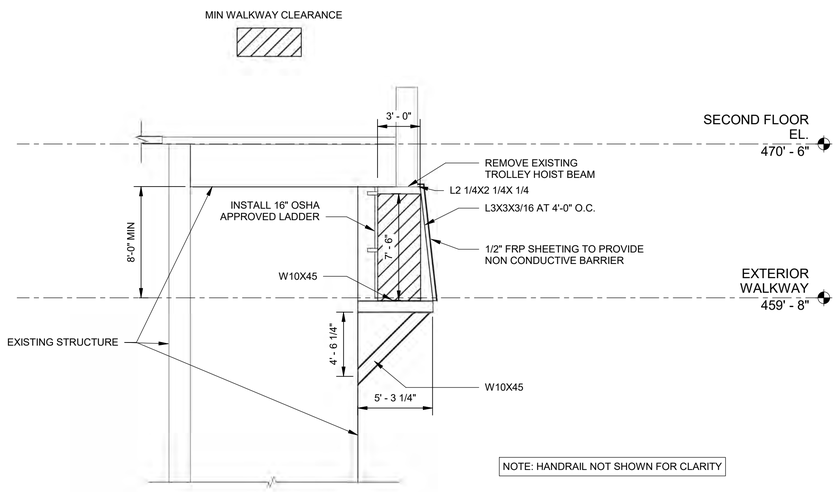
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

BEARGRASS CREEK EXTERIOR WALKWAY-ALTERNATE 2

SHEET ID
ALT 2
BG-S-106

CONCEPT SUBMITTAL

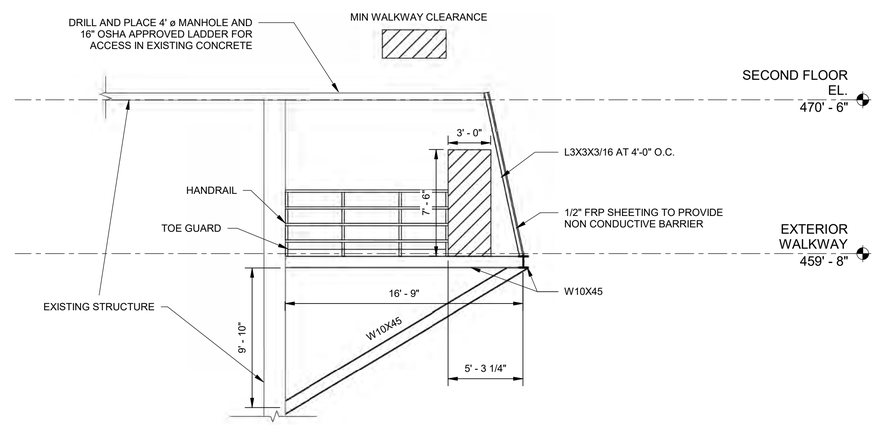
NOTE: EXISTING STRUCTURE DIMENSIONS AND ELEVATIONS ARE APPROXIMATE; FIELD VERIFY



1
BG-S-106

GATE SIDE ELEVATION

3/16" = 1'-0"



2
BG-S-106

ACCESS SECTION

3/16" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

DESIGNED BY: B. EVANS
DRAWN BY: H. ESTES
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOTE
SIZE: ANSI D

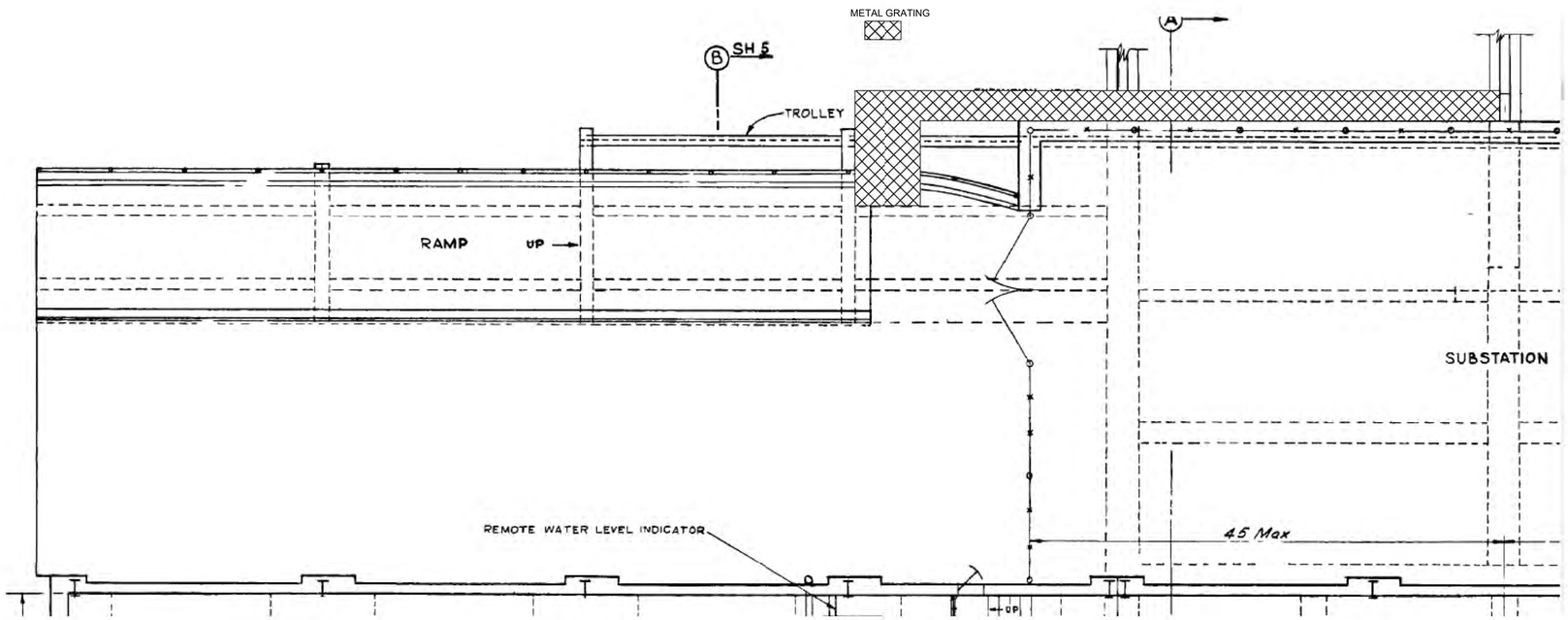
US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR MARTIN LUTHER KING JR PLACE

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

BEARGRASS CREEK EXTERIOR WALKWAY-
ALTERNATE 2

SHEET ID
ALT 2
BG-S-107

CONCEPT SUBMITTAL



1 WALKWAY PLAN CONCEPT

N.T.S.

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR MARTIN LUTHER KING JR PLACE

DESIGNED BY: B. EVANS
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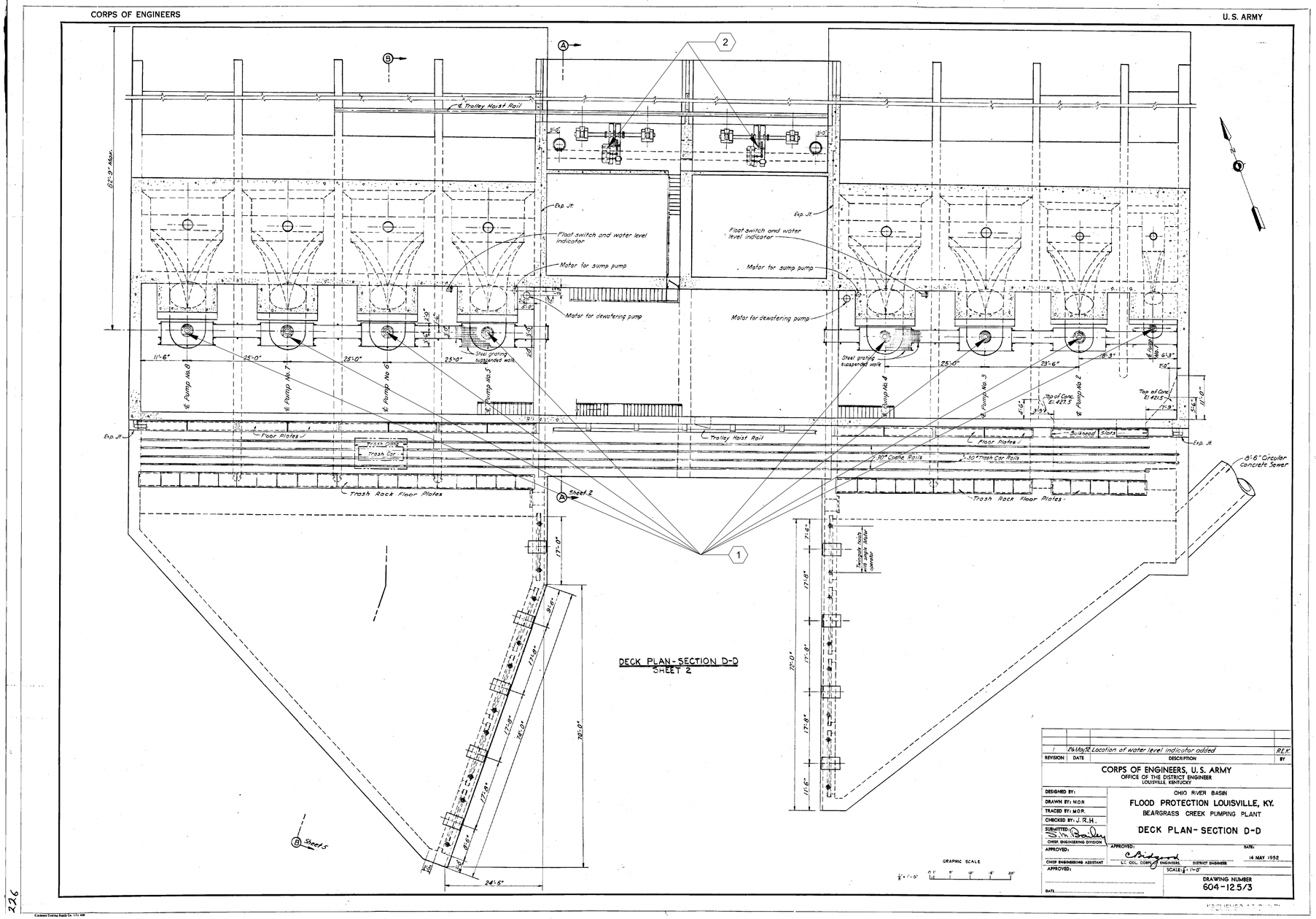
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

BEARGRASS CREEK EXTERIOR WALKWAY
NOTES- ALTERNATE 2

SHEET ID
ALT 2
BG-S-108

CONCEPT SUBMITTAL



PUMP DATA				
PUMP #	TYPE	DESIGN FLOW (GPM)	TDH (FT OF WATER)	NOTES
1	COLUMN	52,750	43.0	RECONDITION PUMP
2	COLUMN	300,000	25.8	RECONDITION PUMP
3	COLUMN	350,000	27.5	RECONDITION PUMP
4	COLUMN	350,000	27.5	RECONDITION PUMP
5	COLUMN	350,000	27.5	RECONDITION PUMP
6	COLUMN	350,000	27.5	RECONDITION PUMP
7	COLUMN	350,000	27.5	RECONDITION PUMP
8	COLUMN	350,000	27.5	RECONDITION PUMP

SHEET KEYNOTES

1. REBUILD EACH PUMP TO FACTORY SPECIFICATIONS. DISCONNECT COLUMNS AT WALL CONNECTION. ABRASIVE BLAST COLUMNS TO WHITE METAL AND COAT WITH C200A.
2. REPLACE RIVERGATE OPERATING MACHINERY. SEE GATE SHEET FOR DETAILS

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

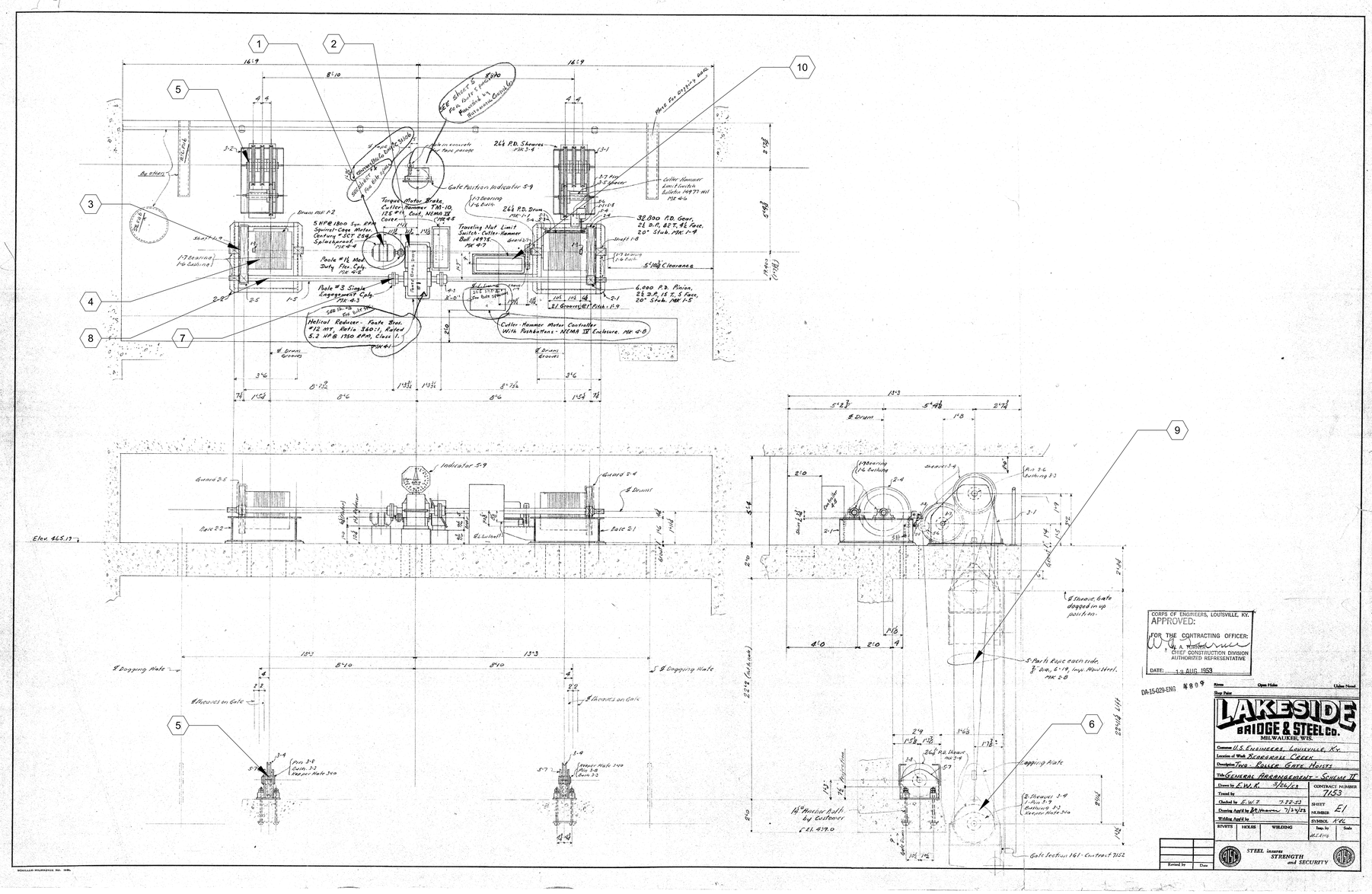
DESIGNED BY: K. BURNS
DRAWN BY: K. BURNS
CHECKED BY:
SUBMITTED BY: J. TOTE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

BEARGRASS CREEK PS
MECHANICAL PLANS

SHEET ID
BG-M-101

CONCEPT SUBMITTAL



CORPS OF ENGINEERS, LOUISVILLE, KY.
APPROVED:
FOR THE CONTRACTING OFFICER:
A. WINNER
CHIEF CONSTRUCTION DIVISION
AUTHORIZED REPRESENTATIVE
DATE: 12 AUG 1953

DA-15-029-ENG 4809

LAKESIDE BRIDGE & STEEL Co.
MILWAUKEE, WIS.

Customer	U.S. ENGINEERS, LOUISVILLE, KY.
Location of Work	BEARGRASS CREEK
Description	TWO ROLLER GATE HOISTS
Title	GENERAL ARRANGEMENT - SCHEME II
Drawn by	E.W.R. 4/26/53
Traced by	
Checked by	E.W.T. 7-22-53
Drawing Appd by	
Welding Appd by	
CONTRACT NUMBER	7153
SHEET NUMBER	E1
SYMBOL	KL
Dwg. by	Sizing
Scale	

REVISITS | HOLES | WELDING

STEEL insures STRENGTH and SECURITY

GENERAL SHEET NOTES

1. EQUIPMENT LAYOUT IS IDENTICAL FOR BOTH GATES

SHEET KEYNOTES

1. REPLACE CURRENT MOTOR WITH 10 HP MOTOR OPERATING AT 1,655 RPM.
2. REPLACE GEARBOX WITH 400:1 GEAR RATIO RATED AT 10 HP, WITH INPUT SPEED OF 1,655 RPM.
3. REPLACE OPEN GEARS WITH GEARS RATED FOR HIGHER LOADING CONDITION. PINION IS 15 TEETH, GEAR IS 82 TEETH, INPUT TORQUE IS EST 6,150 FT-LBS, OUTPUT TORQUE IS EST 29,605 FT-LBS.
4. REPLACE DRUM WITH 1.125" GROOVE, 26.25" PITCH DIAMETER DRUM.
5. REPLACE ALL SHEAVES WITH 1.125" GROOVE, 26.25" PITCH DIAMETER SHEAVES. TOTAL OF 16 SHEAVES PER GATE.
6. ADD SHEAVE TO GATE TO MAKE 6 PART ROPE HOIST. SEE STRUCTURAL DWGS FOR SHEAVE INSTALLATION AND CABLE ANCHOR DETAILS.
7. NEW GEAR COUPLINGS FOR RATED TORQUE. LOVEJOY FFR-TYPE FLEX-RIGID COUPLING, SIZE 3.5.
8. NEW TORQUE SHAFT. STEEL TUBE OD 4.25", ID 3.375"
9. NEW WIRE ROPE TO BE 1 1/8" DIAMETER EXTRA EXTRA IMPROVED PLOW STEEL, 6X36 IWRC.
10. RECALIBRATE/REPLACE LIMIT SWITCH

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXX

DESIGNED BY: K. BURNS
DRAWN BY: K. BURNS
CHECKED BY: K. BURNS
SUBMITTED BY: J. TYOE
SIZE: ANSI D

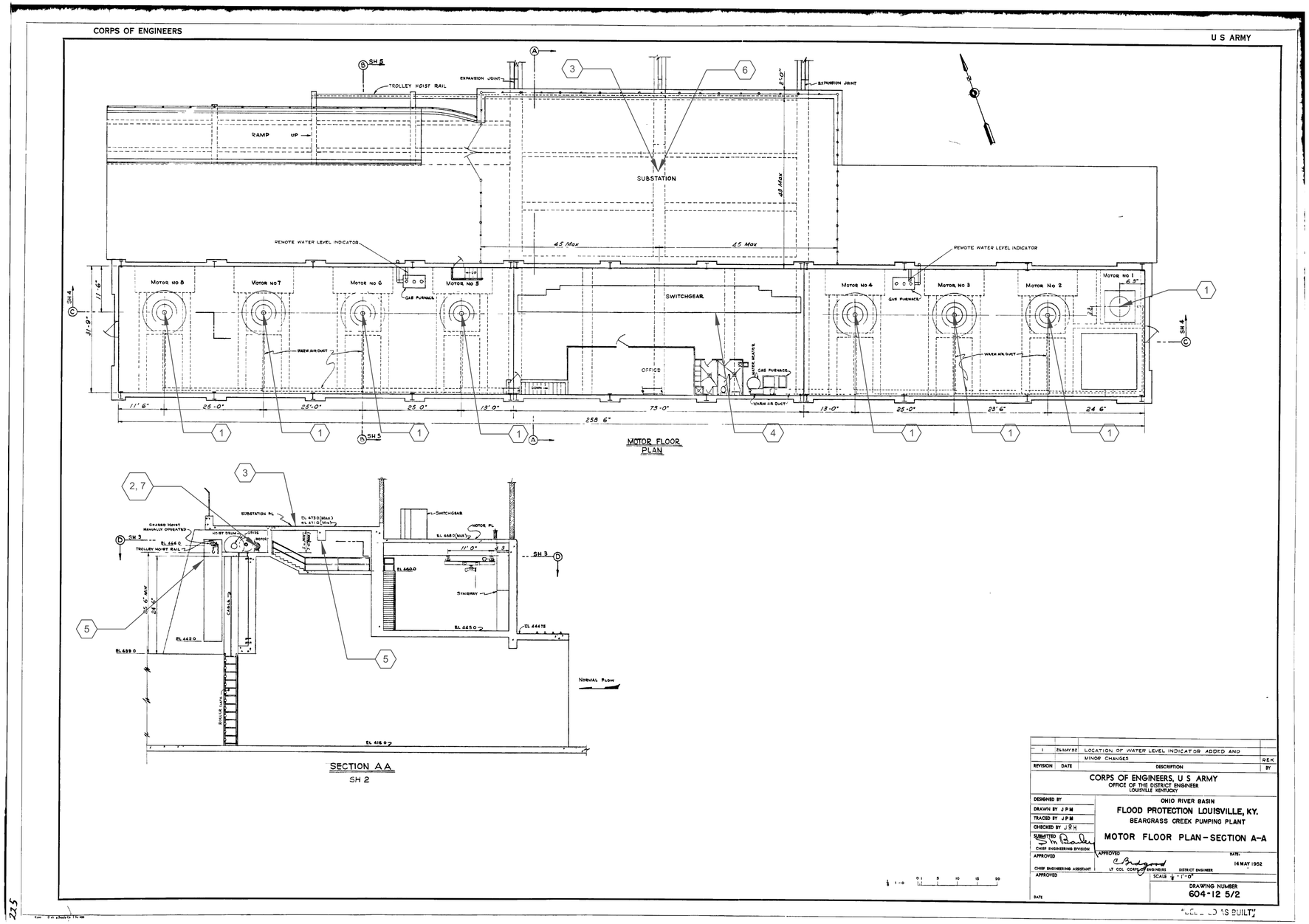
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

BEARGRASS CREEK RIVER
GATE LIFTING EQUIPMENT

SHEET ID
BG-M-102

CONCEPT SUBMITTAL



GENERAL SHEET NOTES

1. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED APPENDIX 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.
2. CURRENTLY, ONLY CHANGES INDICATED ARE REFURBISHMENT OF ROLLER GATE MOTOR AND CONTROLS, ALONG WITH REPLACEMENT OF SERVICE TRANSFORMERS AND ASSOCIATED EQUIPMENT.
3. THE ADDITION OF LEVEL TRANSDUCERS BOTH UPSTREAM AND DOWNSTREAM ARE INDICATED BUT NOT SHOWN.
4. SEE BEARGRASS PS SHEET E-102 FOR ADDTIONAL INFORMATION ON ROLLER GATE WORK.

SHEET KEYNOTES

1. PUMP MOTOR LOCATIONS. NO UPGRADES FOR PUMP MOTORS OR PUMP MOTOR CONTROLS SHALL BE PERFORMED. PUMP UPGRADES WILL REQUIRE MOTORS TO BE DISASSEMBLED TO PULL PUMPS OUT. MOTORS SHALL BE INSPECTED AND REPLACEMENT OF ANY DEFICIENT ITEMS WILL OCCUR UPON INSPECTION.
2. REPLACE 5 HP GATE HOIST MOTOR WITH NEW 10 HP MOTOR.
3. PUMP STATION SUBSTATION LOCATION. GATE HOIST MOTOR REPLACEMENT IS BELOW THIS LOCATION. TEMPORARY SUBSTATION MAY BE NECESSARY DURING GATE HOIST EQUIPMENT UPGRADE.
4. STATION SWITCHGEAR LOCATION
5. WATER LEVEL TRANSDUCERS SHALL BE INSTALLED TO MEASURE WATER LEVEL ON UPSTREAM AND DOWNSTREAM SIDES OF GATE.
6. TRANSFORMERS AND ASSOCIATED SERVICE EQUIPMENT TO BE REPLACED IN SUBSTATION
7. ROLLER GATE CONTROL PANEL

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

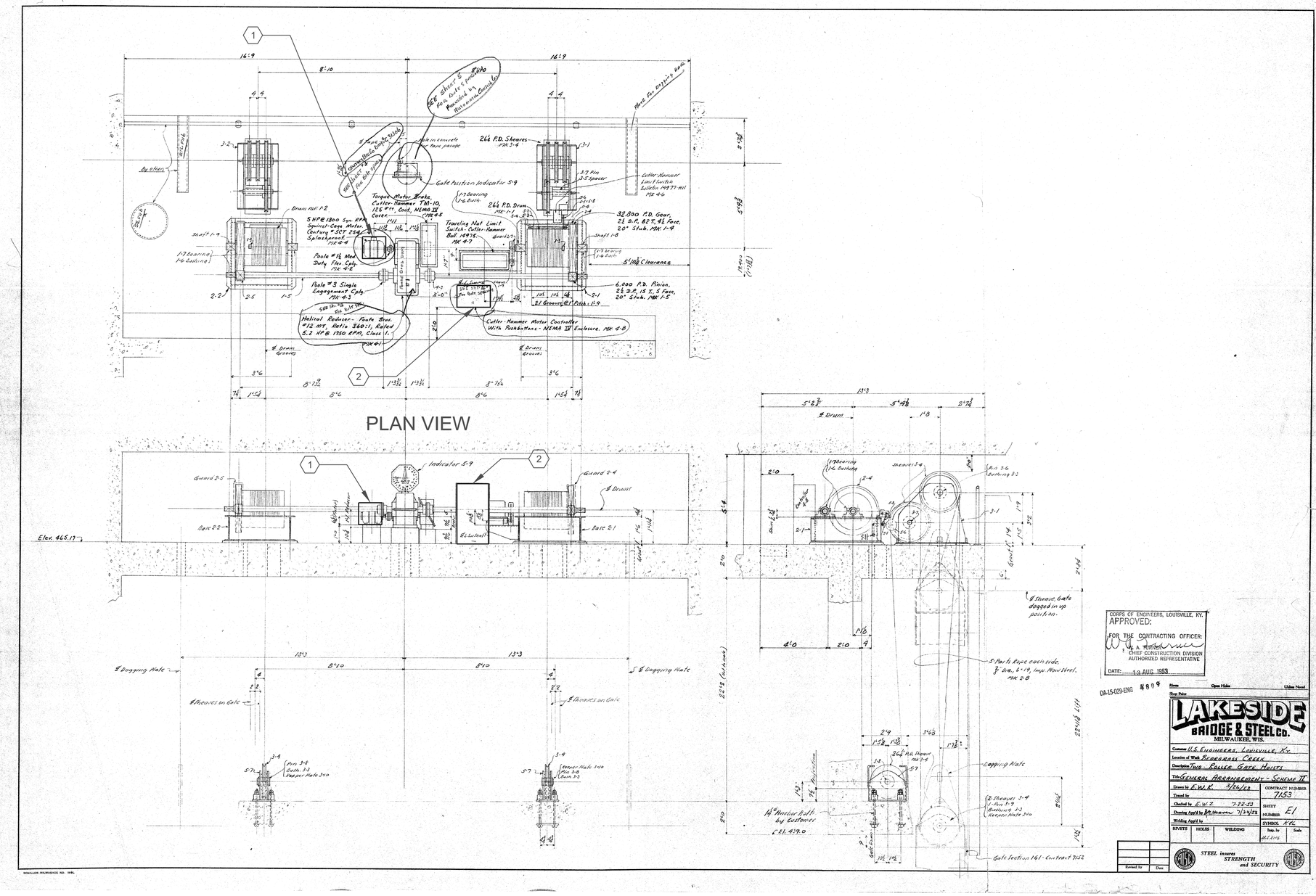
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

BEARGRASS CREEK PS ELECTRICAL PLAN

SHEET ID
BG-E-101

A1 BEARGRASS CREEK PS ELECTRICAL PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL



GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. REPLACE CURRENT MOTOR WITH 10 HP MOTOR OPERATING AT 1,655 RPM.
2. ROLLER GATE CONTROLS - TO BE UPGRADED TO MODERN EQUIVALENT

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

BEARGRASS CREEK PS ROLLERGATE DECK ELECTRICAL PLAN

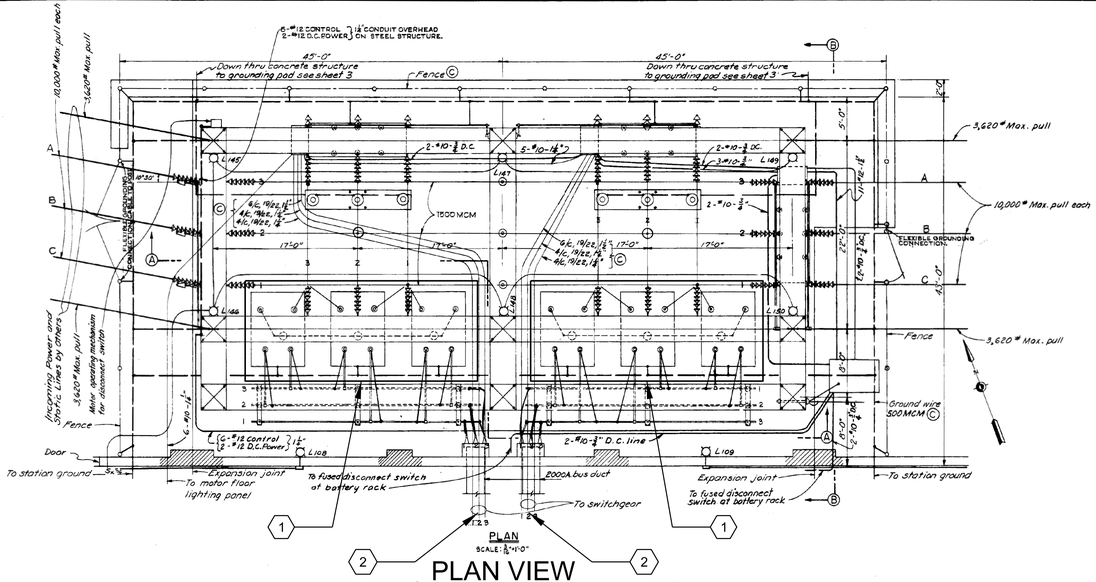
SHEET ID
BG-E-102

A1 BEARGRASS PUMP STATION - ROLLER GATE ELECTRICAL FLOOR PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL

CORPS OF ENGINEERS

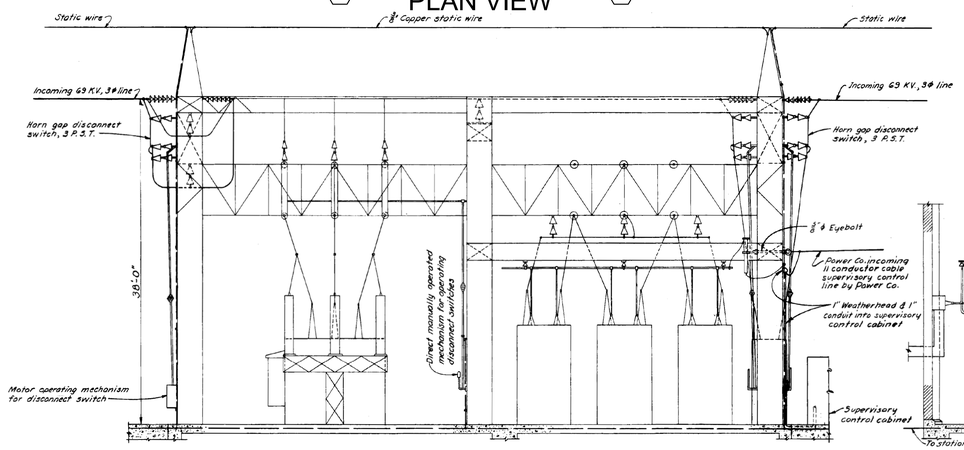
U.S. ARMY



PLAN

SCALE: 3/32"=1'-0"

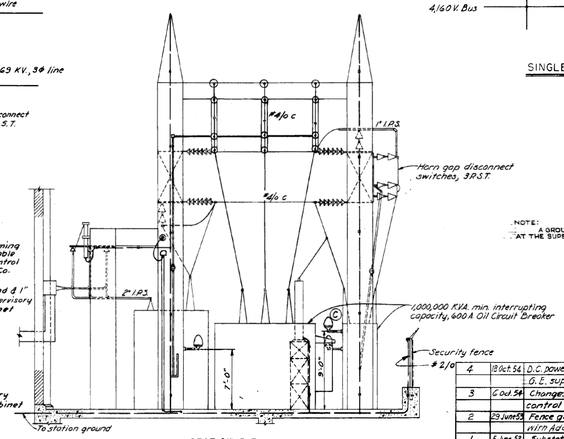
PLAN VIEW



SECTION A-A

SCALE: 3/32"=1'-0"

SECTION VIEW



SECTION B-B

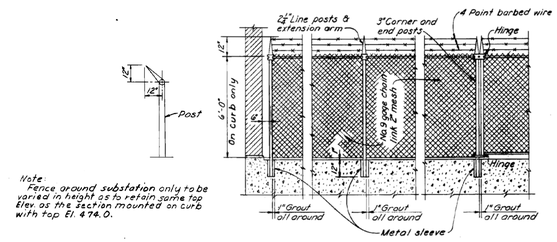
SCALE: 3/32"=1'-0"

SECTION VIEW

NOTE:
1. A GROUND CONNECTION WAS MADE AT THE SUPERVISORY CONTROL CABINET.

Notes:
1. Equipment to be furnished by Contractor. (C)
2. All other equipment furnished by the Government & installed by the Contractor.

GRAPHIC SCALES

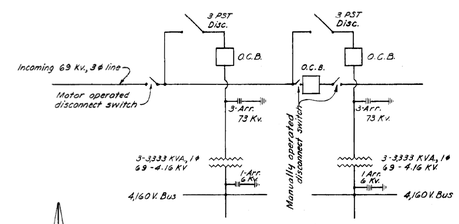


Note
Fence around substation only to be varied in height as to retain same top Elev. as the section mounted on curb with top El. 474.0.

SUBSTATION FENCE DETAIL

SCALE 3/8"=1'-0" (C)

FENCING DETAIL



SINGLE LINE DIAGRAM

SCALE: NONE

REVISION	DATE	DESCRIPTION	BY
4	18 Oct. 56	D.C. power & control leads changed to conform with G.E. supply contract (Contract Mod.)	D.S.
3	6 Oct. 56	Changes to accommodate installation of supervisory control equipment for substation (Contract Mod.)	D.S.
2	29 June 55	Fence grounding conduit & wiring revised in accordance with Add. #6	G.P.B.
1	5 June 53	Substation revised to accommodate two incoming power sources. (Add. No. 5.)	D.S.

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

DESIGNED BY: C.G. - D.S.
DRAWN BY: J.D.J.
TRACED BY: H.J.N.
CHECKED BY: C.J.
SUBMITTED: E.E. Karker
CHIEF, ENGINEERING DIVISION
APPROVED: J.P. Bailey
CHIEF ENGINEERING ASSISTANT
APPROVED:
DATE:

OHIO RIVER BASIN
FLOOD PROTECTION LOUISVILLE, KY.
BEARGRASS CREEK PUMPING PLANT
SUBSTATION

APPROVED: E.A. Lovell
LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER
DATE: 8 MAY 1953

SCALE: AS SHOWN
DRAWING NUMBER
604-12.7/55

RECORD DRAWING-"AS BUILT"

GENERAL SHEET NOTES

1. SUBSTATION EQUIPMENT TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. TWO 10000 KVA GROUPS OF TRANSFORMERS
2. SECONDARY SERVICE TRANSFORMER WIRING

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY:
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

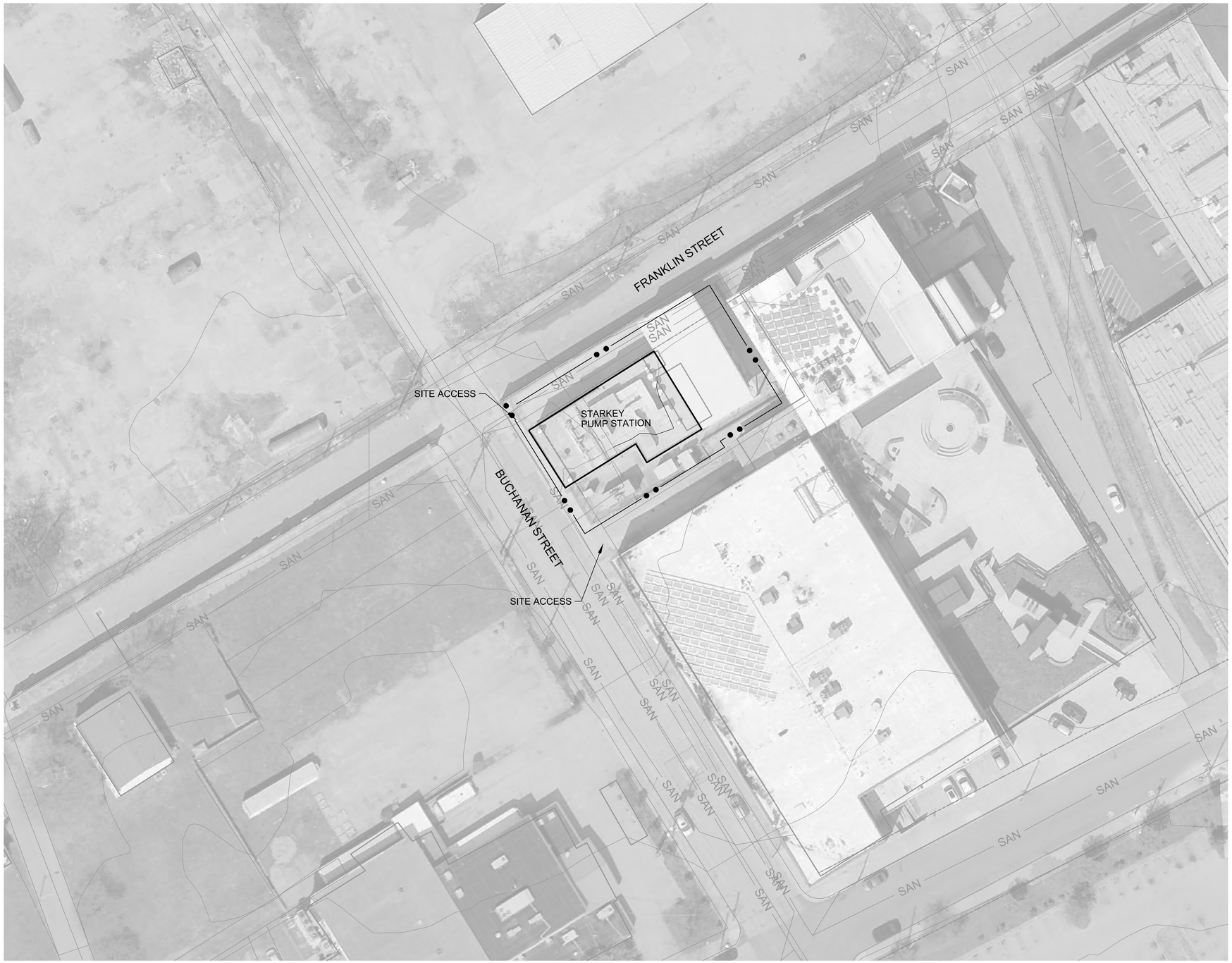
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 1456626

BEARGRASS CREEK PS SUBSTATION PLAN

SHEET ID
BG-E-103

A1 BEARGRASS PUMP STATION - SUBSTATION PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL



A1 STARKEY PS SITE PLAN
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

STARKEY PS SITE PLAN

SHEET ID
ST-C-101

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CONCEPT SUBMITTAL

A1 STARKEY PS RIGHT OF WAY PLAN
1"=50'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
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SIZE:
ISSUE DATE: AUGUST 2019
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DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

STARKEY PS RW
RIGHT OF WAY

SHEET ID
ST-R-101

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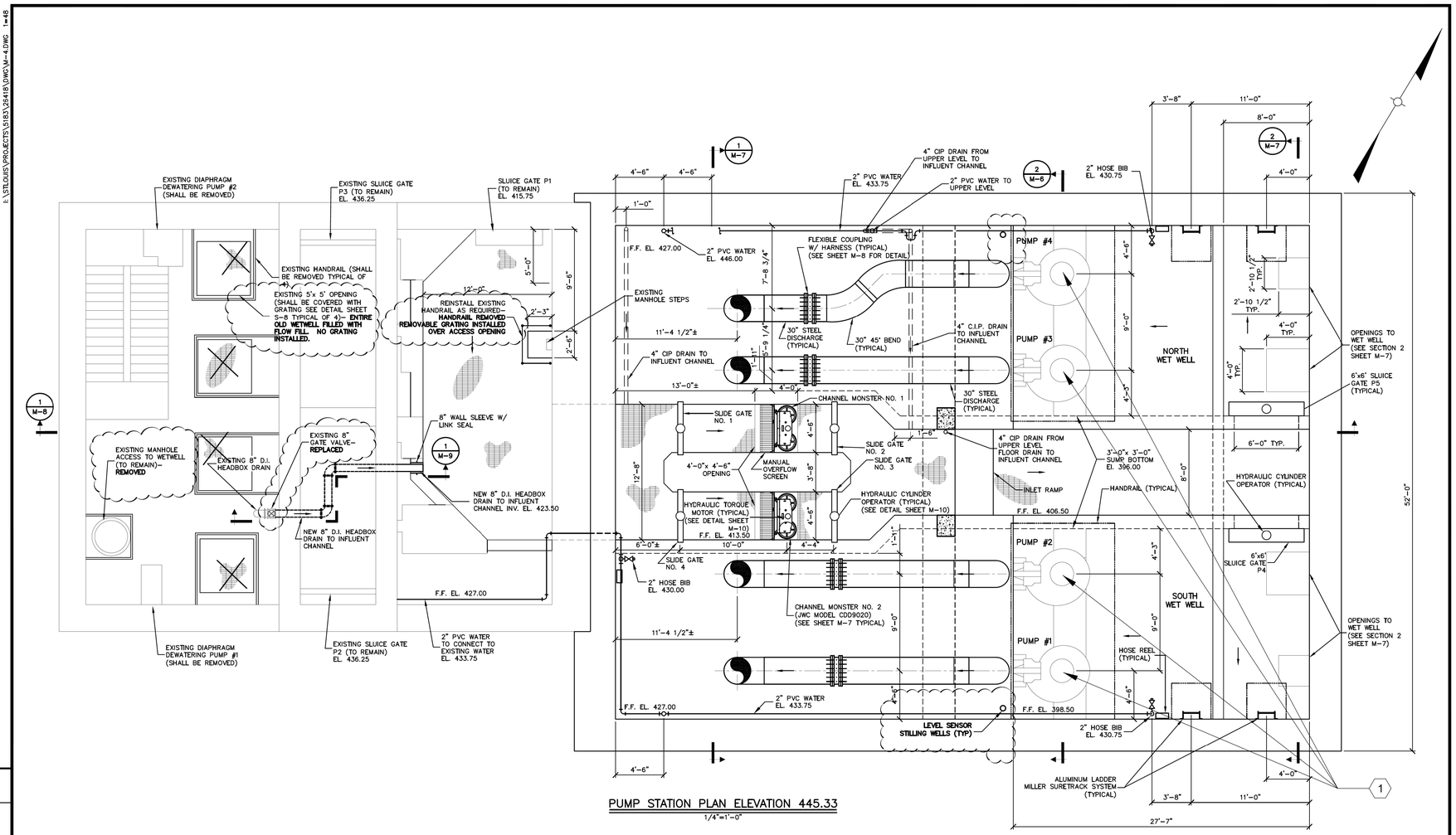
CONCEPT SUBMITTAL



PUMP STATION PLAN ELEVATION 445.33

1/4"=1'-0"

M-4

NAME	DATE
DRAWN BY: JMA	9/28/01
DESIGNED BY: BAS	9/28/01
CHECKED BY: KLM/PAL	9/28/01
RECORD DWG.	

NO.	DATE	REVISION	CHK'D	APPR'D	DATE
0	9/28/01	ISSUED FOR CONSTRUCTION			

MSD APPROVALS

Signature L.S.# — Land Surveyor's Seal

Signature P.E.# — Professional Engineer's Seal

PLANS PREPARED AND SUBMITTED BY: O'BRIEN & GERE ENGINEERS, INC. — Design Consultant

CONSTRUCTED BY: Company Name, Date

FINAL RECORD DRAWING BY: Company Name, Signature, Date — Final Record Drawing

Signature L.S.# — Land Surveyor's Seal

MSD Louisville and Jefferson County Metropolitan Sewer District, 700 W. Liberty St., Louisville, Ky. 40203-1913

BUCHANAN STREET PUMP STATION MODIFICATIONS

PUMP STATION PLAN ELEVATION 445.33

SCALE: 1/4"=1'-0" DATE: 9/28/01

BUDGET I.D. NO. 198364 CONSTRUCTION CONTRACT NO. 13933 RECORD NO. 13933 SHEET 39 OF 82

I:\STLOUIS\PROJECTS\5183\25418\DWG\M-4.DWG 1=48

SHEET KEYNOTES

1. REBUILD EACH PUMP TO FACTORY SPECIFICATIONS.

PUMP DATA				
PUMP #	TYPE	DESIGN FLOW (GPM)	TDH (FT OF WATER)	NOTES
1	SUBMERSIBLE	24,500	65.0	RECONDITION PUMP
2	SUBMERSIBLE	24,500	65.0	RECONDITION PUMP
3	SUBMERSIBLE	24,500	65.0	RECONDITION PUMP
4	SUBMERSIBLE	24,500	65.0	RECONDITION PUMP

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: K. BURNS
DRAWN BY: K. BURNS
CHECKED BY:
SUBMITTED BY:
SIZE: ANSI D

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX

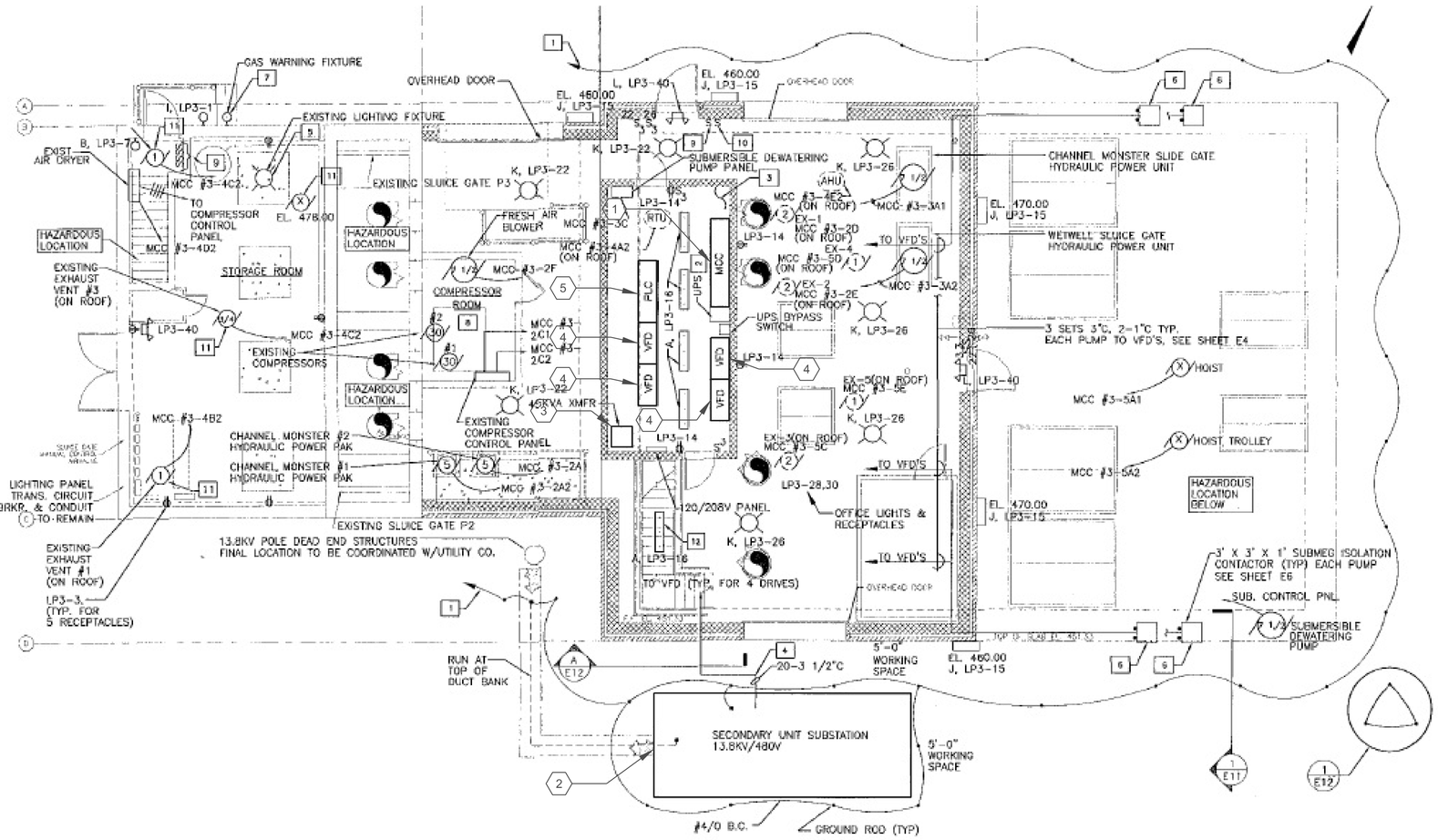
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

STARKEY PS
MECHANICAL PLAN

SHEET ID
ST-M-101

CONCEPT SUBMITTAL



A1 STARKEY PS ELECTRICAL PLAN

SCALE: NOT TO SCALE

GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT SECTION XXXX- ELECTRICAL WRITE UP AND ASSOCIATED APPENDIX 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/ COSTS.

SHEET KEYNOTES

1. MOTOR CONTROL CENTER WILL BE REPLACED WITH A MODERN DAY EQUIVALENT.
2. EXTERIOR SECONDARY UNIT SUBSTATION
3. A 112.5 KVA TRANSFORMER SHALL BE INSTALLED FOR BUILDING SUPPORT SYSTEMS. PUMP CONTROLS, LIGHTING, 208/120 VAC POWER, HVAC, ETC
4. VARIABLE FREQUENCY DRIVE
5. PUMP STATION PLC CONTROL PANEL

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. YOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

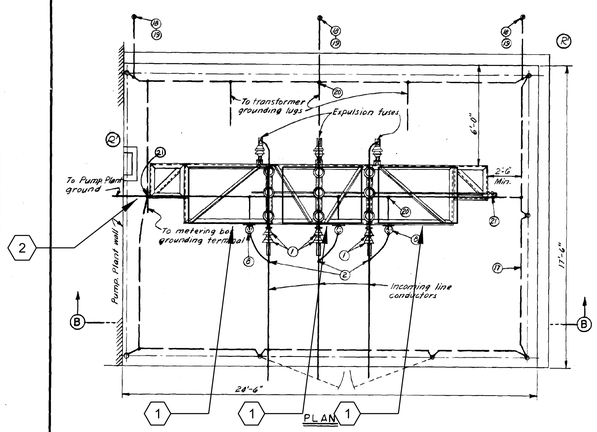
STARKEY PS ELECTRICAL PLAN

SHEET ID
ST-E-101

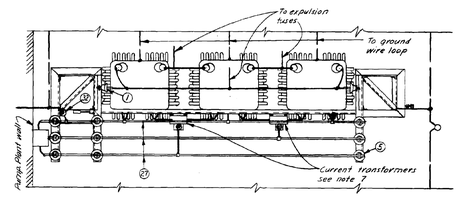
CONCEPT SUBMITTAL

CORPS OF ENGINEERS

U.S. ARMY



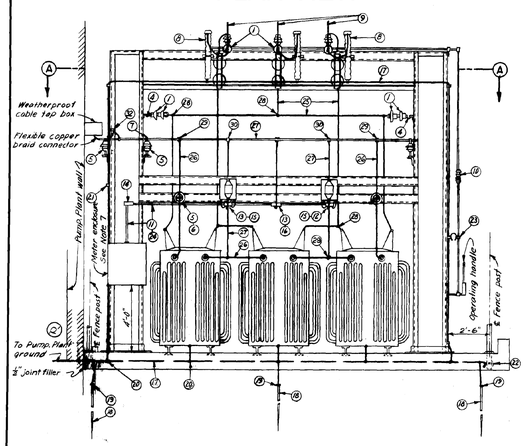
PLAN VIEW



SECTION PLAN A-A

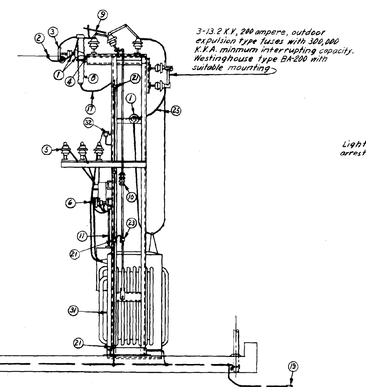
SECTION VIEW

BILL OF MATERIAL			
PART NO.	DESCRIPTION	MFR.	CATALOG NO.
1	6" Strain insulator, 55 KV min. dry flashover		
2	Hot line clamp		
3	Strain clamps	Locke	12926
4	Hooks	"	2563
5	Insulator unit	G.E.	6A999/9P1
6	Bus supports	"	6028206655
7	Bus supports	"	6028206656
8	Lightning arresters, 15 K.V.		
9	3 P.S.T. horn gap disconnect switch, 15 K.V., 400A.	West.	Type RWR
10	Operating rod insulator		6933
11	1" Rigid electrical conduit	Lapp	
12	Condulet	Crouse-Hinds	E37
13	Condulet	" "	C37
14	Condulet with cover	" "	LB37
15	3 Hole composition cover	" "	3773
16	1 Hole composition cover	" "	3771
17	#2/0 Bare stranded copper cable		
18	Copperweld ground rod, $\frac{3}{4}$" ø x 10'-0" lg.		
19	Connector for $\frac{3}{4}$" rod and #2/0 cable	Burndy	GP 6426
20	"T" connector for #2/0 cable	"	HT 2626
21	Connector for #2/0 cable to structural framework	"	GB 26
22	Connector for #2/0 cable and fence post	"	Type GD
23	Connector for #2/0 cable and $1\frac{1}{2}$" pipe	"	GD 1626
24	#2/0 Conductor, insulated		
25	#2/0 Hard drawn bare copper wire		
26	1" I.P.S. copper tubing		
27	$1\frac{1}{2}$" I.P.S. copper tubing (extra heavy)		
28	"T" connector for #2/0 bare copper wire	G.E.	6114360G1
29	"T" connector for $1\frac{1}{2}$" I.P.S. main to 1" I.P.S. branch	"	6114360G19
30	"T" connector for $1\frac{1}{2}$" I.P.S. tubing	"	6114360G21
31	Distribution transformer, 13,200-480V, 250 KVA		
32	Lightning arrester, 600 K		



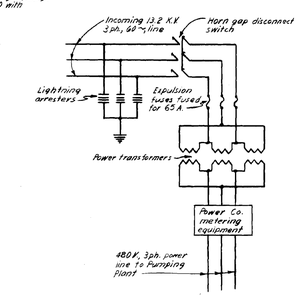
FRONT ELEVATION

ELEVATION VIEW



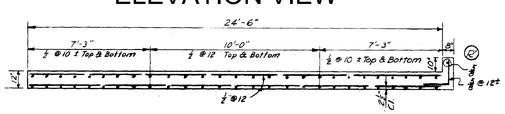
SIDE ELEVATION

ELEVATION VIEW



WIRING DIAGRAM

Notes:
1. Figures in circles refer to part numbers on the Bill of Material
2. Small parts, fittings, etc., not called for shall be furnished as required.
3. All material shall be of the manufacture, type and catalog number specified, or its equal.
4. All bolts and screws shall be furnished with a full complement of washers in accordance with best practice.
5. Solderless connectors shall be used for making splices and taps to bus.
6. All fence post shall be grounded.
7. Current transformers and meter enclosure will be furnished by other agencies and installed under this contract.
8. Watthour meter will be furnished and installed by other agencies.



SECTION B-B

SECTION VIEW

(2) Curb and ventilator well added. Contract Modification No. 6.

GRAPHIC SCALE

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
FLOOD PROTECTION LOUISVILLE, KY.
BUCHANAN ST PUMPING PLANT

SUBSTATION

DESIGNED BY:
DRAWN BY: C.G.
TRACED BY: R.L.M.
CHECKED BY: O.D.
SUBMITTED:
CHIEF, ENGINEERING DIVISION
APPROVED:
CHIEF ENGINEERING ASSISTANT
APPROVED:
CHIEF STRUCTURE SEWER DIST.
DATE: 21 March 1951

APPROVED:
LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER
DATE: MAR. 1951
SCALE: $\frac{3}{8}$"=1'-0"

DRAWING NUMBER
607-12.6/41

AS BUILT

GENERAL SHEET NOTES

1. SUBSTATION EQUIPMENT TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

⬡ SHEET KEYNOTES

1. TOTAL OF 2500 KVA TRANSFORMERS
2. SECONDARY SERVICE TRANSFORMER WIRING

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: TOE
SIZE: ANSI D

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

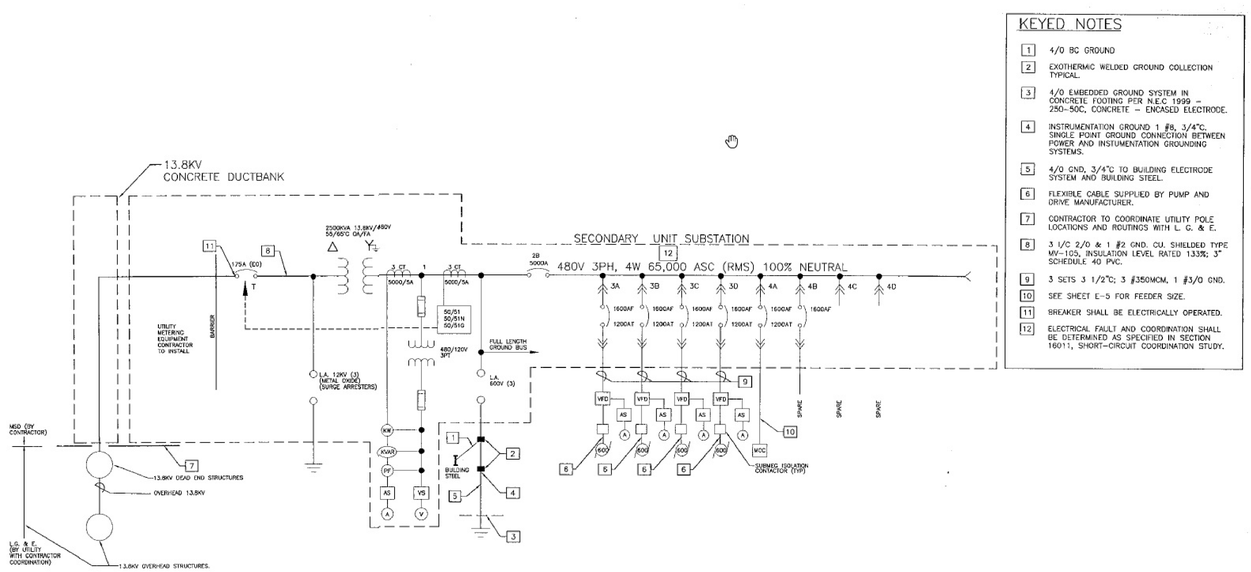
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

STARKEY PS SUBSTATION PLAN

SHEET ID
ST-E-102

A1 STARKEY PUMP STATION - SUBSTATION PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL



KEYED NOTES

1. 4/0 BC GROUND
2. EXOTHERMIC WELDED GROUND COLLECTION TYPICAL.
3. 4/0 EMBEDDED GROUND SYSTEM IN CONCRETE FOOTING PER N.E.C 1999 – 250-50C, CONCRETE – ENCASED ELECTRODE.
4. INSTRUMENTATION GROUND 1 #8, 3/4"C. SINGLE POINT GROUND CONNECTION BETWEEN POWER AND INSTUMENTATION GROUNDING SYSTEMS.
5. 4/0 GND, 3/4"C TO BUILDING ELECTRODE SYSTEM AND BUILDING STEEL.
6. FLEXIBLE CABLE SUPPLIED BY PUMP AND DRIVE MANUFACTURER.
7. CONTRACTOR TO COORDINATE UTILITY POLE LOCATIONS AND ROUTINGS WITH L. G. & E.
8. 3 1/C 2/0 & 1 #2 GND. CU. SHIELDED TYPE MV-105, INSULATION LEVEL RATED 133%; 3" SCHEDULE 40 PVC.
9. 3 SETS 3 1/2"C; 3 #350MCM, 1 #3/0 GND.
10. SEE SHEET E-5 FOR FEEDER SIZE.
11. BREAKER SHALL BE ELECTRICALLY OPERATED.
12. ELECTRICAL FAULT AND COORDINATION SHALL BE DETERMINED AS SPECIFIED IN SECTION 16011, SHORT-CIRCUIT COORDINATION STUDY.

GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. EXISTING ONE LINE DIAGRAM HAS BEEN PROVIDED AS A REFERENCE. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED APPENDIX 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.
3. SEE STARKEY PS E-101 AND E-602 FOR EXISTING STATION FLOOR PLAN AND MOTOR CONTROL CENTER ONE LINE RESPECTIVELY.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

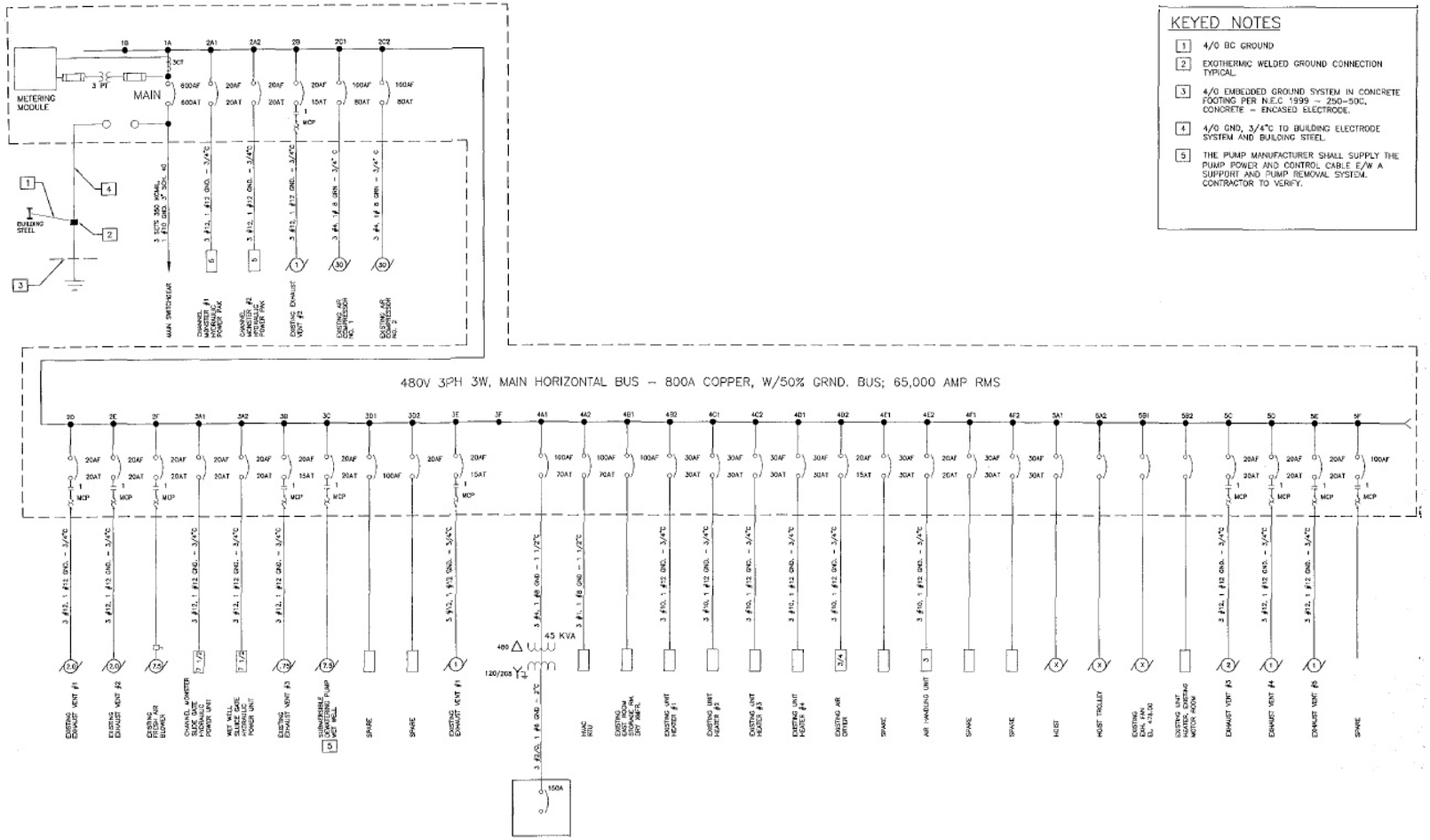
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

STARKEY PS EXISTING POWER ONE LINE (1 OF 2)

SHEET ID
ST-E-601

A1 STARKEY PS EXISTING POWER ONE LINE (1 OF 2)
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL



KEYED NOTES

1. 4/0 BC GROUND
2. EXOTHERMIC WELDED GROUND CONNECTION TYPICAL.
3. 4/0 EMBEDDED GROUND SYSTEM IN CONCRETE FOOTING PER N.E.C 1999 – 250-50C. CONCRETE – ENCASED ELECTRODE.
4. 4/0 GND, 3/4"C TO BUILDING ELECTRODE SYSTEM AND BUILDING STEEL.
5. THE PUMP MANUFACTURER SHALL SUPPLY THE PUMP POWER AND CONTROL CABLE E/W A SUPPORT AND PUMP REMOVAL SYSTEM. CONTRACTOR TO VERIFY.

GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. EXISTING ONE LINE DIAGRAM HAS BEEN PROVIDED AS A REFERENCE. SEE FEASIBILITY REPORT APPENDIX D-ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.
3. SEE STARKEY PS E-101 AND E-601 FOR EXISTING STATION FLOOR PLAN AND SECONDARY UNIT SUBSTATION ONE LINE RESPECTIVELY.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. LOVE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXX
THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

STARKEY PS EXISTING POWER ONE LINE (2 OF 2)

SHEET ID
ST-E-602

A1 STARKEY PS EXISTING POWER ONE LINE (2 OF 2)
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL

A1 BUTCHERTOWN I-WALL SITE PLAN 1 OF 2

1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

BUTCHERTOWN I-WALL
STABILIZATION SITE PLAN

SHEET ID

BT-C-101

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CONCEPT SUBMITTAL

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

A1 BUTCHERTOWN I-WALL STABILIZATION SITE PLAN 2 OF 2

1"=50'

0 50' 100'

N

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MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:

ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

BUTCHERTOWN I-WALL
STABILIZATION SITE PLAN

SHEET ID

BT-C-102

CONCEPT SUBMITTAL

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A1 BUTCHERTOWN I-WALL STABILIZATION RIGHT OF WAY PLAN 1 OF 2
1"=50'

0 50' 100'

N

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

BUTCHERTOWN I-WALL
RIGHT OF WAY 1 OF 2

SHEET ID
BT-R-101

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CONCEPT SUBMITTAL

A1 BUTCHERTOWN I-WALL STABILIZATION RIGHT OF WAY PLAN 2 OF 2

1"=50'

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

BUTCHERTOWN I-WALL
RIGHT OF WAY 2 OF 2

SHEET ID

BT-R-102

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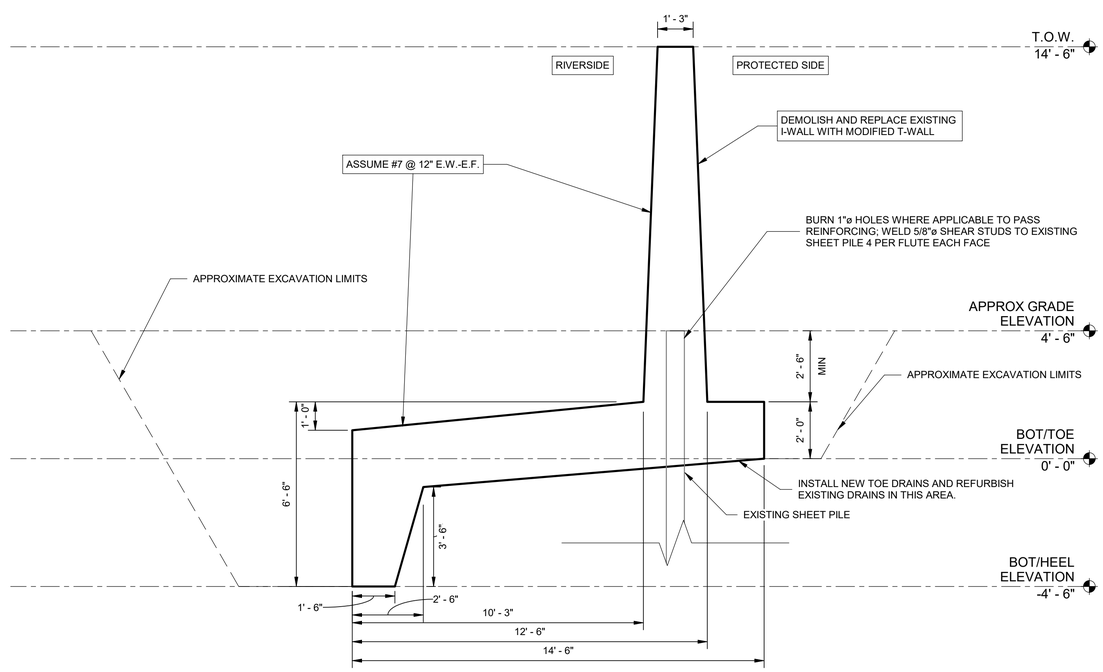
CONCEPT SUBMITTAL

REMOVE EXISTING CONCRETE PORTION OF THE I-WALL NEAR STATION 77+00 (MONOLITHS 269 AND 270) FROM APPROXIMATE ELEVATION 464.7 TO 450.7 AND STATION 77+96 (MONOLITH 271) FROM APPROXIMATE ELEVATION 464.7 TO 447.95. SEE CIVIL FOR ALIGNMENT. REMOVE EXISTING CONCRETE AND REINFORCING AND REPLACE WITH MODIFIED T-WALL DESIGN INDICATED. SHEET PILING SHALL REMAIN. INSTALL NEW WATER STOPS BETWEEN NEW T-WALL AND ADJACENT I-WALL.

ELEVATIONS AND DIMENSIONS ARE APPROXIMATE.

DUE TO THE PROXIMITY OF A STRUCTURE ON THE PROTECTED SIDE ADDITIONAL SHORING WILL BE REQUIRED DURING EXCAVATION.

SHELBY STREET ALONG T-WALL CONSTRUCTION WILL BE TEMPORARILY DEMOLISHED.



1 MODIFIED T-WALL SECTION

3/8" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

DESIGNED BY: B. EVANS
DRAWN BY: B. EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOTE
SIZE ANSI D

US ARMY CORPS OF ENGINEERS

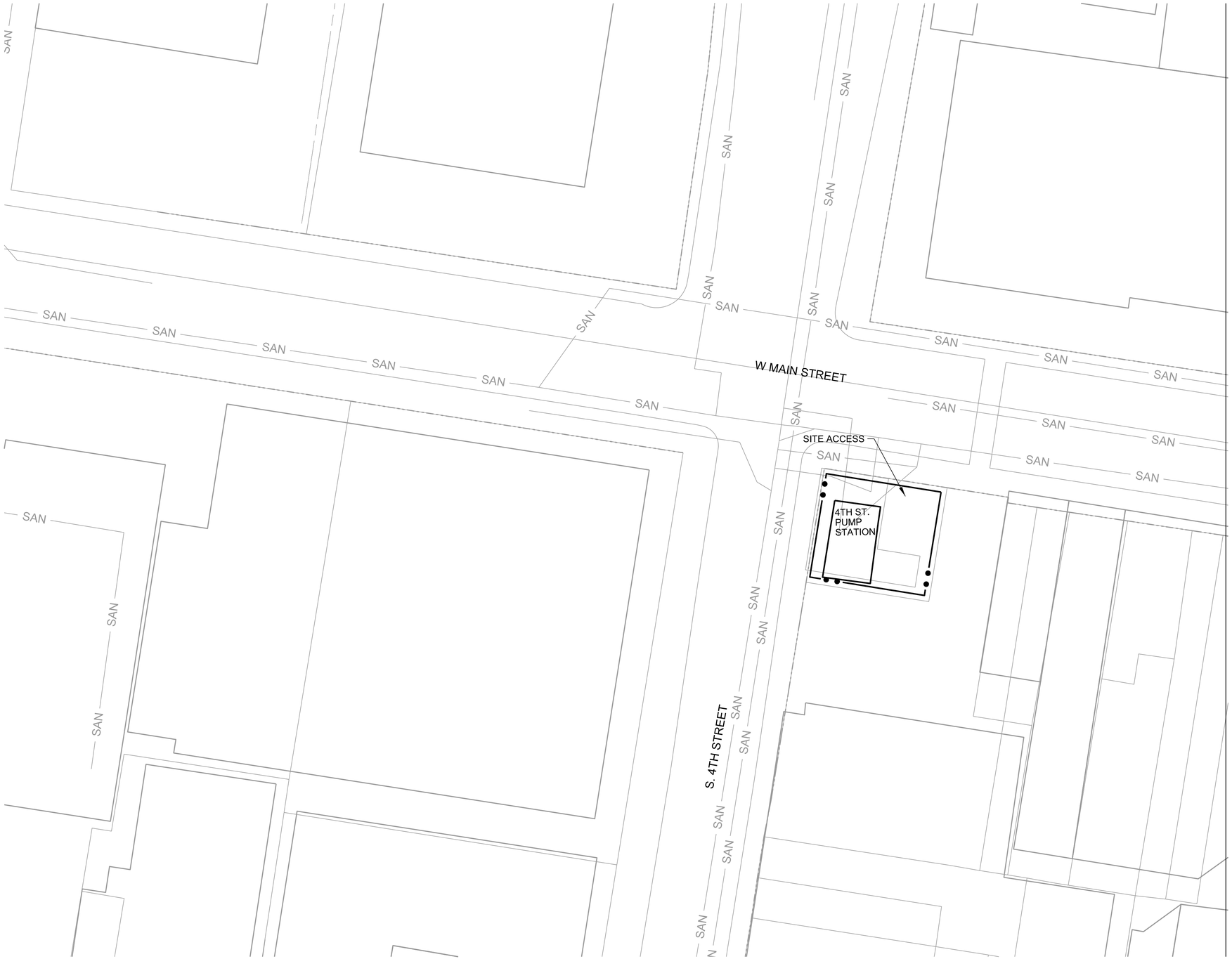
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

I-WALL STABILIZATION- T-WALL DETAILS

SHEET ID

BT-S-101

CONCEPT SUBMITTAL



A1 4TH STREET PS SITE PLAN
1"=50'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET. DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOIE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

4TH STREET PS SITE PLAN

SHEET ID
4-C-101

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CONCEPT SUBMITTAL

A1 4TH STREET PS RIGHT OF WAY PLAN
1"=50'

0 50' 100'

N

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET. DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOIE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

4TH STREET PS
RIGHT OF WAY

SHEET ID
4-R-101

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CONCEPT SUBMITTAL

A1 5TH STREET PS SITE PLAN
1"=50'

0 50' 100'

N

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET. DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

5TH STREET PS SITE PLAN

SHEET ID
5-C-101

...\145626\05\530\CAD_BIM_Sheets\5TH-C-101
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CONCEPT SUBMITTAL

A1 5TH STREET PS RIGHT OF WAY
1"=50'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

5TH STREET PS
RIGHT OF WAY

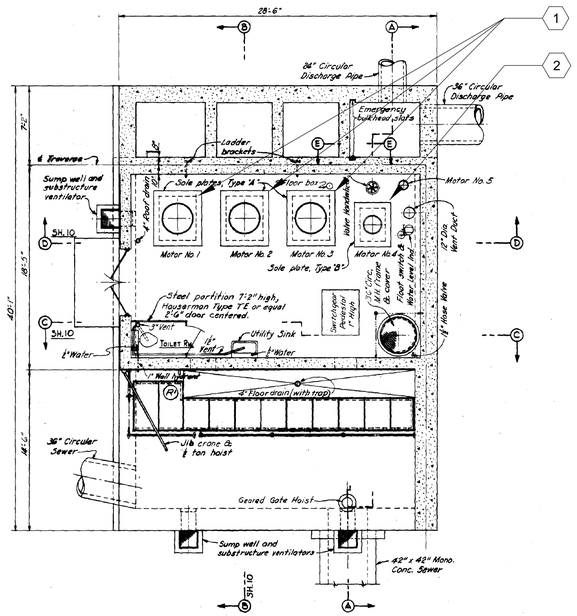
SHEET ID
5-R-101

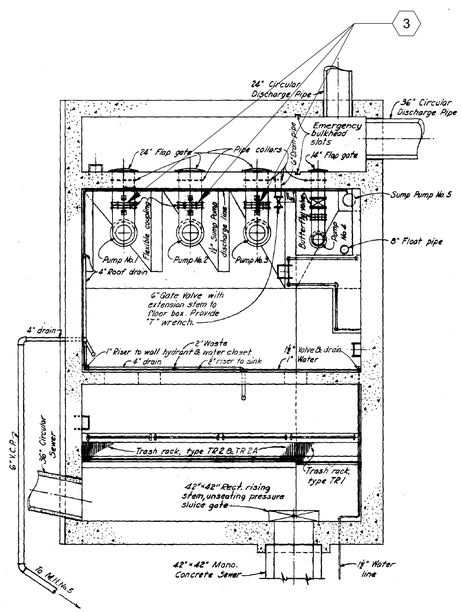
...\145626\05\530\CAD_BIM_Sheets\5TH-R-101
1:07:23 PM 8/27/2019 LRL_pdf.pltcfg LRL_Screen.dscript

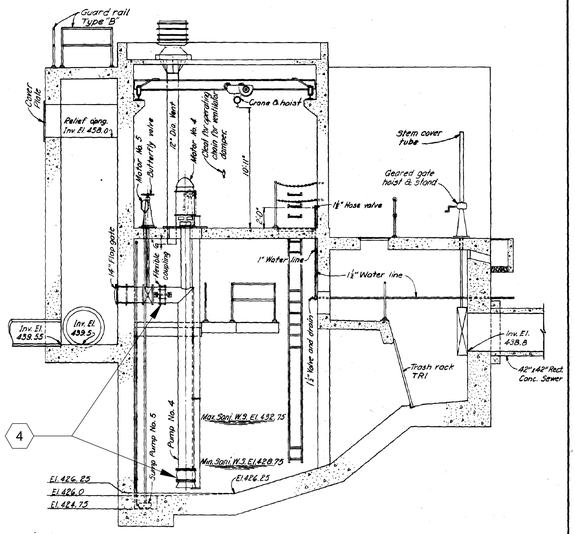
CONCEPT SUBMITTAL

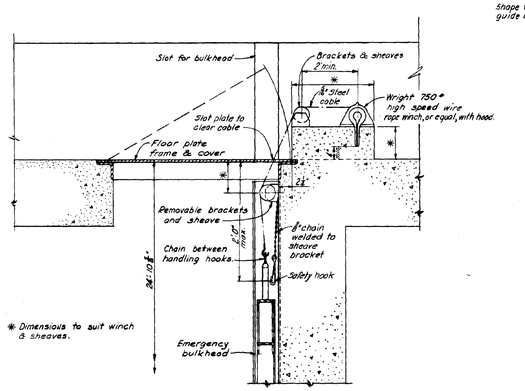
CORPS OF ENGINEERS

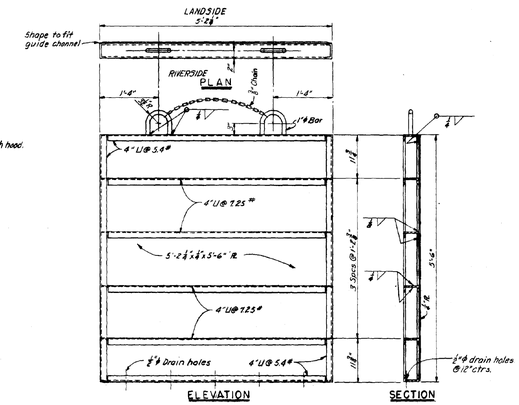
U. S. ARMY











Note: Provide 1 aluminum extension ladder, total length of sections 24 ft.

(R1) Latch added for Jib Crane see Sheet 87, Contract Mod. No. 14.

GRAPHIC SCALES

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
FLOOD PROTECTION LOUISVILLE, KY.
FIFTH ST. PUMPING PLANT

MECHANICAL EQUIPMENT
PLANS, SECTION & DETAILS

DESIGNED BY:
DRAWN BY: K.C.Z.-W.E.R.
TRACED BY: K.C.Z.
CHECKED BY:
SUBMITTED:
CHIEF, ENGINEERING DIVISION
APPROVED:
CHIEF, PLANNING & REPORTS BRANCH
APPROVED:
DATE:
APPROVED: Chief, Corps of Engineers, District Engineer
DATE: OCT. 1990
SCALE: AS SHOWN
DRAWING NUMBER
607-12.5/9

AS BUILT

PUMP DATA				
PUMP #	TYPE	DESIGN FLOW (GPM)	TDH (FT OF WATER)	NOTES
1	SUBMERSIBLE	11,070	5.9	NEW PUMP
2	SUBMERSIBLE	11,070	5.9	NEW PUMP
3	SUBMERSIBLE	11,070	5.9	NEW PUMP
4	SUBMERSIBLE	3,000	28.2	NEW PUMP

SHEET KEYNOTES

1. REPLACE PUMPS WITH SUBMERSIBLE COLUMN PUMPS. NEW COLUMNS TO BE PROVIDED, SIZED FOR THE SUBMERSIBLE COLUMN PUMPS.
2. REPLACE PUMP WITH SUBMERSIBLE SUMP PUMP ON RAILS.
3. CONNECT NEW COLUMNS TO EXISTING DISCHARGE PIPING AT FLEXIBLE COUPLINGS. INSTALL NEW FLEXIBLE COUPLINGS.
4. FOR DEWATERING PUMP, INSTALL DISCHARGE ELBOW AND NEW DISCHARGE PIPING FROM ELBOW UP TO FLEXIBLE COUPLE. INSTALL NEW FLEXIBLE COUPLING. DISCHARGE ELBOW TO BE AUTOMATIC CONNECTION TYPE WITH GUIDE RAILS TO FACILITATE INSTALLATION AND REMOVAL OF PUMP WITHOUT UNBOLTING PUMP FROM ELBOW.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX

DESIGNED BY: K. BURNS
DRAWN BY: K. BURNS
CHECKED BY:
SUBMITTED BY:
TYPE:
SIZE:
ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

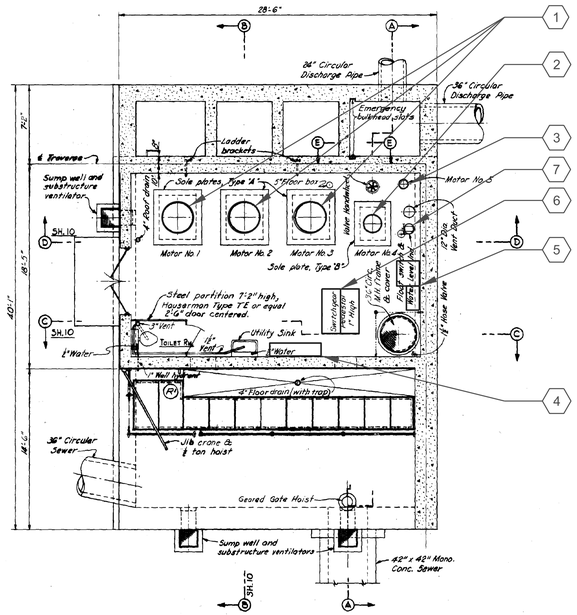
5TH STREET PS
MECHANICAL PLANS

SHEET ID
5TH-M-101

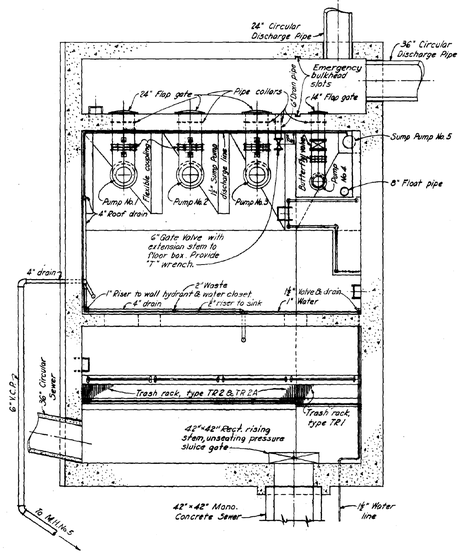
CONCEPT SUBMITTAL

CORPS OF ENGINEERS

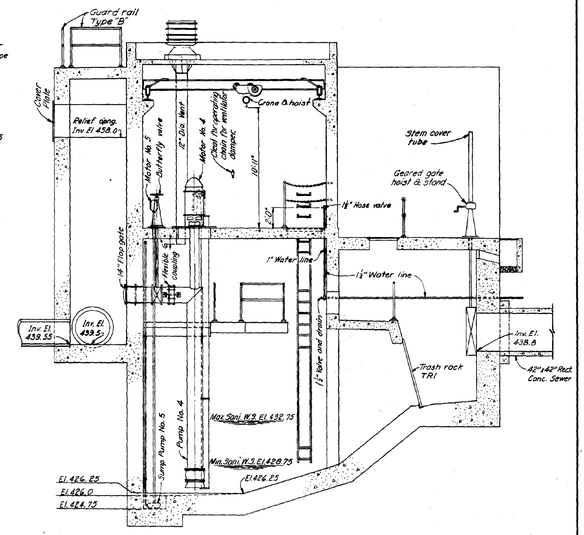
U. S. ARMY



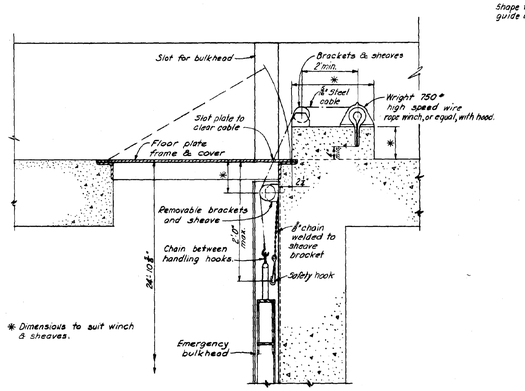
MOTOR FLOOR PLAN



SUMP PLAN

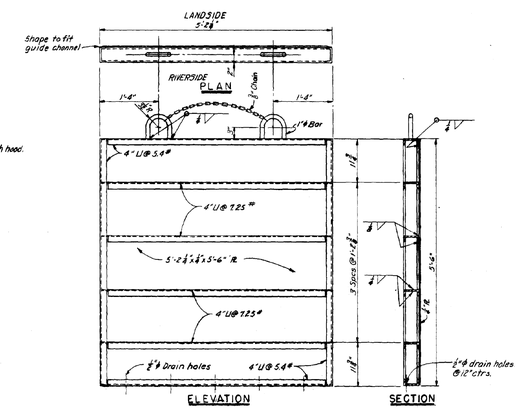


SECTION A-A



SECTION E-E

SCALE: 1½" = 1'-0"



ELEVATION

SECTION

EMERGENCY BULKHEAD

MATERIAL STRUCTURAL STEEL

SCALE 1" = 1'-0"

Note: Provide 1 aluminum extension ladder, total length of sections 24 ft.

(R1) Latch added for Jib Crane see Sheet 87, Contract Mod. No. 14.

GRAPHIC SCALES

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
FLOOD PROTECTION LOUISVILLE, KY.
FIFTH ST. PUMPING PLANT

MECHANICAL EQUIPMENT
PLANS, SECTION & DETAILS

DESIGNED BY:
DRAWN BY: K.C.Z.-W.E.R.
TRACED BY: K.C.Z.
CHECKED BY:
SUBMITTED:
CHIEF, ENGINEERING DIVISION
APPROVED: CHIEF, PLANNING & REPORTS BRANCH
APPROVED: CHIEF, CORPS OF ENGINEERS, DISTRICT ENGINEER
DATE: OCT. 1950
APPROVED:
DATE:
SCALE: AS SHOWN
DRAWING NUMBER
607-12.5/9

AS BUILT

GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. REPLACE EXISTING 50 HP PUMPS WITH SUBMERSIBLE COLUMN PUMPS. MOTOR HP VALUES EXPECTED TO INCREASE
2. REPLACE EXISTING 25 HP PUMP WITH SUBMERSIBLE PUMP ON RAILS. MOTOR HP VALUE EXPECTED TO INCREASE
3. REPLACE SUMP PUMP IN KIND
4. PUMP CONTROLS WILL BE UPDATED AND INTEGRATED INTO MSD SCADA SYSTEM
5. A 112.5 KVA TRANSFORMER WILL BE INSTALLED FOR BUILDING SUPPORT SYSTEMS. PUMP CONTROLS, LIGHTING, 208/120 VAC POWER, HVAC, ETC.
6. MOTOR CONTROL CENTER WILL BE REPLACED WITH A MODERN DAY EQUIVALENT
7. REPLACEMENT CONTROLS INSTRUMENTATION (SUBMERSIBLE LEVEL TRANSDUCER/ FLOAT SWITCH MAST)

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXX
THRU 0023

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY:
CODE:
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

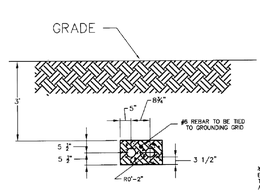
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

FIFTH STREET PS ELECTRICAL PLAN

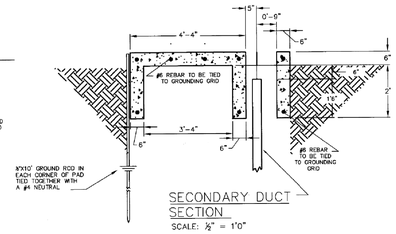
SHEET ID
5TH-E-101

A1 FIFTH STREET PS ELECTRICAL PLAN
SCALE: NOT TO SCALE

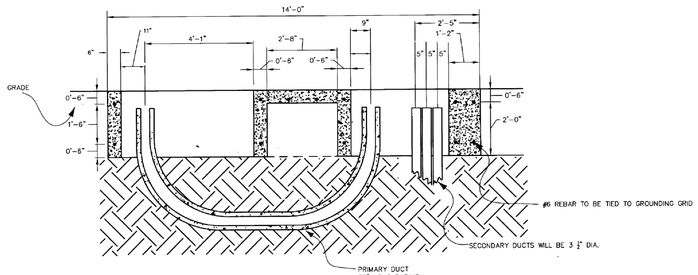
CONCEPT SUBMITTAL



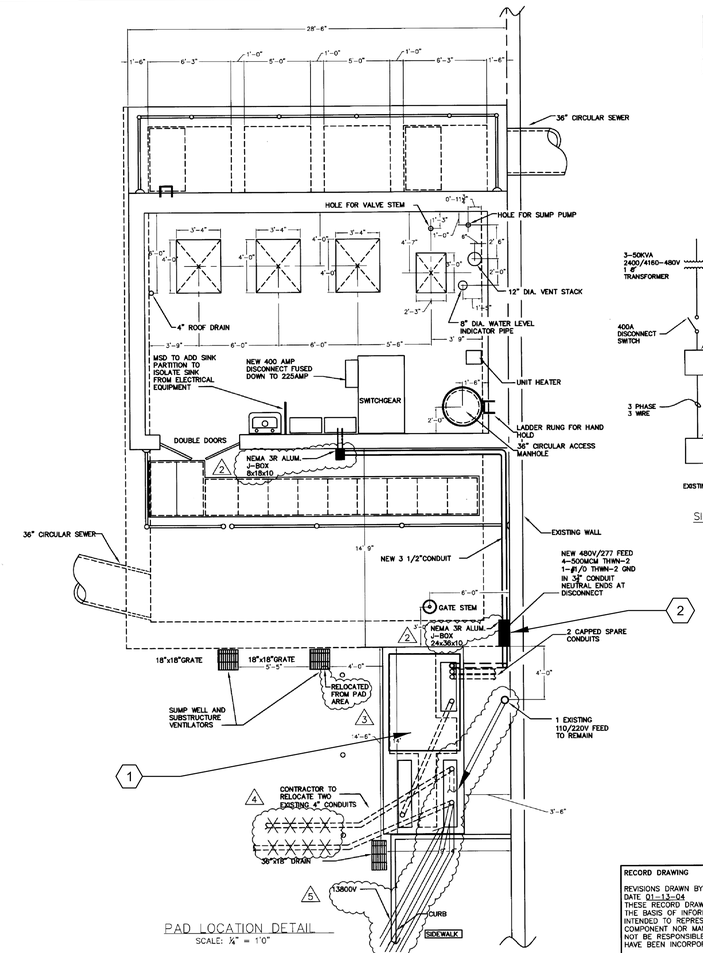
TYPICAL DUCT SECTION
SCALE: ½" = 1'0"



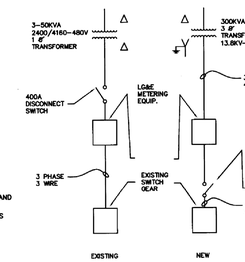
SECONDARY DUCT SECTION
SCALE: ½" = 1'0"



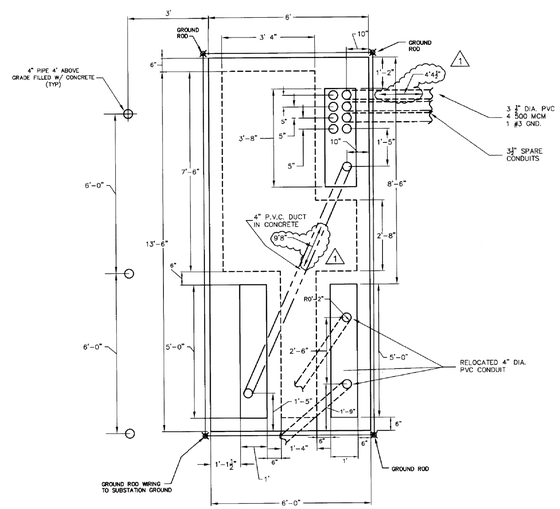
PRIMARY/SECONDARY DUCT SECTIONS
SCALE: ½" = 1'0"



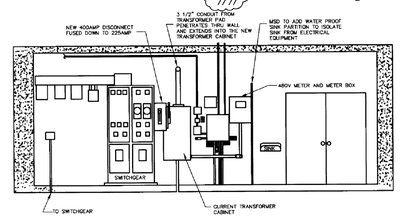
PAD LOCATION DETAIL
SCALE: ¼" = 1'0"



SINGLE LINE DIAGRAM



TYPICAL PAD DETAIL
SCALE: ¼" = 1'0"



RENOVATED CONDITION PUMP ROOM DETAIL
NO SCALE

RECORD DRAWING

REVISIONS DRAWN BY JACOBI, TOOMBS & LANZ, INC.
DATE 01-13-04
THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION TYPE OR COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED TO THESE RECORD DRAWINGS.

BY CH2MHILL / QUEST Alex E. Thomas

NOTES:

1. NOTIFY L.G.&E. ELEC. DISTRIBUTION DEPT. FOR INSPECTION AFTER PAD IS FORMED AND DUCT IS INSTALLED BUT, BEFORE POURING ANY CONCRETE.

2. THIS PAD MEETS STATE FIRE MARSHALL APPROVAL, FOR LOCATION.

3. ADD #6 REBAR AS INDICATED TO 3000 PSI CONCRETE PAD.

4. SECONDARY SIDE CABLE SIZED TO MATCH 300 KVA TRANSFORMER. FUSED DISCONNECT SIZED TO PRESENT LOAD OF 150 KVA UNIT.

KHAFRA ENGINEERING CONSULTANTS, INC.
304 WEST LIBERTY STREET, SUITE 306
LOUISVILLE, KENTUCKY 40202
502-584-8599 FAX 502-584-9812

Professional Engineer's Seal
Signature L.S. #

RECORD DWGS:	–	06-18-02
CHECKED BY:	BW	06-18-02
DESIGNED BY:	BW	06-18-02
DRAWN BY:	MN	06-18-02
FILE NAME: E1		
PLOT DATE: JULY 8 2002		

PLANS PREPARED and SUBMITTED BY:
CH2M HILL / Quest
405 South Fourth Avenue Suite 100 Louisville, KY 40202 502-584-8098

MSD
Louisville and Jefferson County Metropolitan Sewer District
700 West Liberty Street
Louisville, Kentucky 40203

NO.	REVISION	DATE
1	DIMENSION ADDED PER RECORD DOCUMENTS	
2	JUNCTION BOX ADDED PER RECORD DOCUMENTS	
3	NOTE ADDED PER RECORD DOCUMENTS	
4	CONDUIT REMOVED PER RECORD DOCUMENTS	
5	CONDUITS ADDED PER RECORD DOCUMENTS	

SHEET TITLE: ELECTRICAL PLANS
PROJECT TITLE: 5TH. STREET PUMP STATION TRANSFORMER REPLACMENT
GRAPHIC SCALE = 1" ON ORIGINAL

BUDGET I.D. F02126
CONSTRUCTION ORDER NO. 2003-25
RECORD NO. 14456-RD
DRAWING NO: E2
3 OF 3 ~~2 of 2~~

JOB NO. 02906
PATH: S:\MSD\STANDARDS\F001\BORDER\ACORNJECTS\MSDBORDER.DWGS1\/12/01\0800

ELEVATION VIEW

PLAN VIEW

A1 FIFTH STREET PS - SUBSTATION PLAN
SCALE: NOT TO SCALE

GENERAL SHEET NOTES

1. SUBSTATION EQUIPMENT TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. 150 KVA PAD-MOUNT TRANSFORMER. GENERAL LOCATION
2. SECONDARY SERVICE TRANSFORMER WIRING

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. LUZE
SIZE: ANSI D

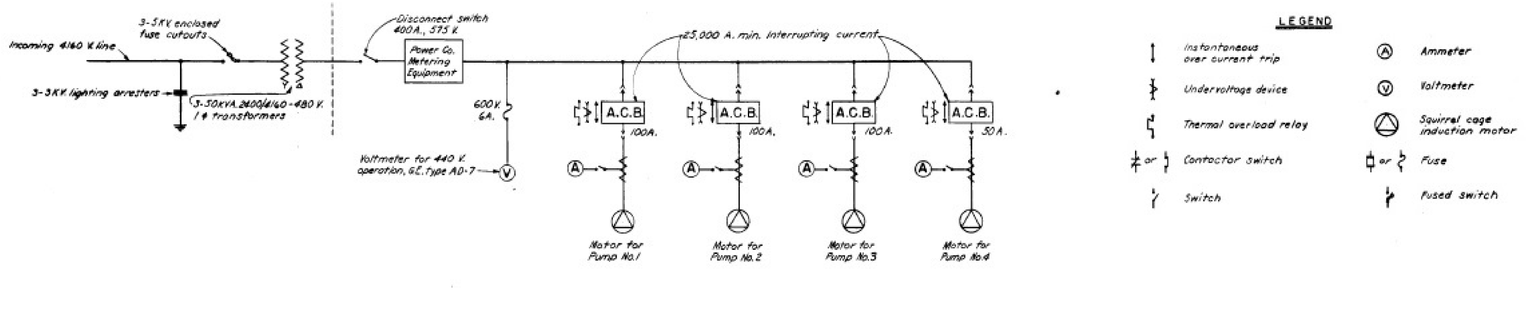
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

FIFTH STREET PS SUBSTATION PLAN

SHEET ID
5TH-E-102

CONCEPT SUBMITTAL



A1 FIFTH STREET PS EXISTING ONE LINE DIAGRAM

SCALE: NOT TO SCALE

GENERAL SHEET NOTES

1. SEE PS5 E-101 FOR EXISTING STATION FLOOR PLAN. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. EXISTING ONE LINE DIAGRAM HAS BEEN PROVIDED AS A REFERENCE. SEE FEASIBILITY REPORT APPENDIX D-ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TOTE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXX
THRU 0023

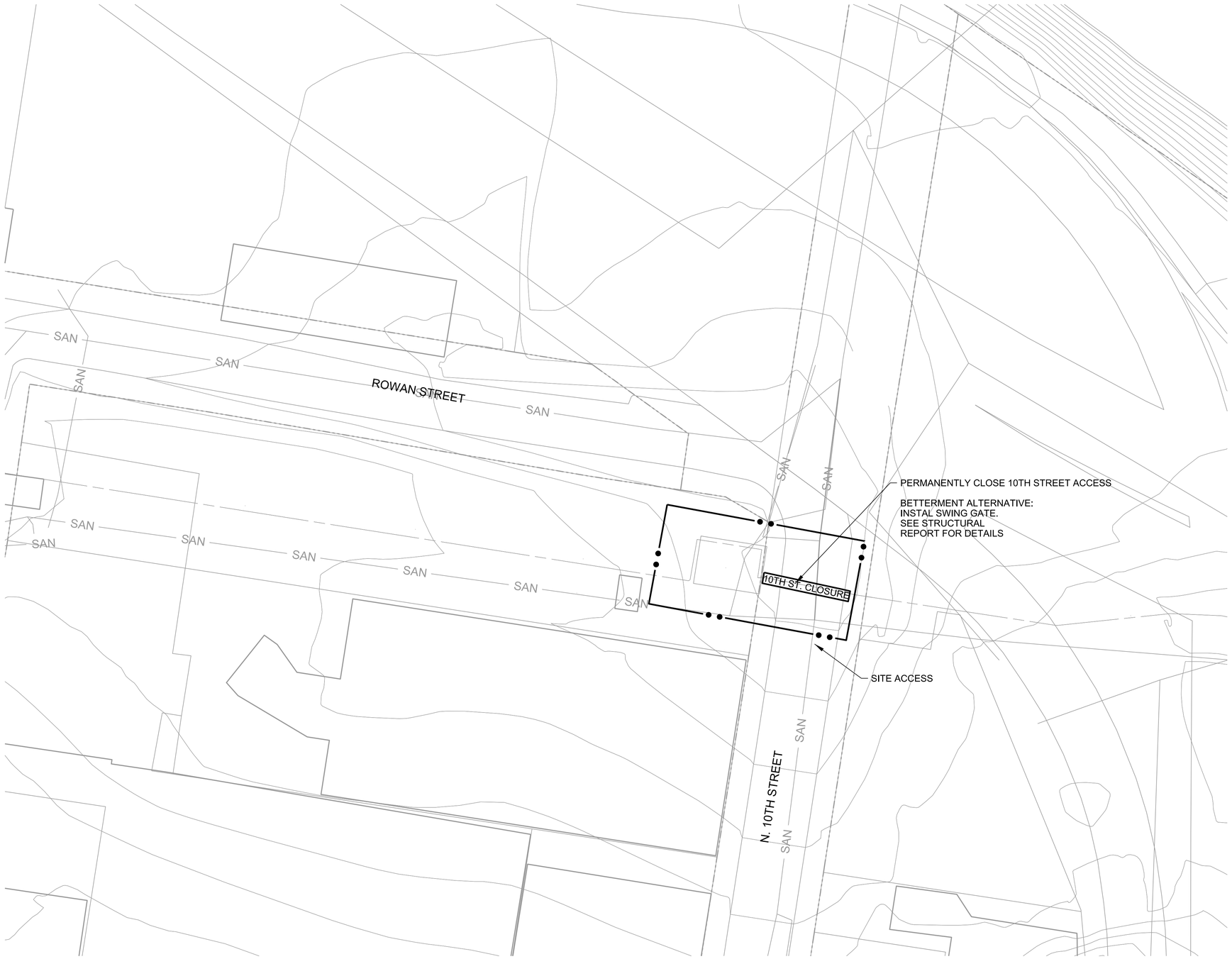
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

EXISTING FIFTH STREET PS
POWER ONE LINE DIAGRAM

SHEET ID
5TH-E-601

CONCEPT SUBMITTAL



A1 10TH STREET CLOSURE SITE PLAN
1"=50'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

10TH STREET PS SITE PLAN

SHEET ID
10-C-101

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CONCEPT SUBMITTAL

A1 10TH STREET PS RIGHT OF WAY PLAN
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
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DRAWING CODE:

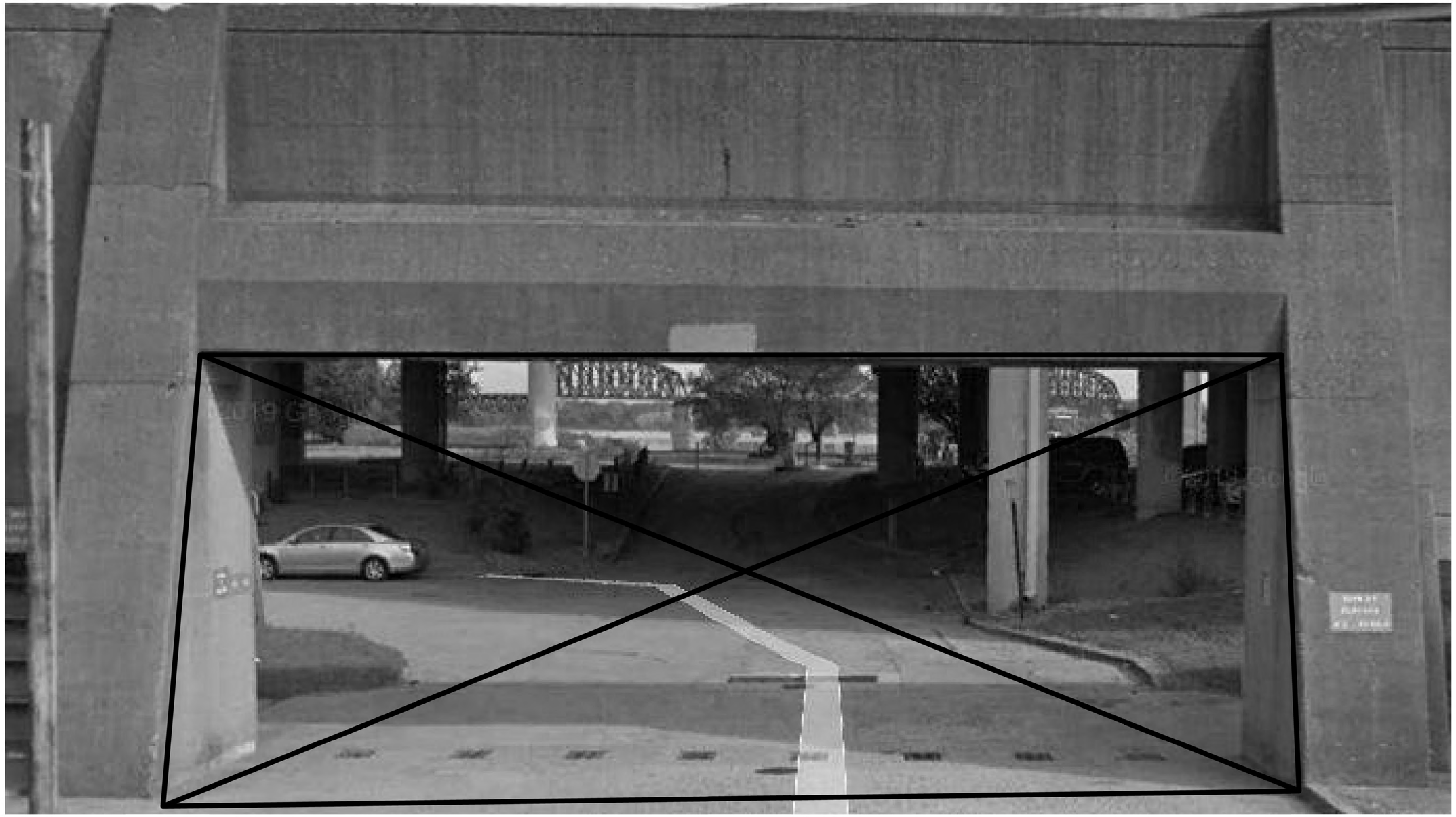
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

10TH ST PS
RIGHT OF WAY

SHEET ID
10-R-101

...\145626\05\530\CAD_BIM_Sheets\10-R-101
1:07:27 PM 8/27/2019 LRL_pdf.pltcfg LRL_Screen.dscript

CONCEPT SUBMITTAL



INSTALL CLOSURE AND ENCASE IN CONCRETE. TIE T&S STEEL TO CLOSURE STRUCTURE. IF PARTS OF CLOSURE STRUCTURE ARE ALUMINUM REEVALUATION OF PERMANENT CLOSURE METHOD WILL BE REQUIRED IN DESIGN.

1 10TH STREET PERMANENT CLOSURE

N.T.S

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR MARTIN LUTHER KING JR PLACE

DESIGNED BY: B. EVANS
DRAWN BY: B.EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

10TH STREET PERMANENT CLOSURE-
ALTERNATE 1

SHEET ID
ALT 1
10-S-101

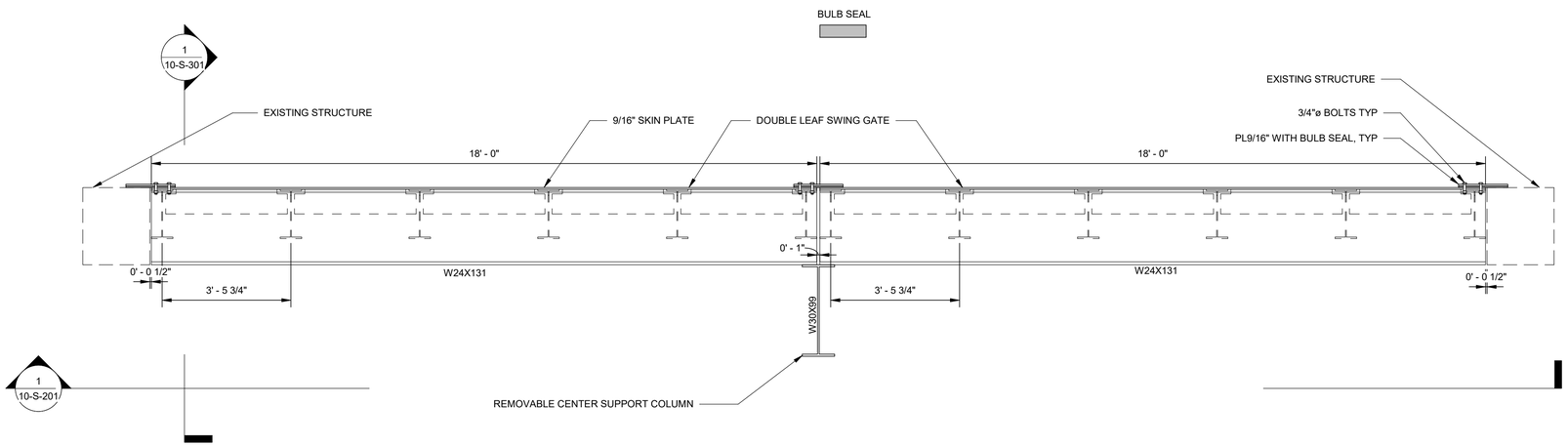
CONCEPT SUBMITTAL

CENTER SUPPORT COLUMN TO BE INSTALLED PRIOR TO GATE CLOSING VIA CHAIN FALL/WINCH/CRANE. SYSTEM TO BE DESIGNED IN FUTURE.

ALL CONNECTIONS ARE ASSUMED TO BE WELDS UNLESS NOTED OTHERWISE

ALL DIMENSIONS/ELEVATIONS ARE APPROXIMATE

LIFT HINGES TO BE PROVIDED



1 / 10-S-201 TOP OF GATE PLAN VIEW

1/2" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

DESIGNED BY: B J EVANS
DRAWN BY: B J EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOTE
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRIC
600 DR MARTING LUTHER KING JR PLACE

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

TOP OF GATE PLAN VIEW- ALTERNATE 2

SHEET ID
ALT 2
10-S-101

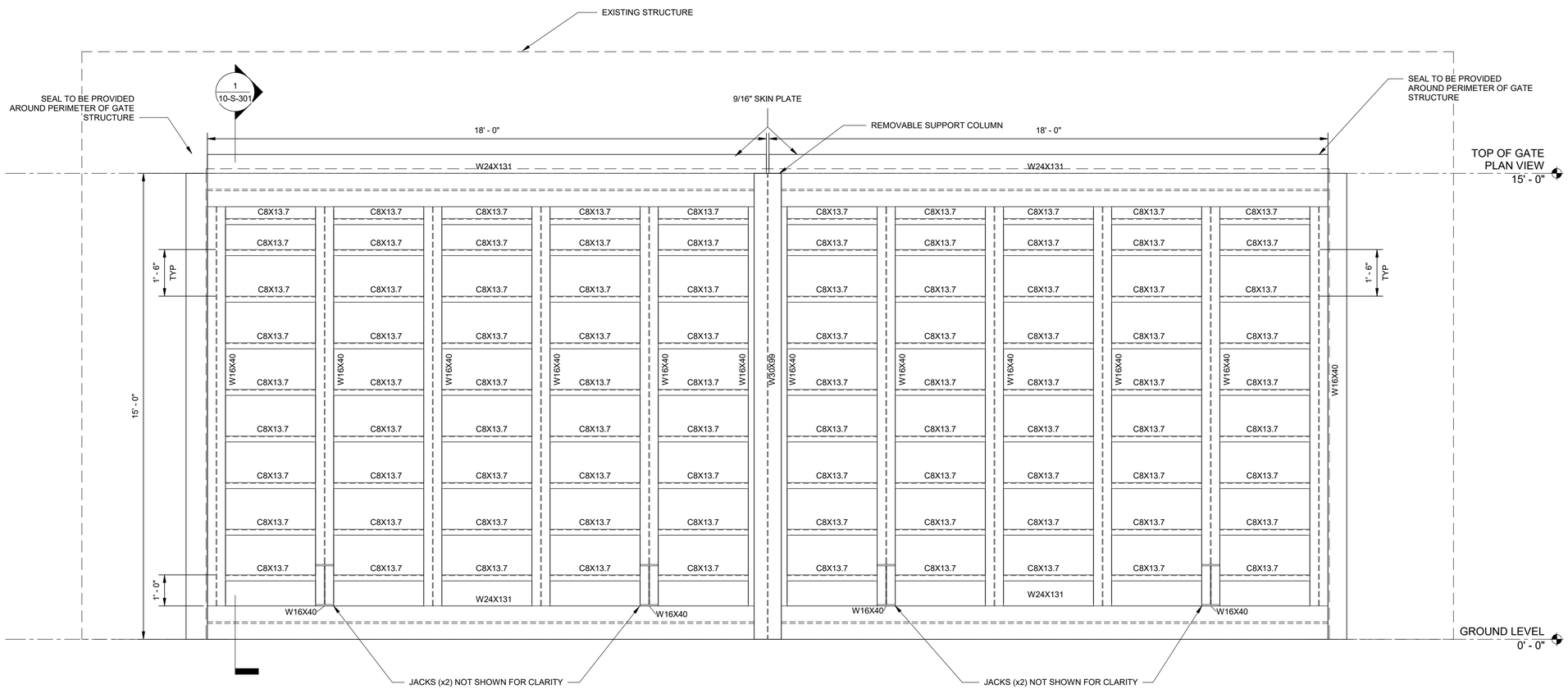
CONCEPT SUBMITTAL

CENTER SUPPORT COLUMN TO BE INSTALLED PRIOR TO GATE CLOSING VIA CHAIN FALL/WINCH/CRANE.

ALL CONNECTIONS ARE ASSUMED TO BE WELDS UNLESS NOTED OTHERWISE

ALL DIMENSIONS/ELEVATIONS ARE APPROXIMATE

LIFT HINGES TO BE PROVIDED



1
10-S-101

GATE ELEVATION

1/2" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: B J EVANS
DRAWN BY: B J EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRIC
600 DR MARTING LUTHER KING JR PLACE

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

GATE ELEVATION- ALTERNATE 2

SHEET ID
ALT 2
10-S-201

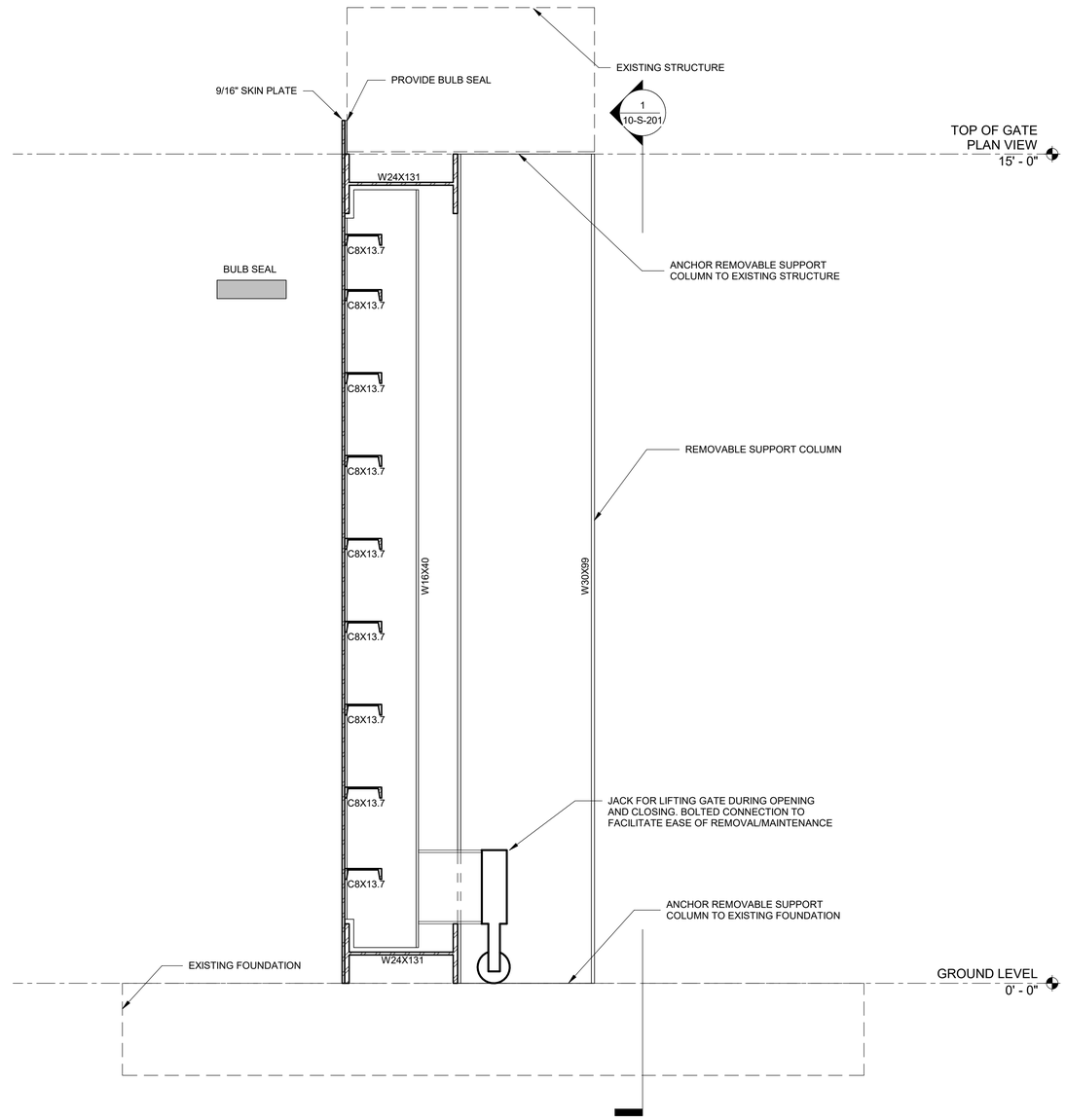
CONCEPT SUBMITTAL

CENTER SUPPORT COLUMN TO BE INSTALLED PRIOR TO GATE CLOSING VIA CHAIN FALL/WINCH/CRANE

ALL CONNECTIONS ARE ASSUMED TO BE WELDS UNLESS NOTED OTHERWISE

ALL DIMENSIONS/ELEVATIONS ARE APPROXIMATE

LIFT HINGES TO BE PROVIDED



1
10-S-101

GATE SECTION

3/4" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: B J EVANS
DRAWN BY: B J EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

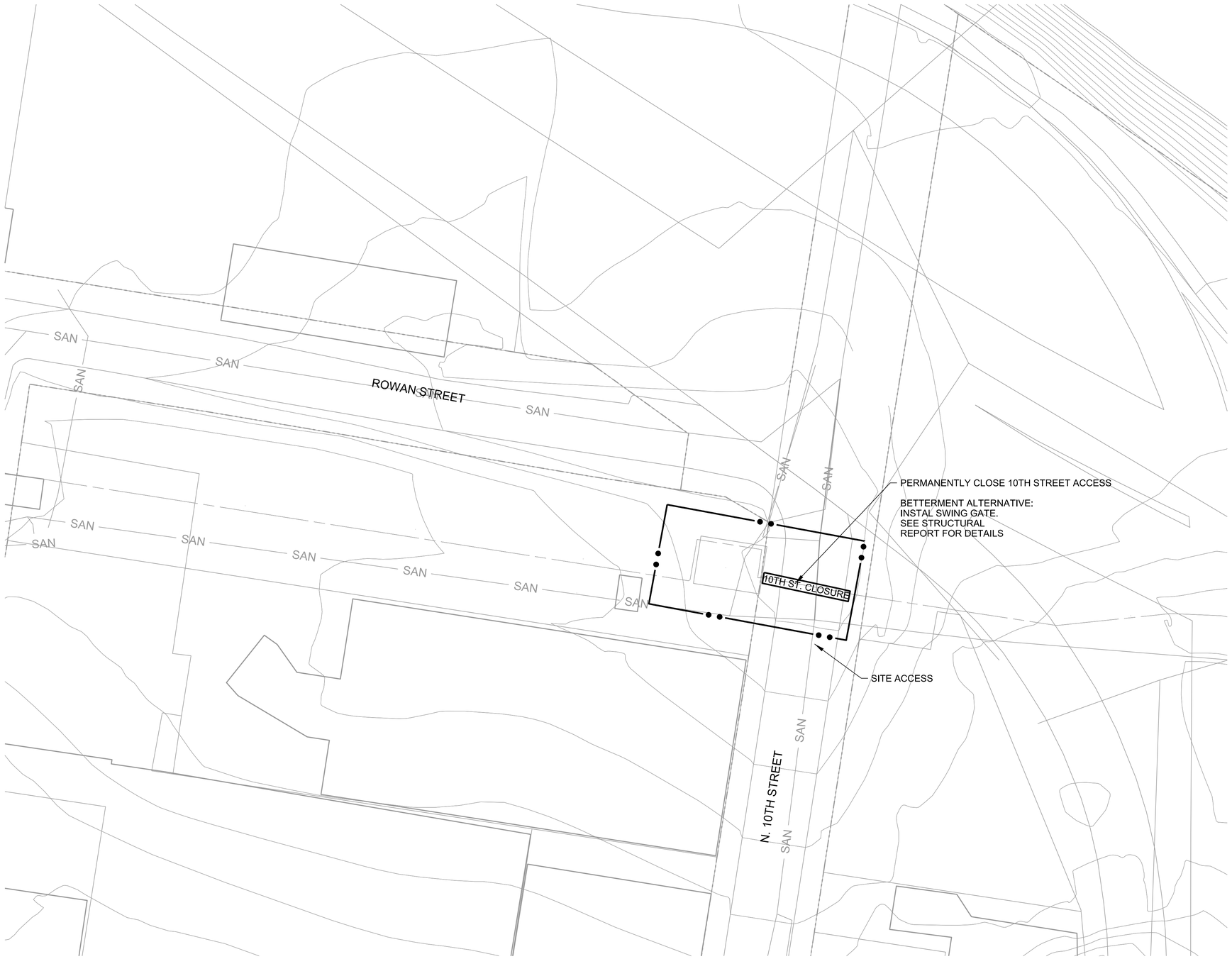
US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRIC
600 DR MARTING LUTHER KING JR PLACE

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

GATE SECTION- ALTERNATE 2

SHEET ID
ALT 2
10-S-301

CONCEPT SUBMITTAL



A1 10TH STREET CLOSURE SITE PLAN
1"=50'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

10TH STREET PS SITE PLAN

SHEET ID
10-C-101

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CONCEPT SUBMITTAL

A1 10TH STREET PS RIGHT OF WAY PLAN
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

10TH ST PS
RIGHT OF WAY

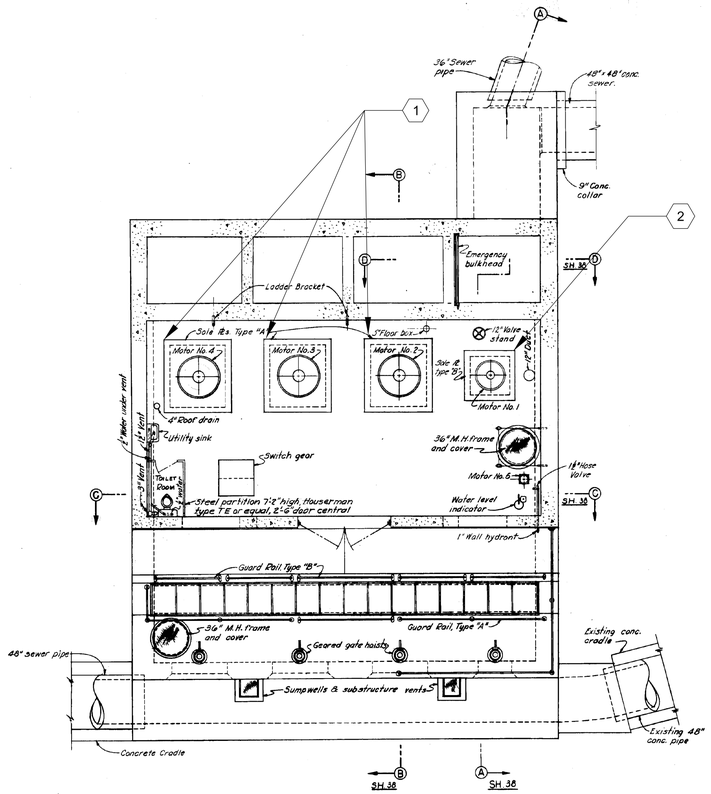
SHEET ID
10-R-101

...\145626\05\530\CAD_BIM_Sheets\10-R-101
1:07:27 PM 8/27/2019 LRL_pdf.pltcfg LRL_Screen.dscript

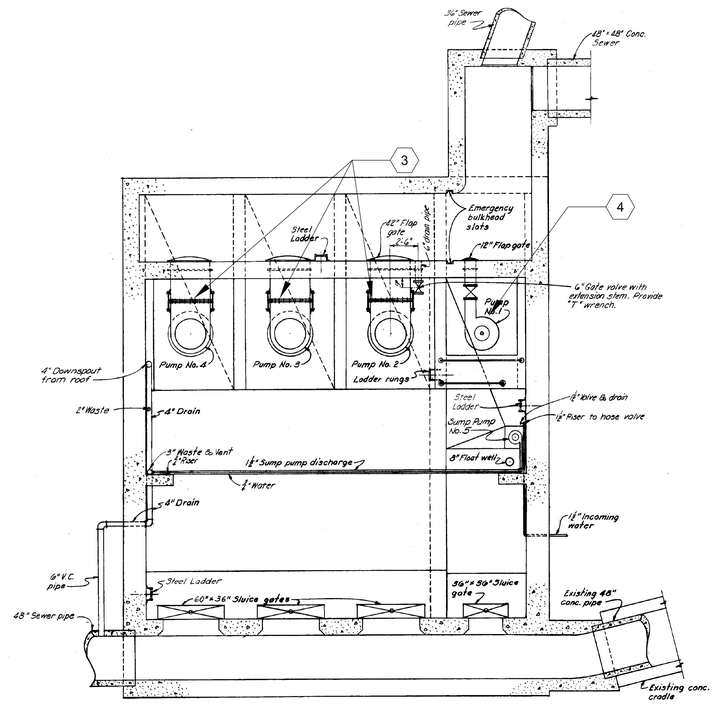
CONCEPT SUBMITTAL

CORPS OF ENGINEERS

U.S. ARMY



PLAN – MOTOR FLOOR



PLAN – SUMP

GRAPHIC SCALE

1" = 1'-0" 0 1' 5' 10'

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
FLOOD PROTECTION LOUISVILLE, KY.
TENTH ST. PUMPING PLANT

MECHANICAL EQUIPMENT PLANS

DESIGNED BY:
DRAWN BY: J.W.J.
TRACED BY: J.W.J.
CHECKED BY:
SUBMITTED:
CHIEF, ENGINEERING DIVISION
APPROVED:
CHIEF ENGINEERING ASSISTANT
APPROVED:
LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER
DATE: OCT 1950
SCALE: 24"=0"
APPROVED:
DATE:
DRAWING NUMBER 607-125/37

AS BUILT

PUMP DATA				
PUMP #	TYPE	DESIGN FLOW (GPM)	TDH (FT OF WATER)	NOTES
1	SUBMERSIBLE	1,530	40.1	NEW PUMP
2	SUBMERSIBLE	19,950	30.0	NEW PUMP
3	SUBMERSIBLE	19,950	30.0	NEW PUMP
4	SUBMERSIBLE	19,950	30.0	NEW PUMP

SHEET KEYNOTES

1. REPLACE PUMPS WITH SUBMERSIBLE COLUMN PUMPS.
2. REPLACE PUMP WITH SUBMERSIBLE SUMP PUMP ON RAILS.
3. INSTALL NEW PUMP COLUMNS AND CONNECT TO EXISTING 42" DISCHARGE PIPES AT FLEXIBLE COUPLINGS. INSTALL NEW FLEXIBLE COUPLINGS.
4. INSTALL NEW DISCHARGE ELBOW AND NEW DISCHARGE PIPING UP TO BUTTERFLY VALVE. DISCHARGE ELBOW TO BE AUTOMATIC CONNECTION TYPE WITH GUIDE RAILS TO FACILITATE PUMP INSTALLATION AND REMOVAL WITHOUT UNBOLTING PUMP FROM ELBOW.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: K. BURNS
DRAWN BY: K. BURNS
CHECKED BY:
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145628

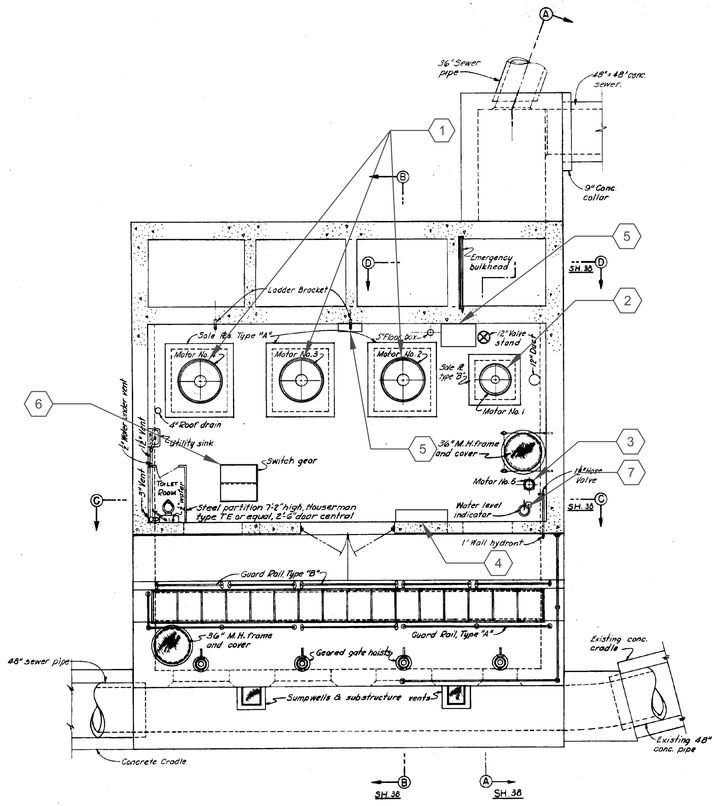
TENTH STREET PS
MECHANICAL PLANS

SHEET ID
10-M-101

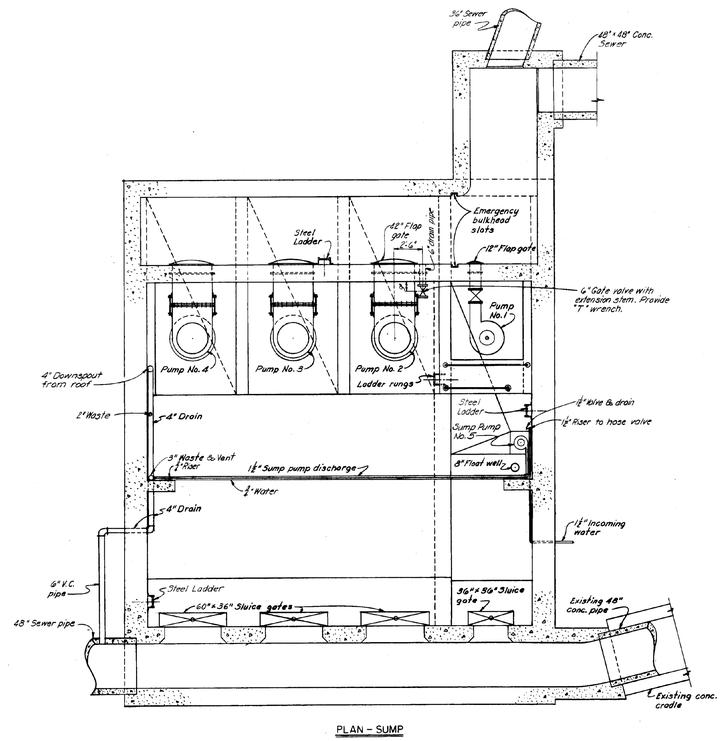
CONCEPT SUBMITTAL

CORPS OF ENGINEERS

U.S. ARMY



PLAN – MOTOR FLOOR



PLAN – SUMP

GRAPHIC SCALE

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
FLOOD PROTECTION LOUISVILLE, KY.
TENTH ST. PUMPING PLANT

MECHANICAL EQUIPMENT PLANS

DESIGNED BY:
DRAWN BY: J.W.J.
TRACED BY: J.W.J.
CHECKED BY:
SUBMITTED: CHIEF, ENGINEERING DIVISION
APPROVED: CHIEF, ENGINEERING ASSISTANT
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER
DATE: OCT. 1950
SCALE: 1/4"=1'-0"
APPROVED:
DATE:
DRAWING NUMBER 607-125/37

AS BUILT

GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. REPLACE 200 HP PUMPS WITH SUBMERSIBLE COLUMN PUMPS. MOTOR HP VALUES EXPECTED TO INCREASE.
2. REPLACE 25 HP PUMP WITH SUBMERSIBLE PUMP ON RAILS. MOTOR HP VALUE EXPECTED TO INCREASE.
3. REPLACE SUMP PUMP IN KIND.
4. PUMP CONTROLS WILL BE UPDATED AND INTEGRATED INTO MSD SCADA SYSTEM.
5. A 112.5 KVA TRANSFORMER WILL BE INSTALLED FOR BUILDING SUPPORT SYSTEMS. PUMP CONTROLS, LIGHTING, 208/120 VAC POWER, HVAC, ETC.
6. MOTOR CONTROL CENTER WILL BE REPLACED WITH A MODERN DAY EQUIVALENT.
7. CONTROL SYSTEM INSTRUMENTATION (PRESSURE TRANSDUCER, FLOAT MAST)

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

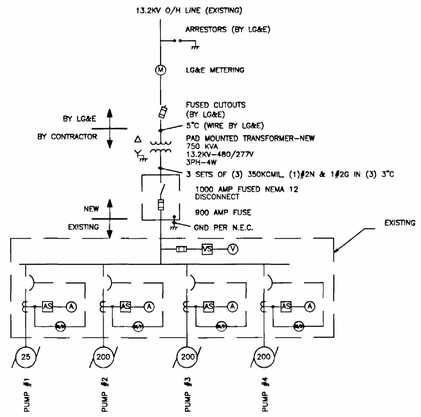
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

TENTH ST PS ELECTRICAL PLAN

SHEET ID
10-E-101

A1 TENTH ST PS ELECTRICAL PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL

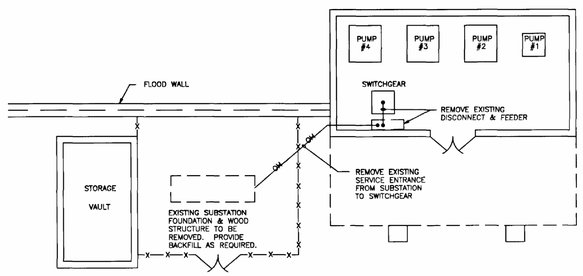


SINGLE LINE DIAGRAM

M	UTILITY METER
M	PANEL MOUNTED METER: A -AMP, V -VOLT
AS	AMMETER SWITCH
VS	VOLTMETER SWITCH
	POWER TRANSFORMER
	SURGE ARRESTOR
50/51	OVERCURRENT RELAY
	CURRENT TRANSFORMER
200	MOTOR, HORSEPOWER SHOWN

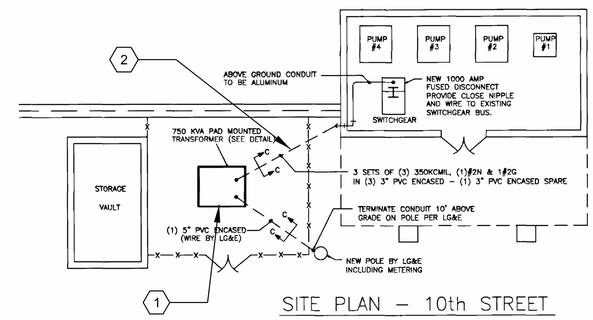
	CONDUIT, EXPOSED
	CONDUIT, UNDERGROUND ENCASED
	CONDUIT, TURNING DOWN
	FUSE
	PRIMARY ISOLATING SWITCH FUSED
	CIRCUIT BREAKER, 3 POLE
	SWITCH, 3 POLE

LEGEND AND SYMBOLS



DEMOLITION PLAN – 10th STREET

SCALE: 1/8" = 1'-0"



SITE PLAN – 10th STREET

SCALE: 1/8" = 1'-0"

PLAN VIEW

NO.	DATE	REVISION	CH'D	APPR'D	DATE
0		BID DOCUMENTS			

MSD APPROVALS

Signature L.S.# — Land Surveyor's Seal

STATE OF KENTUCKY — DANIEL P. DONNARD 10215 — REGISTERED PROFESSIONAL ENGINEER

Signature P.E.# 10215 — Professional Engineer's Seal

PLANS PREPARED AND SUBMITTED BY:

MINNA AND ASSOCIATES, INC. PROCESS AUTOMATION SPECIALISTS (502) 585-4100

Design Consultant

CONSTRUCTED BY:

Company Name — Date

FINAL RECORD DRAWING BY:

Company Name

Signature — Date

Final Record Drawing

Signature L.S.# — Land Surveyor's Seal

MSD Louisville and Jefferson County Metropolitan Sewer District 700 W. Liberty St., Louisville, Ky. 40203-1913

10th STREET PUMPING STATION PLANS

SCALE: AS NOTED — DATE: 10/30/96

NAME	DATE
DRAWN BY: DJW	10/30/96
DESIGNED BY: CKW	10/30/96
CHECKED BY: DPD	10/30/96
RECORD DWG.	

MSDBASE-06/94

PLOT DATE: 11/04/96 15:24:35

BUDGET I.D. NO. 094-3790 CONSTRUCTION CONTRACT NO. 12580 RECORD NO. 12580 SHEET 2 OF 3

A1 TENTH STREET PS - SUBSTATION PLAN

SCALE: NOT TO SCALE

GENERAL SHEET NOTES

1. SUBSTATION EQUIPMENT TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. 750 KVA PAD-MOUNTED TRANSFORMER
2. SECONDARY WIRING

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. COX
SIZE: ANSI D

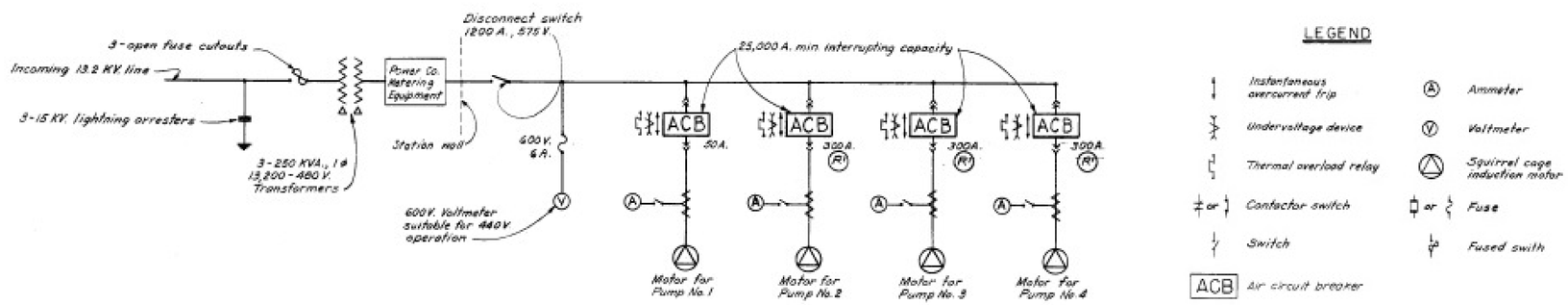
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

TENTH STREET PS SUBSTATION PLAN

SHEET ID
10-E-102

CONCEPT SUBMITTAL



A1 TENTH ST PUMP STATION EXISTING ONE LINE DIAGRAM

SCALE: NOT TO SCALE

GENERAL SHEET NOTES

1. SEE TENTH ST E-101 FOR EXISTING STATION FLOOR PLAN. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. EXISTING ONE LINE DIAGRAM HAS BEEN PROVIDED AS A REFERENCE. SEE FEASIBILITY REPORT APPENDIX D-ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

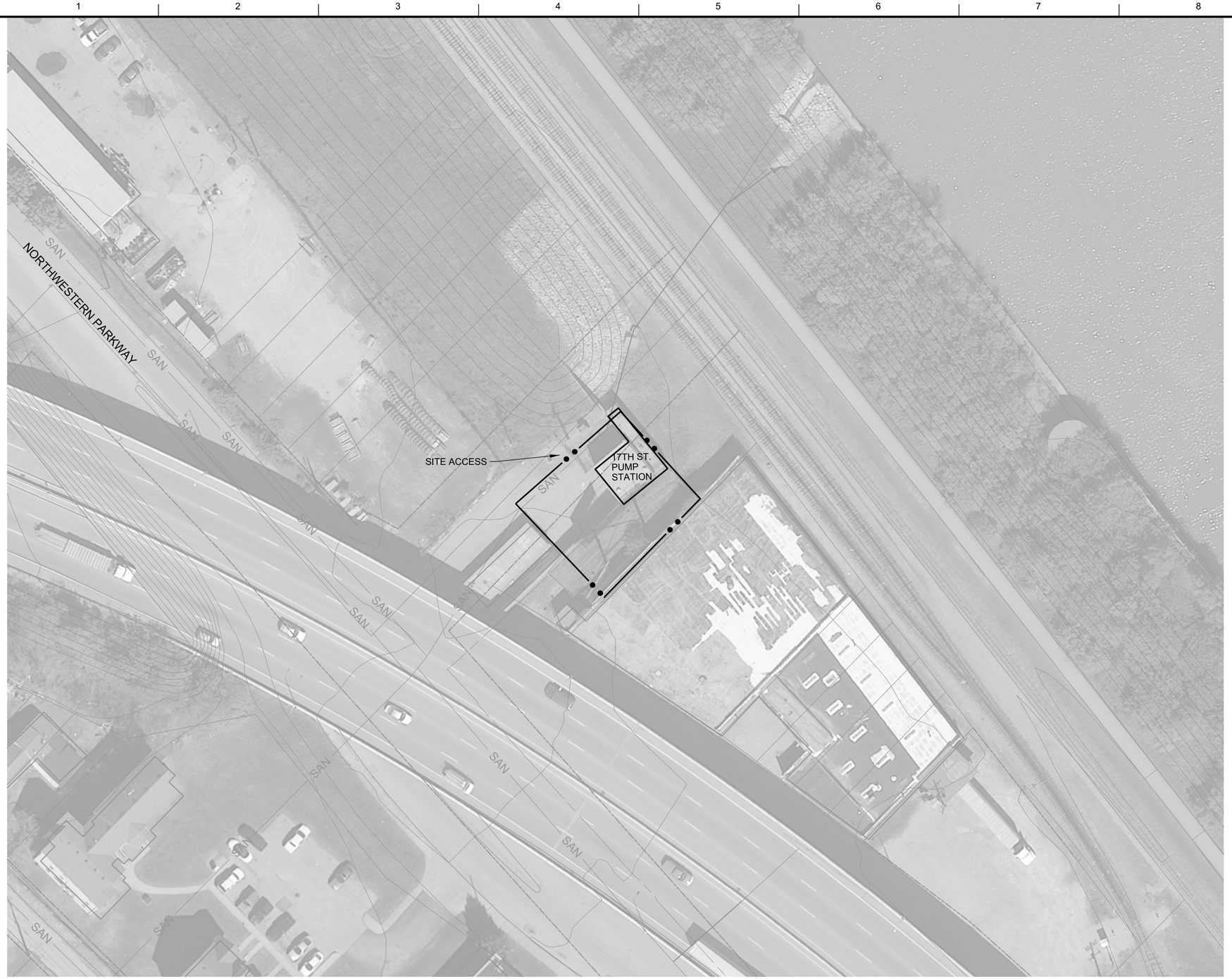
DESIGNED BY: R. MORRISON	ISSUE DATE: AUGUST 2019
DRAWN BY: R. MORRISON	SOLICITATION NO.: XXXXXX-XX-X-XXXX
CHECKED BY: J. TIMBAS	CONTRACT NO.: XXXXXXXXXXXXX
SUBMITTED BY: J. TOE	THRU 0023
SIZE: ANSI D	

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

TENTH ST PUMP STATION
EXISTING ONE LINE DIAGRAM

SHEET ID
10-E-601

CONCEPT SUBMITTAL



GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

A1 17TH ST PS SITE PLAN
1"=50'

N

0 50' 100'

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
T22 145626

17TH STREET PS SITE PLAN

SHEET ID
17-C-101

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CONCEPT SUBMITTAL

A1 17TH STREET PS RIGHT OF WAY PLAN
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOYE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

17TH STREET PS
RIGHT OF WAY

SHEET ID
17-R-101

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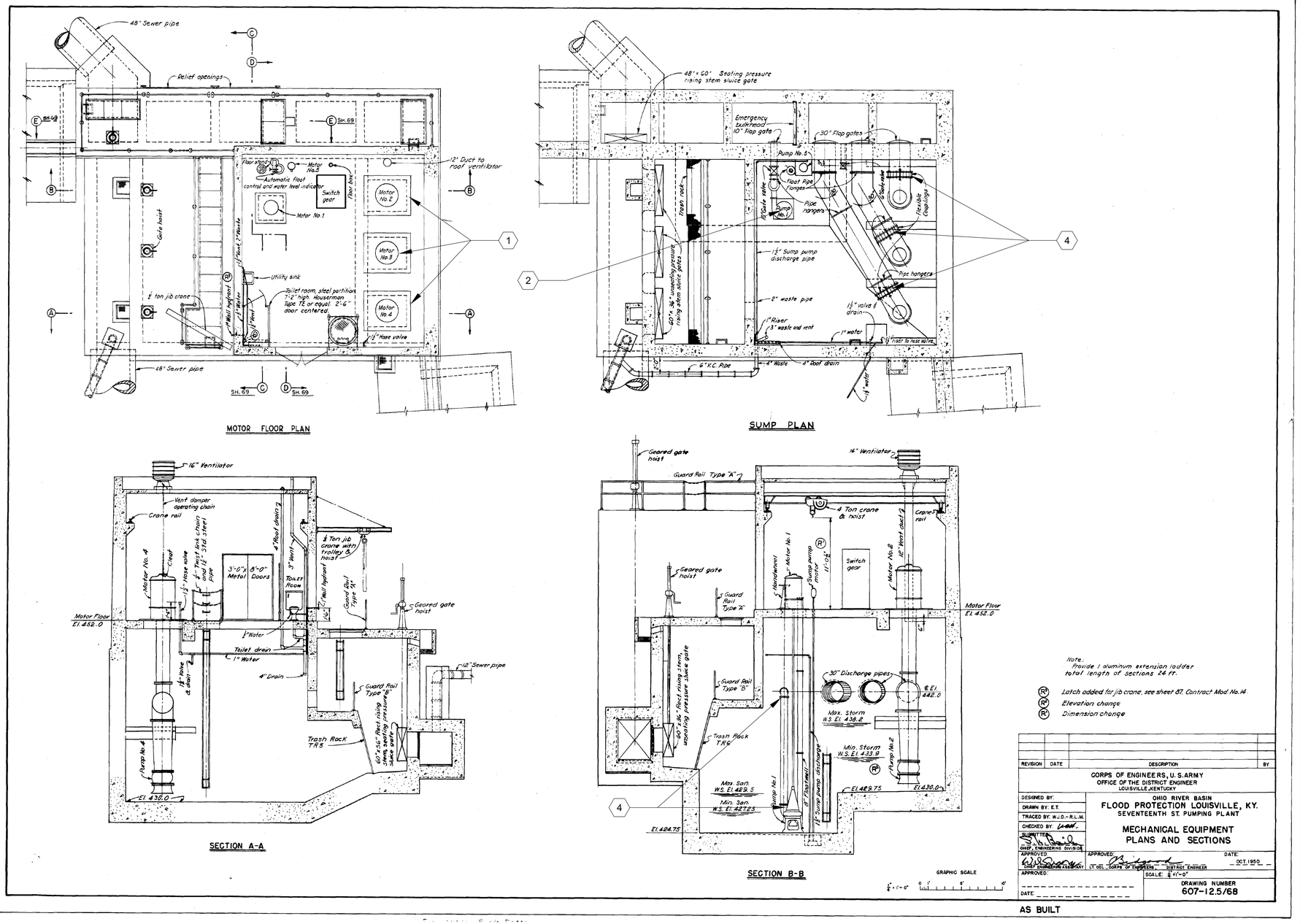
CONCEPT SUBMITTAL



Note:
Provide 1 aluminum extension ladder total length of sections 24 ft.

(R) Latch added for jib crane, see sheet 67, Contract Mod No. 14.
(R) Elevation change
(R) Dimension change

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

DESIGNED BY:
DRAWN BY: E.T.
TRACED BY: W.J.D.-R.L.M.
CHECKED BY:
SUBMITTED:
CHIEF, ENGINEERING DIVISION
APPROVED:
CHIEF, CONSTRUCTION ASSISTANT

OHIO RIVER BASIN
FLOOD PROTECTION LOUISVILLE, KY.
SEVENTEENTH ST. PUMPING PLANT

MECHANICAL EQUIPMENT
PLANS AND SECTIONS

APPROVED:
LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER
DATE: OCT. 1950
APPROVED:
DATE:
SCALE: ¼"=1'-0"
DRAWING NUMBER
607-12.5/68

AS BUILT

PUMP DATA				
PUMP #	TYPE	DESIGN FLOW (GPM)	TDH (FT OF WATER)	NOTES
1	SUBMERSIBLE	1,300	13.6	NEW PUMP
2	SUBMERSIBLE	11,400	7.1	NEW PUMP
3	SUBMERSIBLE	11,400	7.1	NEW PUMP
4	SUBMERSIBLE	11,400	7.1	NEW PUMP

SHEET KEYNOTES

1. REPLACE PUMPS WITH SUBMERSIBLE COLUMN PUMPS.
2. REPLACE PUMP WITH SUBMERSIBLE SUMP PUMP ON RAILS.
3. INSTALL NEW PUMP COLUMNS AND CONNECT TO EXISTING DISCHARGE PIPING AT FLEXIBLE COUPLING. INSTALL NEW FLEXIBLE COUPLING.
4. INSTALL NEW DISCHARGE ELBOW AND DISCHARGE PIPING UP TO GATE VALVE. DISCHARGE ELBOW TO HAVE RAIL GUIDES AND AUTOMATIC CONNECTION TYPE TO FACILITATE PUMP INSTALLATION AND REMOVAL WITHOUT UNBOLTING PUMP FROM ELBOW.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX

DESIGNED BY: K. BURNS
DRAWN BY: K. BURNS
CHECKED BY:
SUBMITTED BY:
SCALE: ANSI D

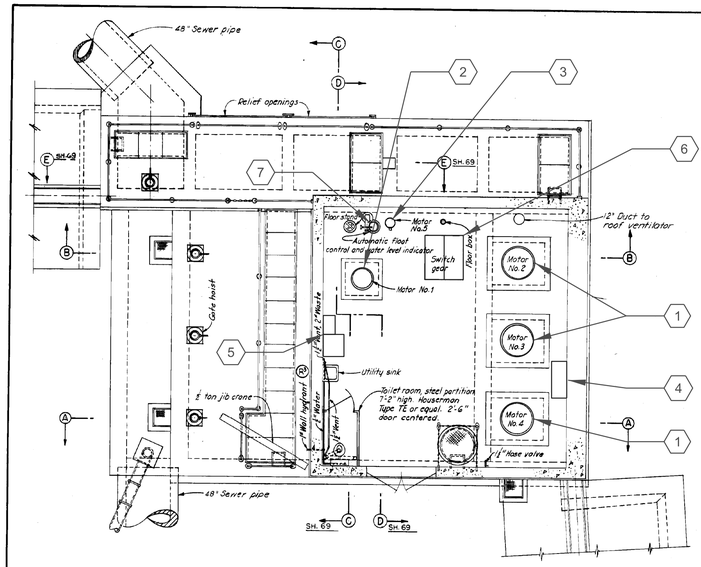
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

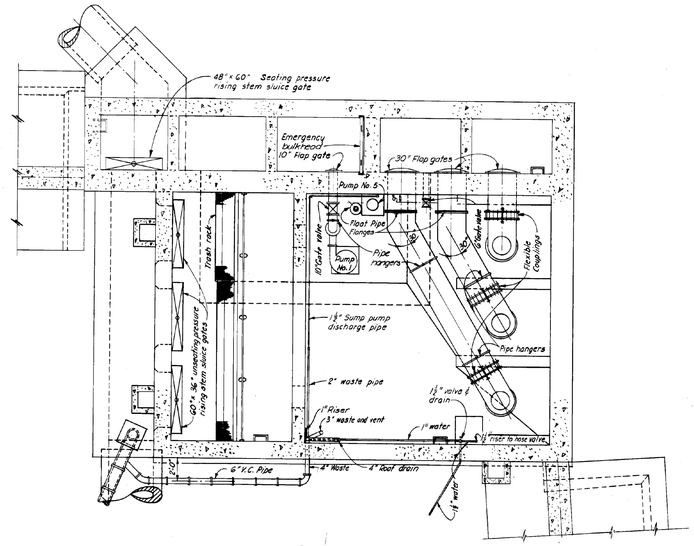
SEVENTEENTH STREET PS
MECHANICAL PLANS

SHEET ID
17-M-101

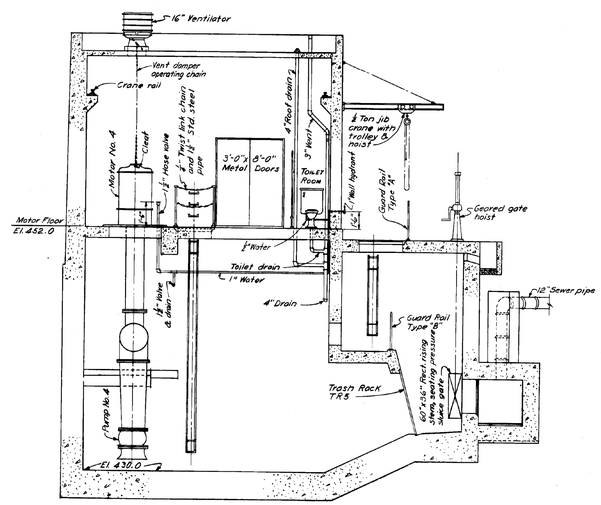
CONCEPT SUBMITTAL



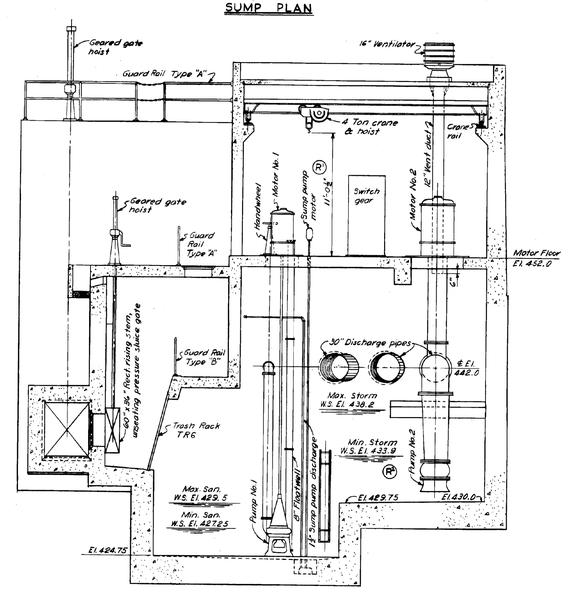
MOTOR FLOOR PLAN



SUMP PLAN



SECTION A-A



SECTION B-B

Note:
Provide 1 aluminum extension ladder total length of sections 24 ft.

(R) Latch added for jib crane, see sheet 67, Contract Mod. No. 14.
(R) Elevation change
(R) Dimension change

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
FLOOD PROTECTION LOUISVILLE, KY.
SEVENTEENTH ST. PUMPING PLANT

MECHANICAL EQUIPMENT
PLANS AND SECTIONS

DESIGNED BY:
DRAWN BY: E.T.
TRACED BY: W.J.D.-R.L.M.
CHECKED BY:
SUBMITTED:
CHIEF, ENGINEERING DIVISION
APPROVED:
CHIEF, DESIGN BRANCH
APPROVED:
LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER
APPROVED:
DATE:
DATE: OCT. 1950
SCALE: 1/4" = 1'-0"
DRAWING NUMBER
607-12.5/68

GRAPHIC SCALE

AS BUILT

GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. REPLACE 75 HP PUMPS WITH SUBMERSIBLE COLUMN PUMPS. MOTOR HP VALUES EXPECTED TO INCREASE.
2. REPLACE 15 HP PUMP WITH SUBMERSIBLE PUMP ON RAILS. MOTOR HP VALUE EXPECTED TO INCREASE.
3. REPLACE SUMP PUMP IN KIND.
4. PUMP CONTROLS WILL BE UPDATED AND INTEGRATED INTO MSD SCADA SYSTEM.
5. A 112.5 KVA TRANSFORMER WILL BE INSTALLED FOR BUILDING SUPPORT SYSTEMS. PUMP CONTROLS, LIGHTING, 208/120 VAC POWER, HVAC, ETC.
6. MOTOR CONTROL CENTER WILL BE REPLACED WITH A MODERN DAY EQUIVALENT.
7. REPLACEMENT CONTROL SYSTEM INSTRUMENTATION (PRESSURE TRANSDUCER, FLOAT MAST)

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. LEE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

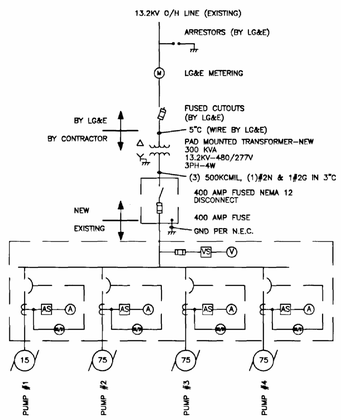
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

SEVENTEENTH ST PS ELECTRICAL PLAN

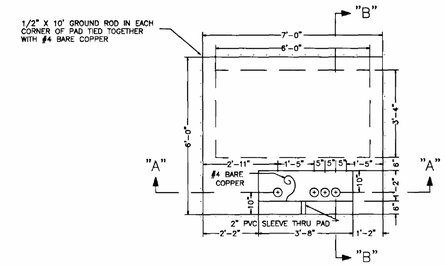
SHEET ID
17-E-101

A1 SEVENTEENTH ST PS ELECTRICAL PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL

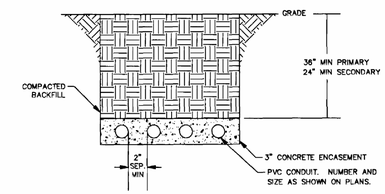


SINGLE LINE DIAGRAM

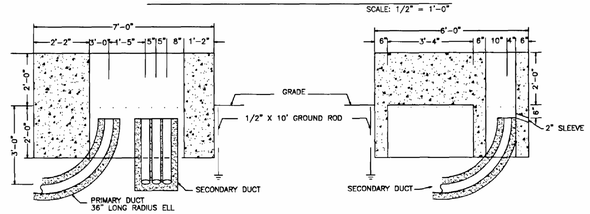


CONCRETE TRANSFORMER PAD

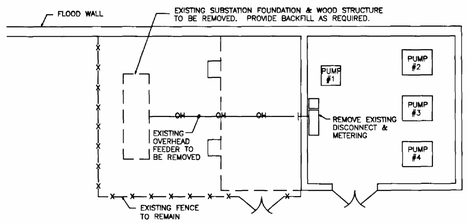
SCALE: 1/2" = 1'-0"



SECTION "C"–"C"
(TYPICAL)

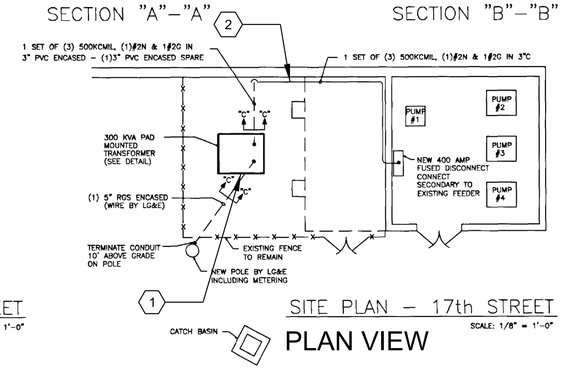


SECTION "A"–"A" SECTION "B"–"B"



DEMOLITION PLAN – 17th STREET

SCALE: 1/8" = 1'-0"



SITE PLAN – 17th STREET

SCALE: 1/8" = 1'-0"

PLAN VIEW

NOTES:
1.) UNDERGROUND CONDUIT IS TO BE PVC ENCASED. ALL ELBOWS AND EXPOSED CONDUIT IS TO BE HEAVY WALL ALUMINUM.
2.) ALL CONCRETE IS TO BE 3000 PSI.
3). ONE SPARE CONDUIT WILL BE INSTALLED FOR SECONDARY UNDERGROUND RUNS ONLY. CAP AT GRADE.
4). INSTALL PRIMARY CONDUIT PER ALL APPLICABLE LG&E STANDARDS.

NO.	DATE	REVISION	CHK'D	APPRO'D	DATE MSD APPROVALS
0		BID DOCUMENTS			

Signature L.S.# — Land Surveyor's Seal

STATE OF KENTUCKY — DANIEL P. DOWNARD 10215 — REGISTERED PROFESSIONAL ENGINEER

Signature P.E.# 10215 — Professional Engineer's Seal

PLANS PREPARED AND SUBMITTED BY:

MEPPA, AND ASSOCIATES, INC. PROCESS AUTOMATION SPECIALISTS (502) 585-4100

Design Consultant

CONSTRUCTED BY:

Company Name — Date

FINAL RECORD DRAWING BY:

Company Name

Signature — Date

Final Record Drawing

Signature L.S.# — Land Surveyor's Seal

MSD Louisville and Jefferson County Metropolitan Sewer District 700 W. Liberty St., Louisville, Ky. 40203-1913

17th STREET PUMPING STATION PLANS

SCALE: AS NOTED — DATE: 10/30/96

BUDGET I.D. NO. 094-3790 — CONSTRUCTION CONTRACT NO. 12580 — RECORD NO. 12580 — SHEET 3 OF 3

PLT DATE: 11/04/96 10:25:23

NAME	DATE
DRAWN BY: CMW	10/30/96
DESIGNED BY: CMW	10/30/96
CHECKED BY: DPD	10/30/96
RECORD DWG.	

MSDBASE-09/94

A1 SEVENTEENTH STREET PS - SUBSTATION PLAN

SCALE: NOT TO SCALE

GENERAL SHEET NOTES

1. SUBSTATION EQUIPMENT TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. 300 KVA PAD-MOUNT TRANSFORMER
2. SECONDARY WIRING

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON	ISSUE DATE: AUGUST 2019
DRAWN BY: R. MORRISON	SOLICITATION NO.: XXXXXX-XX-X-XXXX
CHECKED BY: J. TIMBAS	CONTRACT NO.: XXXXXXXXXXXXXX
SUBMITTED BY: J. TOLLE	THRU 0023
SIZE: ANSI D	

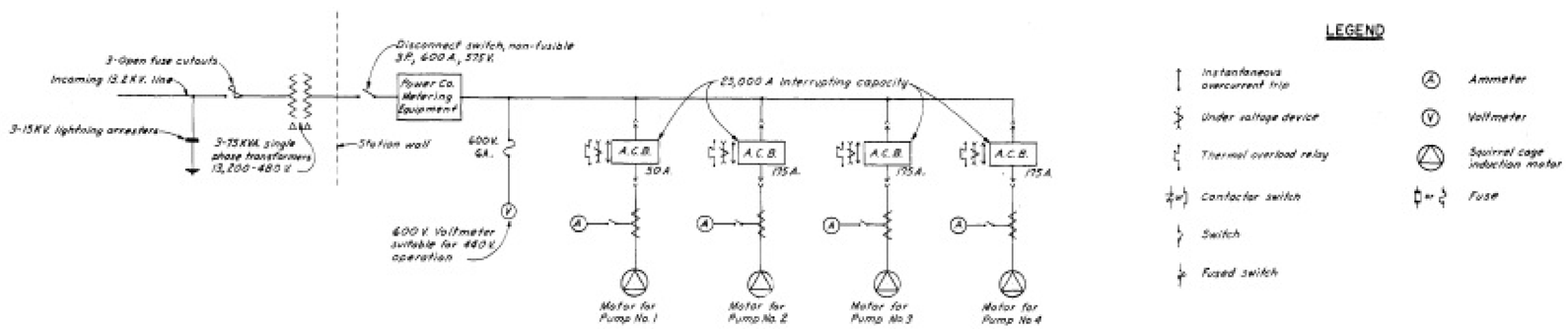
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

SEVENTEENTH STREET PS SUBSTATION PLAN

SHEET ID
17-E-102

CONCEPT SUBMITTAL



A1 SEVENTEENTH ST PUMP STATION EXISTING ONE LINE DIAGRAM

SCALE: NOT TO SCALE

GENERAL SHEET NOTES

1. SEE SEVENTEENTH ST E-101 FOR EXISTING STATION FLOOR PLAN. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. EXISTING ONE LINE DIAGRAM HAS BEEN PROVIDED AS A REFERENCE. SEE FEASIBILITY REPORT APPENDIX D-ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXX
THRU 0023

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TIMBAS
SIZE: ANSI D

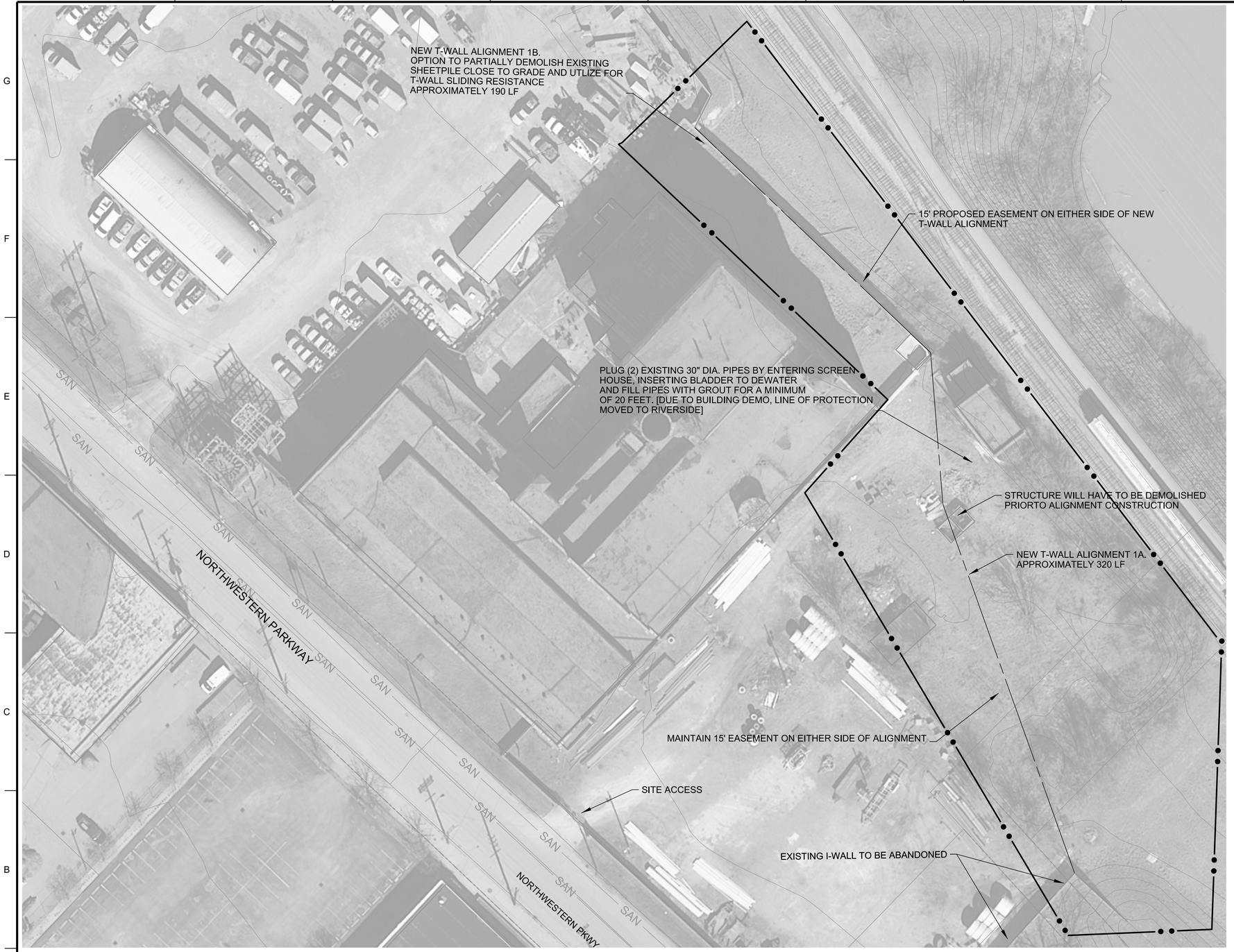
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

SEVENTEENTH ST PS EXISTING POWER ONE LINE

SHEET ID
17-E-601

CONCEPT SUBMITTAL



A1 CANAL STATION SITE PLAN
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOYE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

CANAL STATION SITE PLAN

SHEET ID
CN-C-101

CONCEPT SUBMITTAL

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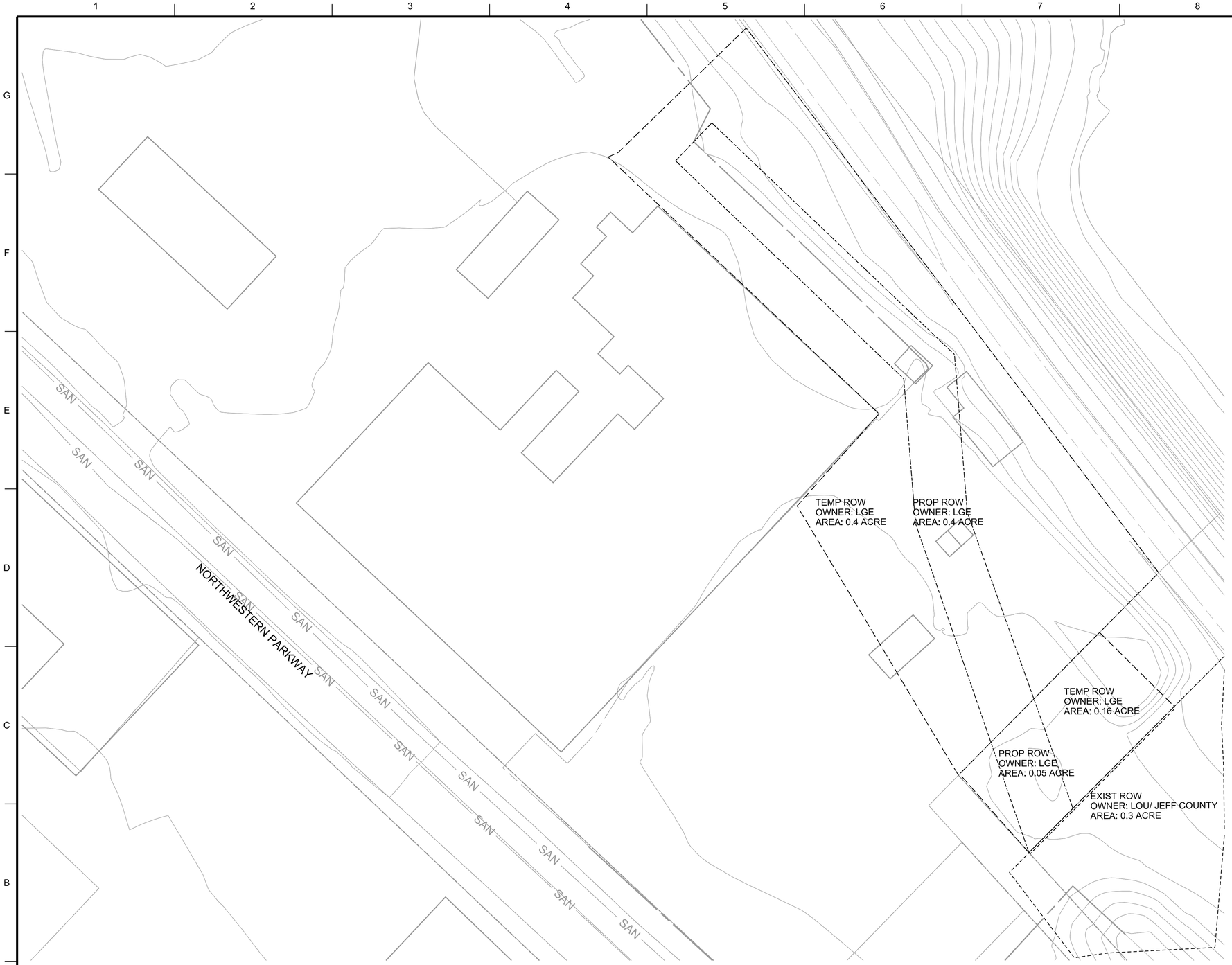

A1 CANAL STATION RIGHT OF WAY PLAN
1"=50'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2: 145626

CANAL STATION
RIGHT OF WAY

SHEET ID
CN-R-101

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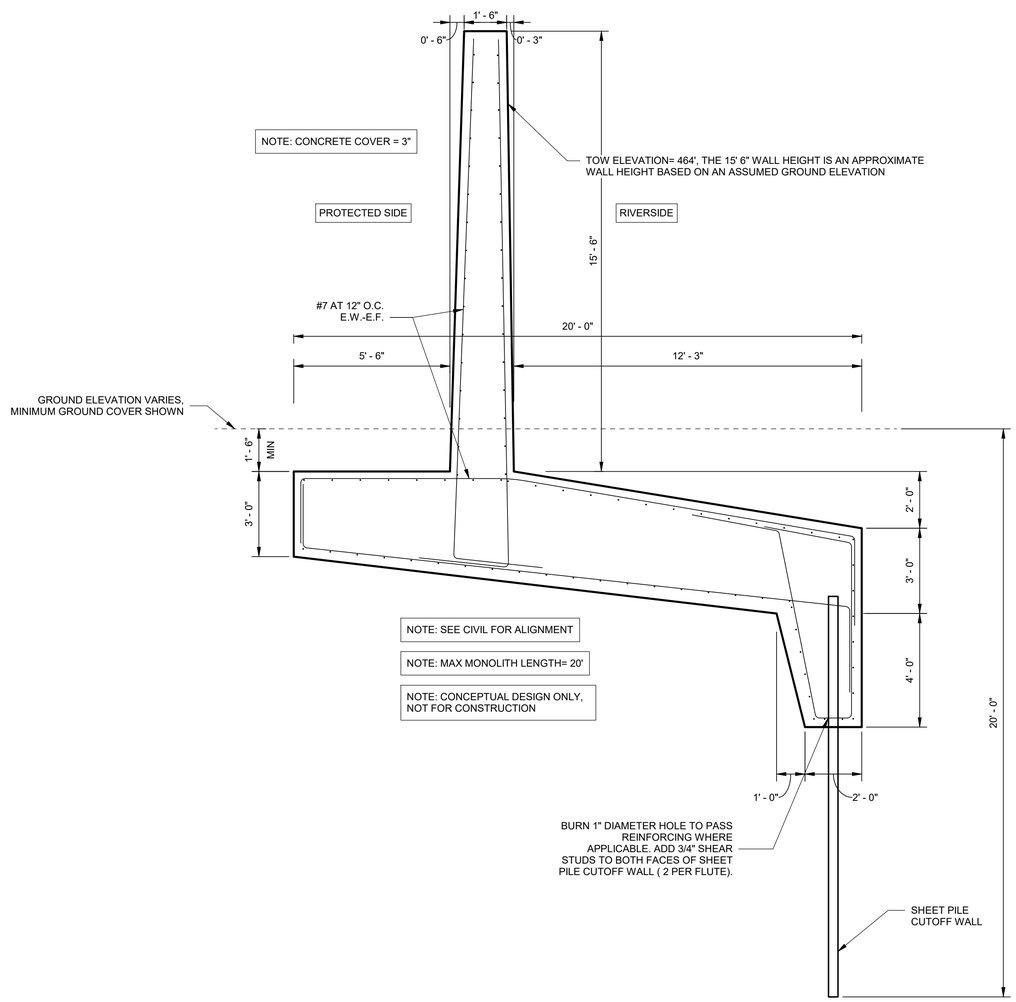

1 TYP T-WALL DETAILS

3/8" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: B. EVANS
DRAWN BY: B. EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOYE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR MARTIN LUTHER KING JR PLACE

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

T-WALL DETAILS

SHEET ID

CN-S-101

CONCEPT SUBMITTAL

A1 27TH STREET SITE PLAN
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOYE
SIZE:

ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

27TH STREET PUMP STATION
SITE PLAN

SHEET ID
27-C-101

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CONCEPT SUBMITTAL

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

A1 27TH STREET PS RIGHT OF WAY PLAN
1"=50'

0 50' 100'

N

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

27TH STREET PS
RIGHT OF WAY

SHEET ID
27-R-101

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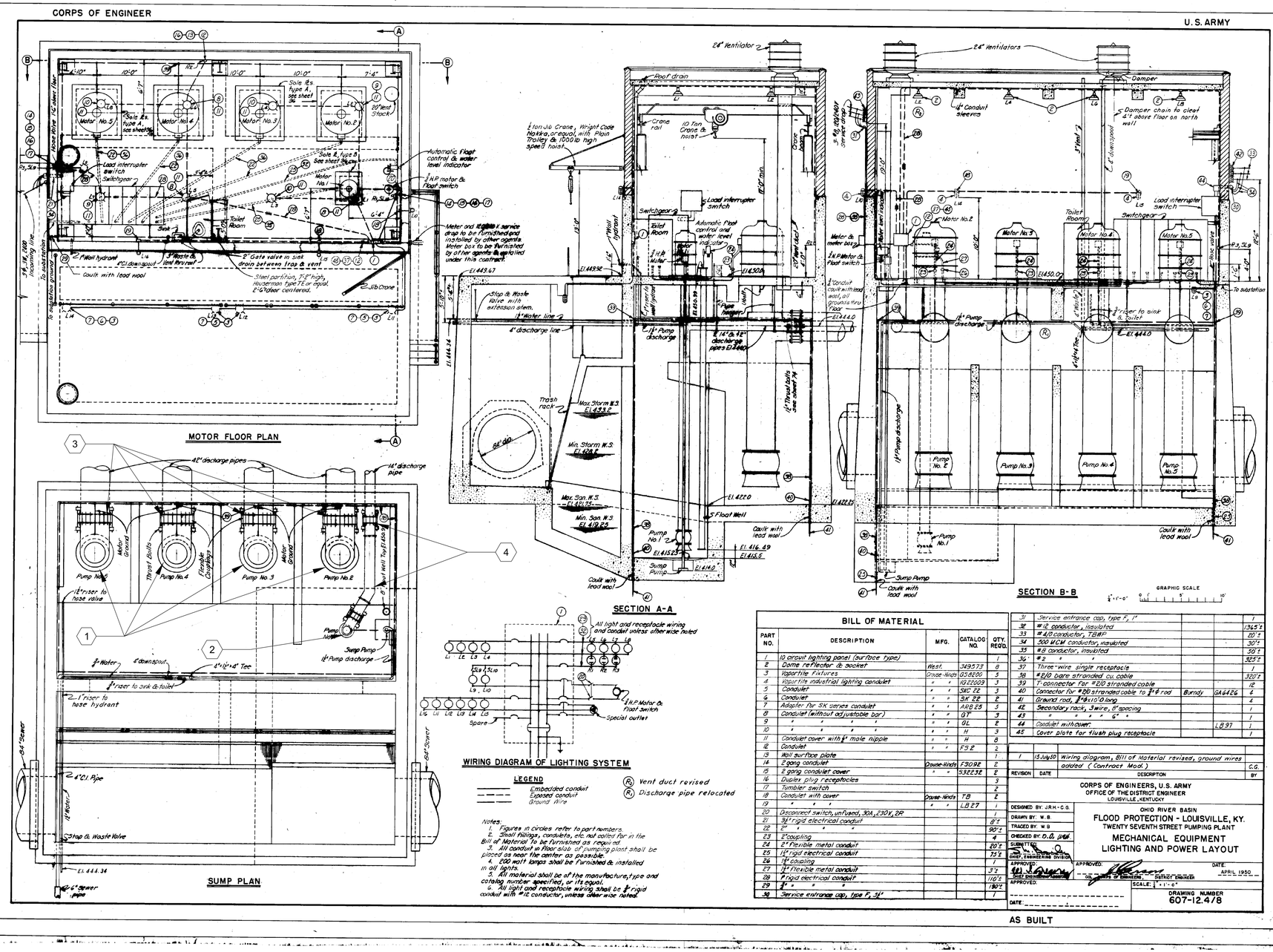


PUMP DATA				
PUMP #	TYPE	DESIGN FLOW (GPM)	TDH (FT OF WATER)	NOTES
1	SUBMERSIBLE	5,710	32.0	NEW PUMP
2	SUBMERSIBLE	40,000	31.5	NEW PUMP
3	SUBMERSIBLE	40,000	31.5	NEW PUMP
4	SUBMERSIBLE	40,000	31.5	NEW PUMP
5	SUBMERSIBLE	40,000	31.5	NEW PUMP

SHEET KEYNOTES

1. REPLACE PUMPS WITH SUBMERSIBLE COLUMN PUMPS.
2. REPLACE PUMP WITH SUBMERSIBLE SUMP PUMP ON RAILS.
3. PROVIDE AND CONNECT NEW COLUMNS TO EXISTING 42" DISCHARGE PIPING AT FLEXIBLE COUPLINGS. INSTALL NEW FLEXIBLE COUPLINGS.
4. INSTALL NEW FLEXIBLE COUPLINGS AND DISCHARGE PIPING UP TO FLEXIBLE COUPLING NEAREST THE WALL PENETRATION. KEEP CURRENT WALL PENETRATION PIPING. NEW PUMP DISCHARGE ELBOW TO BE AUTOMATIC CONNECTION TYPE WITH RAIL GUIDES TO FACILITATE REMOVAL OF PUMP WITHOUT UNBOLTING PUMP FROM ELBOW.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

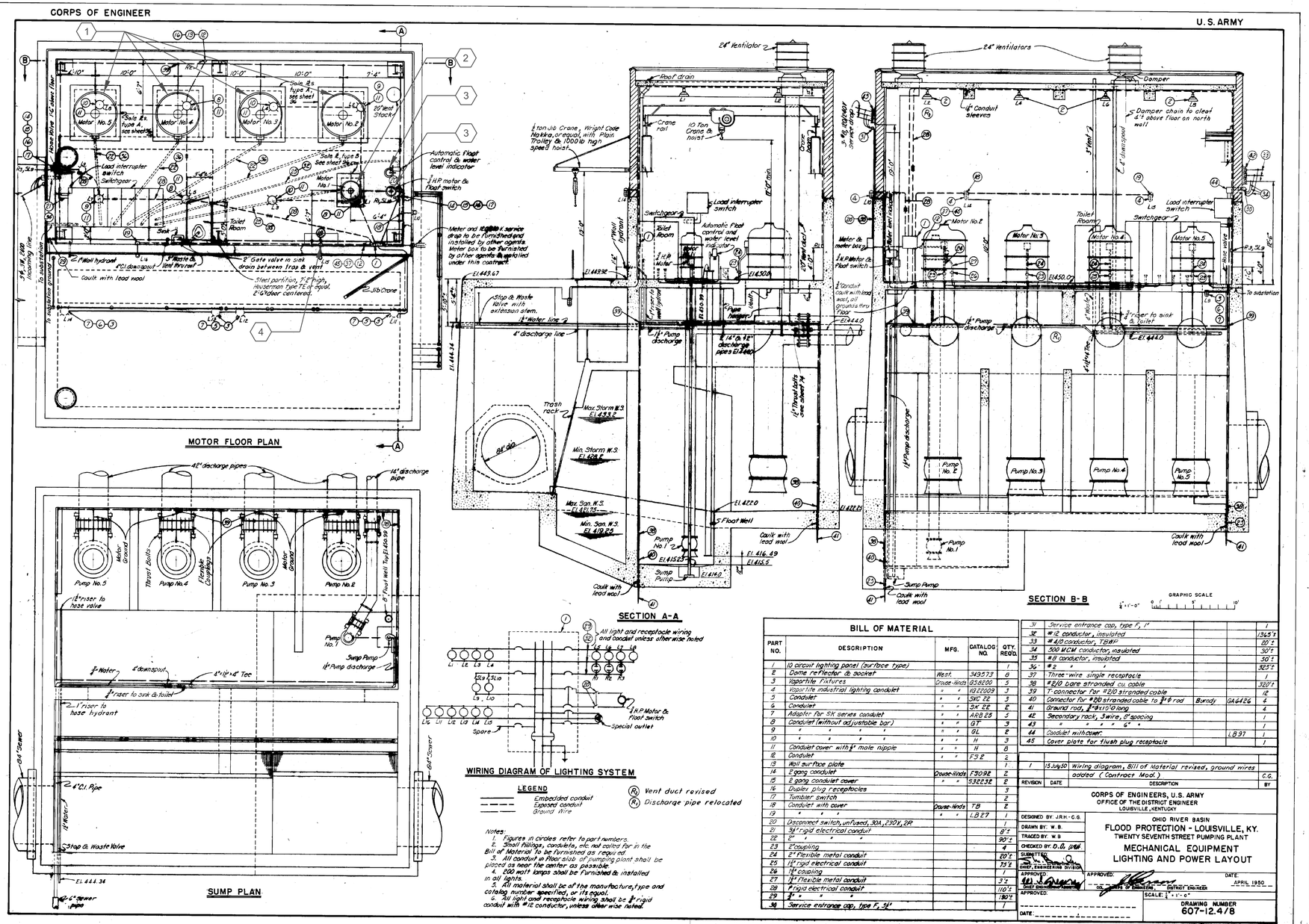
DESIGNED BY: K. BURNS
DRAWN BY: K. BURNS
CHECKED BY:
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

TWENTY SEVENTH STREET PS
MECHANICAL PLANS

SHEET ID
27-M-101

CONCEPT SUBMITTAL



BILL OF MATERIAL

PART NO.	DESCRIPTION	MFG.	CATALOG NO.	QTY. REQ'D.
1	10 circuit lighting panel (surface type)			1
2	Dome reflector & socket	West.	349573	8
3	Vapor-tite fixtures	Crouse-Hinds	93B200	5
4	Vapor-tite industrial lighting condulet	" "	AD12009	3
5	Condulet	" "	SKC 22	3
6	Condulet	" "	SK 22	2
7	Adapter for SK series condulet	" "	ARB 23	5
8	Condulet (without adjustable bar)	" "	GT	3
9	" " " "	" "	GL	2
10	" " " "	" "	H	3
11	Condulet cover with ¾" male nipple	" "	H	8
12	Condulet	" "	FS 2	2
13	Wall surface plate			1
14	2 gang condulet	Crouse-Hinds	FS09E	2
15	2 gang condulet cover	" "	53283E	2
16	Duplex plug receptacles			3
17	Tumbler switch			2
18	Condulet with cover	Crouse-Hinds	TB	2
19	" " "	" "	LB27	1
20	Disconnect switch, unfused, 30A, 230V, 2P			1
21	¾" rigid electrical conduit			8'±
22	2" " " "			90'±
23	2" coupling			4
24	2" flexible metal conduit			20'±
25	1¼" rigid electrical conduit			75'±
26	1¼" coupling			1
27	1¼" flexible metal conduit			3'±
28	¾" rigid electrical conduit			110'±
29	¾" " "			180'±
30	Service entrance cap, type F, 3¼"			1
31	Service entrance cap, type F, 1"			1
32	#12 conductor, insulated			1345'±
33	#4/0 conductor, THWN			80'±
34	500 MCM conductor, insulated			30'±
35	#8 conductor, insulated			30'±
36	#2 " "			925'±
37	Three-wire single receptacle			1
38	#2/0 bare stranded cu. cable			320'±
39	T-connector for #2/0 stranded cable			12
40	Connector for #2/0 stranded cable to ¾" ϕ rod	Burndy	GAE426	4
41	Ground rod, ¾"ϕ x 10'-0" long			4
42	Secondary rack, 3 wire, 8" spacing			1
43	" " " " " 6" "			1
44	Conduit with cover		LB37	1
45	Cover plate for flush plug receptacle			1

REVISION	DATE	DESCRIPTION	BY
1	15 July 50	Wiring diagram, Bill of Material revised, ground wires added (Contract Mod.)	C.G.

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
FLOOD PROTECTION - LOUISVILLE, KY.
TWENTY SEVENTH STREET PUMPING PLANT
MECHANICAL EQUIPMENT
LIGHTING AND POWER LAYOUT

DESIGNED BY: J.R.H.-C.G.
DRAWN BY: W.B.
TRACED BY: W.B.
CHECKED BY: D.D.
SUBMITTED: CHIEF, ENGINEERING DIVISION
APPROVED: CHIEF, PLANNING & REPORTS BRANCH
APPROVED: COL., CORPS OF ENGINEERS, DISTRICT ENGINEER
DATE: APRIL 1950
SCALE: ¾" = 1'-0"
DRAWING NUMBER 607-12.4/8

GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. REPLACE 350 HP PUMPS WITH SUBMERSIBLE COLUMN PUMPS. MOTOR HP VALUES EXPECTED TO INCREASE.
2. REPLACE 60 HP PUMP WITH SUBMERSIBLE PUMP ON RAILS. MOTOR HP VALUE EXPECTED TO INCREASE.
3. REPLACE SUMP PUMP IN KIND
4. PUMP CONTROLS WILL BE UPDATED AND INTEGRATED INTO MSD SCADA SYSTEM.
5. CONTROL SYSTEM INSTRUMENTATION (PRESSURE TRANSDUCER, FLOAT MAST)

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:	R. MORRISON
DRAWN BY:	R. MORRISON
CHECKED BY:	J. TIMBAS
SUBMITTED BY:	SJ TOE
SIZE:	ANSI D
ISSUE DATE:	AUGUST 2019
SOLICITATION NO.:	XXXXXX-XX-X-XXXX
CONTRACT NO.:	XXXXXXXXXXXXXX
	THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

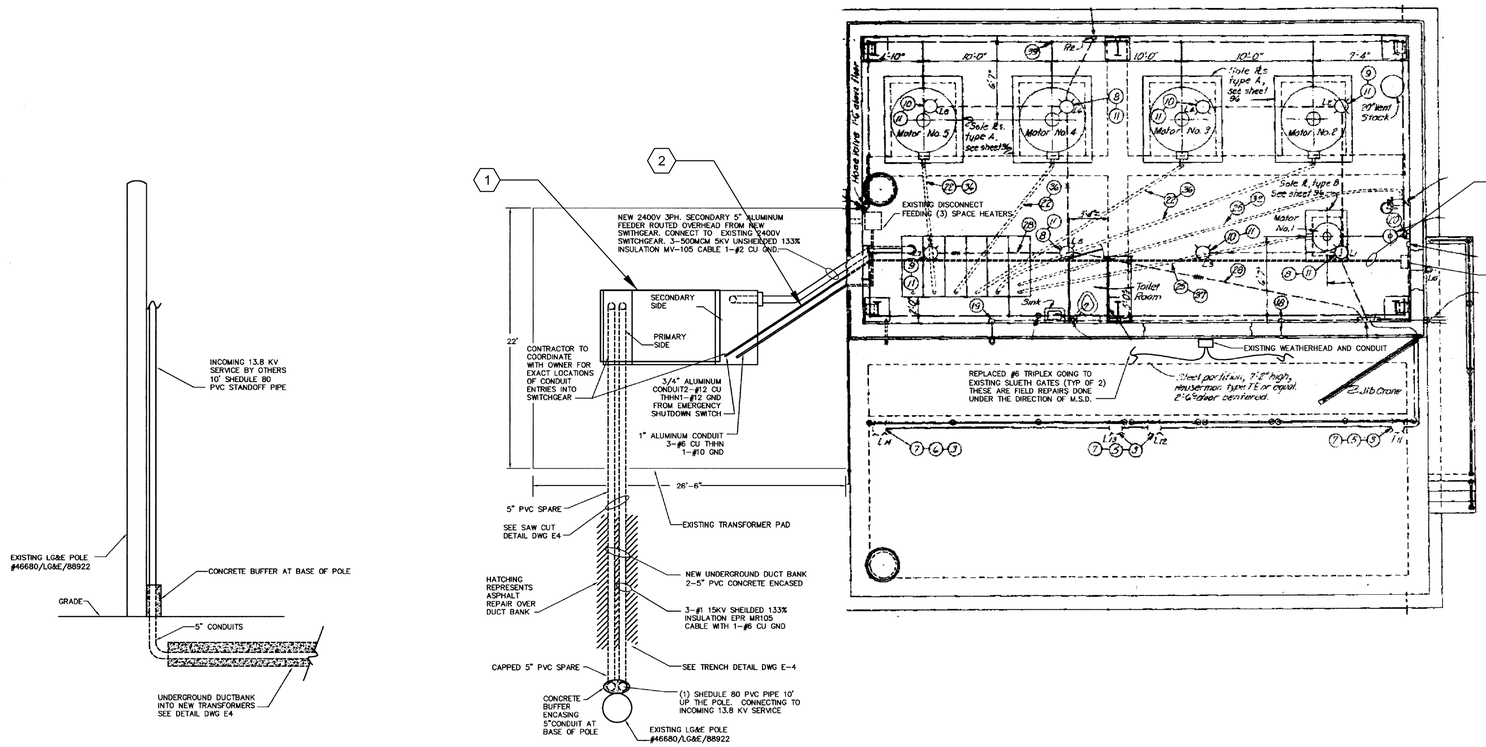
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

TWENTY SEVENTH ST PS ELECTRICAL PLAN

SHEET ID
27-E-101

A1 TWENTY SEVENTH ST PS ELECTRICAL PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL



PLAN VIEW

JOB NO. 02906
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KHAFRA ENGINEERING CONSULTANTS, INC.
304 WEST LIBERTY STREET, SUITE 306
LOUISVILLE, KENTUCKY 40202
502-584-8599 FAX 502-584-9812

Professional Engineer's Seal
STATE OF KENTUCKY
CHARLES J. WINKLER 23327
LICENSED PROFESSIONAL ENGINEER
Signature L.S. PE-23327
7-22-05

RECORD DWGS:	WN	07-25-05
CHECKED BY:	BW	04-19-04
DESIGNED BY:	BW	04-19-04
DRAWN BY:	WN	04-19-04

FILE NAME: 03935
PLOT DATE: APRIL 19 2004

PLANS PREPARED and SUBMITTED BY:
CH2M HILL / Quest
455 South Fourth Avenue Suite 1100
Louisville, KY 40202
502-584-6686

MSD
Louisville and Jefferson County Metropolitan Sewer District
700 West Liberty Street
Louisville, Kentucky 40203

NO.	REVISION	DATE
1	FIELD CORRECTIONS	01/07/05

SHEET TITLE: ELECTRICAL INSTALLATION SHEET
PROJECT TITLE: 27TH. STREET PUMP STATION TRANSFORMER REPLACEMENT
GRAPHIC SCALE = 1" ON ORIGINAL

BUDGET I.D. F04072
CONSTRUCTION ORDER NO. 2004-12
RECORD NO. 14776
DRAWING NO: E3
4 of 5

GENERAL SHEET NOTES

1. SUBSTATION EQUIPMENT TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. 2000 KVA PAD-MOUNT TRANSFORMER
2. SECONDARY WIRING

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TIMBAS
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

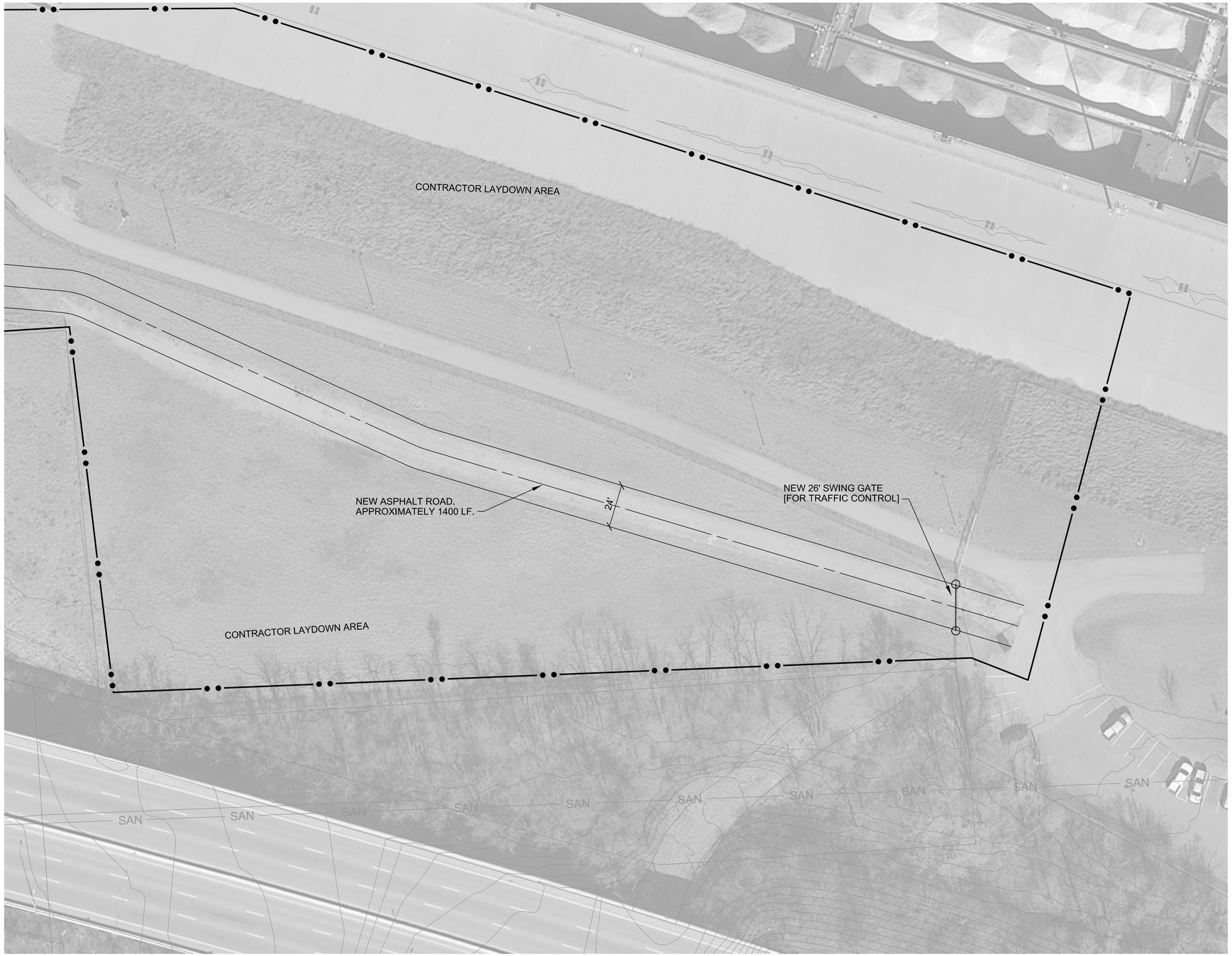
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

TWENTY SEVENTH STREET PS SUBSTATION PLAN

SHEET ID
27-E-102

A1 TWENTY SEVENTH STREET PS - SUBSTATION PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL



GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

A1 MCALPINE ACCESS ROAD SITE PLAN 1 OF 2
1"=50'

N

0 50' 100'

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

MACALPINAE ACCES ROAD
SITE PLAN 1 OF 2

SHEET ID
MR-C-101

CONCEPT SUBMITTAL

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A1 MCALPINE ACCESS ROAD SITE PLAN 2 OF 2
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET. DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

MCALPINE ACCESS ROAD SITE
2 OF 2

SHEET ID
MR-C-102

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CONCEPT SUBMITTAL

A1 MCALPINE ACCESS ROAD RIGHT OF WAY PLAN 1 OF 2
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET. DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2: 145626

MCALPINE ACCESS ROAD
RIGHT OF WAY 1 OF 2

SHEET ID
MR-R-101

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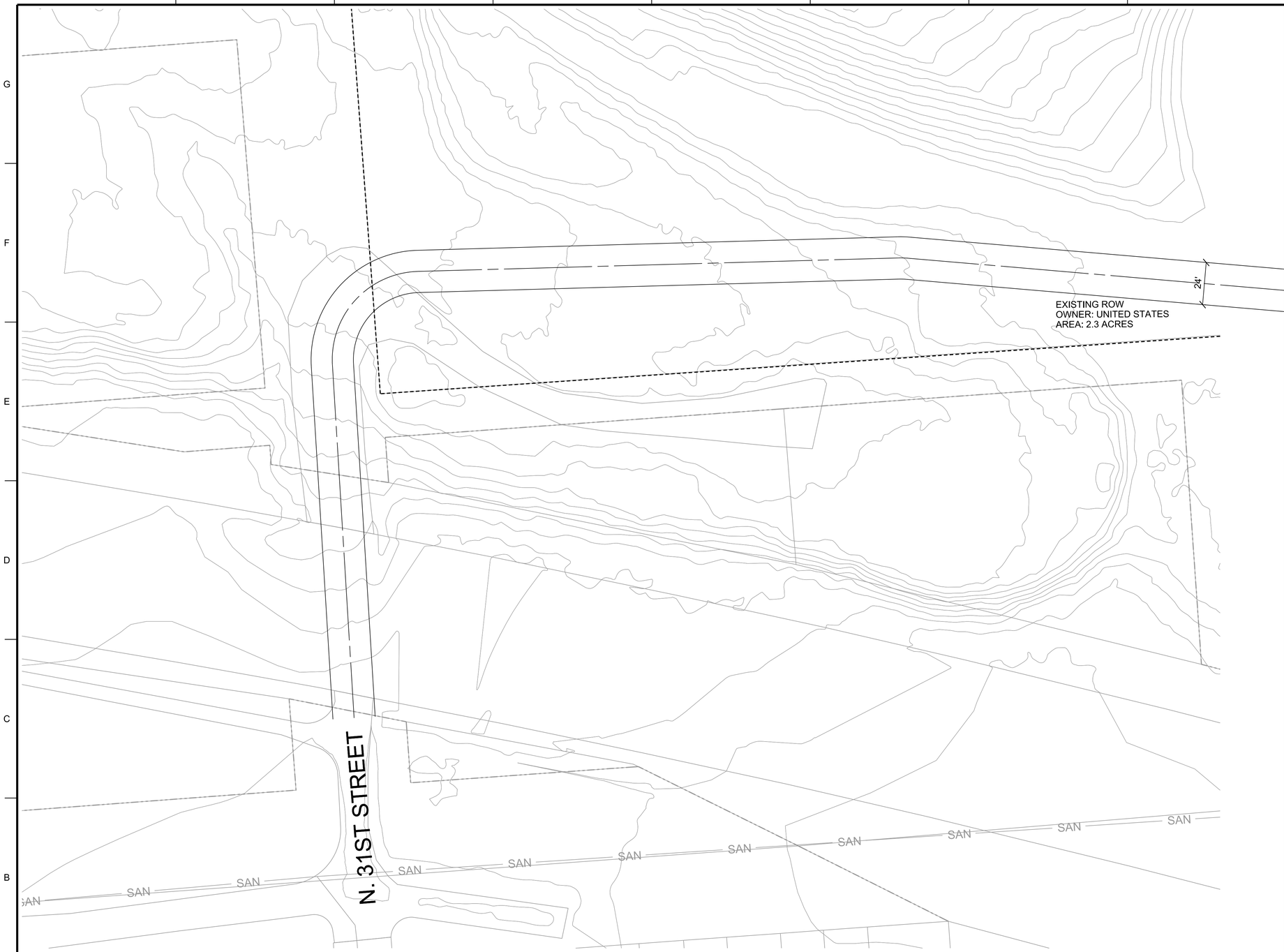
CONCEPT SUBMITTAL



A1 MCALPINE ACCESS ROAD RIGHT OF WAY PLAN 2 OF 2
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

MCALPINE ACCESS ROAD
RIGHT OF WAY 2 OF 2

SHEET ID
MR-R-102

...\145626\05\530\CAD_BIM_Sheets\MR-R-102
1:10:29 PM 8/27/2019 LRL_pdf.pltcfg LRL_Screen.dscript

CONCEPT SUBMITTAL

A1 34TH ST PUMP STATION SITE PLAN
1"=50'

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

34TH STREET PUMP STATION

SHEET ID
34-C-101

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1:10:33 PM 8/27/2019 LRL_pdf.pltcfg LRL_Screen.dscript

CONCEPT SUBMITTAL

A1 34TH STREET PS RIGHT OF WAY PLAN
1"=50'

0 50' 100'

N

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

34TH ST PS
RIGHT OF WAY

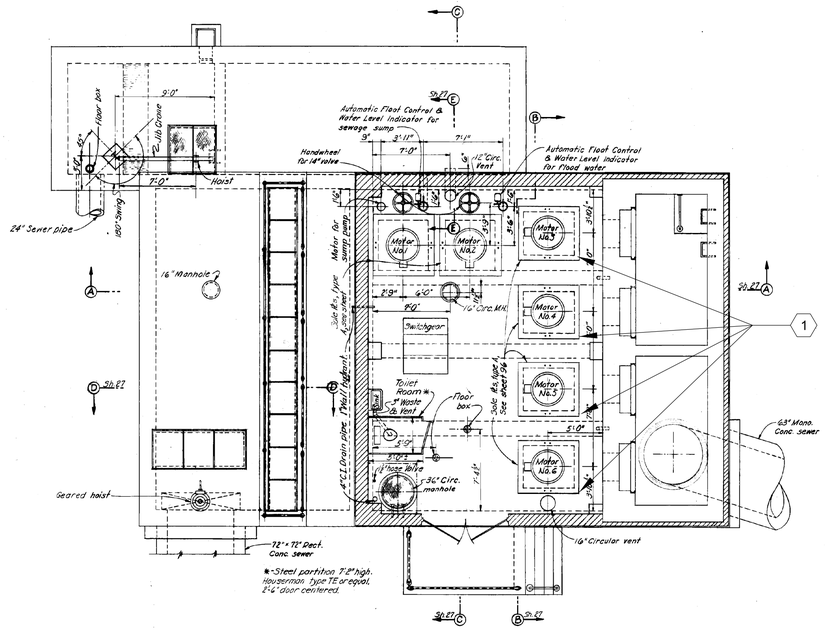
SHEET ID
34-R-101

...\145626\05\530\CAD_BIM_Sheets\34-R-101
1:11:04 PM 8/27/2019 LRL_pdf.pltcfg LRL_Screen.dscript

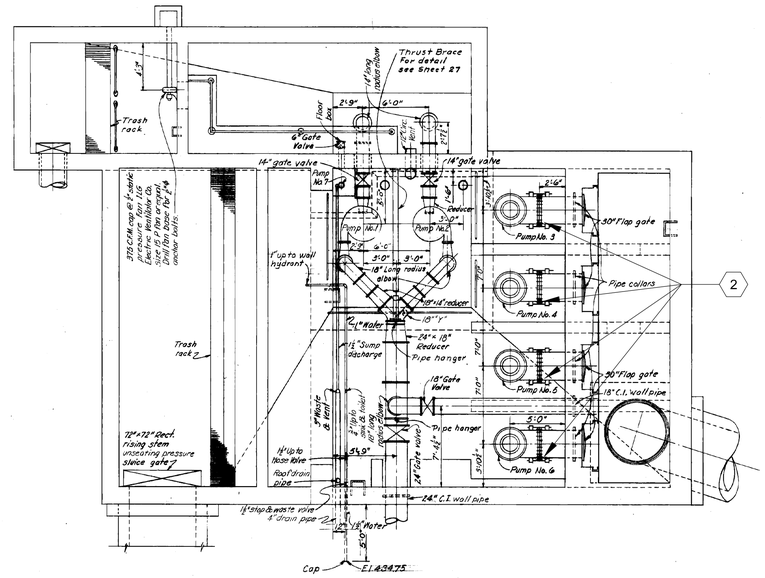
CONCEPT SUBMITTAL

CORPS OF ENGINEERS

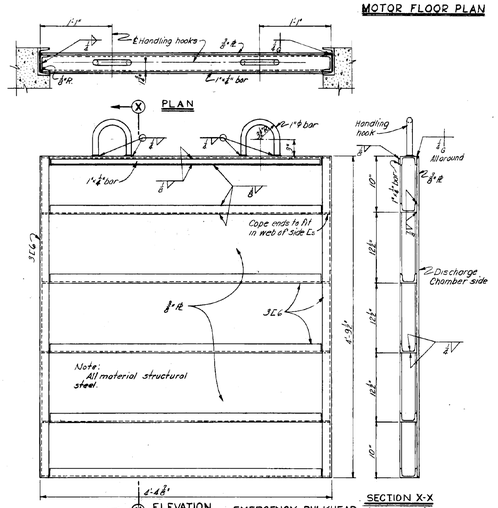
U.S. ARMY



MOTOR FLOOR PLAN



SUMP PLAN



EMERGENCY BULKHEAD

SCALE: 1/4"=1'-0"

Note: Provide 30' extension type aluminum ladder.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
FLOOD PROTECTION – LOUISVILLE, KY.
THIRTY FOURTH STREET PUMPING PLANT

MECHANICAL EQUIPMENT LAYOUT

DESIGNED BY:
DRAWN BY: J.W.J.
TRACED BY: J.W.J.
CHECKED BY:
SUBMITTED:
CHIEF, ENGINEERING DIVISION
APPROVED:
CHIEF ENGINEERING ASSISTANT
APPROVED:
CHIEF, ENGINEERING DIVISION
DATE: MAY 2, 1996
APPROVED:
CHIEF, CONSTRUCTION DIVISION
DATE:
DISTRICT ENGINEER
APRIL 1990
SCALE: 1/4"=1'-0"
DRAWING NUMBER 607-12.4/26

GRAPHIC SCALE

AS BUILT

PUMP DATA				
PUMP #	TYPE	DESIGN FLOW (GPM)	TDH (FT OF WATER)	NOTES
3	SUBMERSIBLE	15,600	34.0	NEW PUMP
4	SUBMERSIBLE	15,600	34.0	NEW PUMP
5	SUBMERSIBLE	15,600	34.0	NEW PUMP
6	SUBMERSIBLE	15,600	34.0	NEW PUMP

SHEET KEYNOTES

1. REPLACE PUMPS WITH SUBMERSIBLE COLUMN PUMPS.
2. INSTALL AND CONNECT NEW COLUMNS TO EXISTING 30" DISCHARGE PIPING AT FLEXIBLE COUPLINGS. INSTALL NEW FLEXIBLE COUPLINGS.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: K. BURNS
DRAWN BY: K. BURNS
CHECKED BY:
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145026

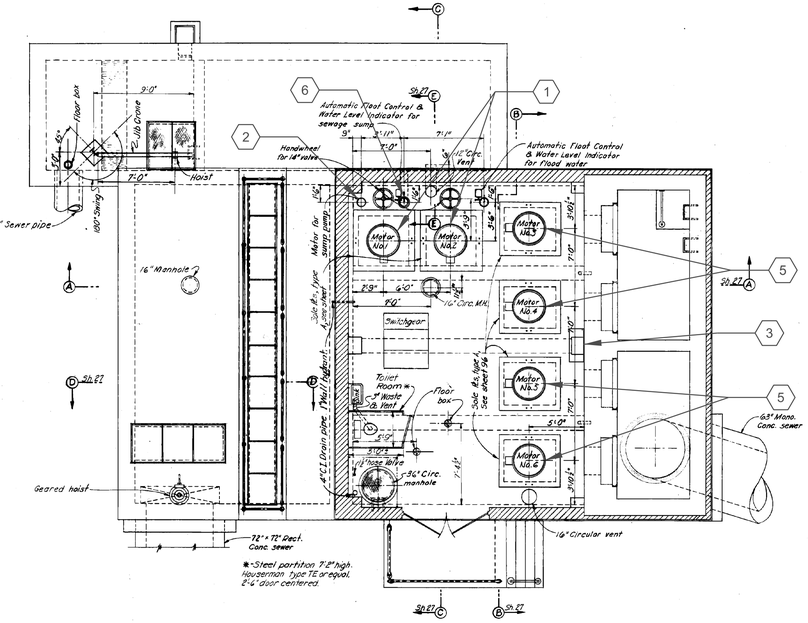
THIRTY FOURTH PS
MECHANICAL PLANS

SHEET ID
34-M-101

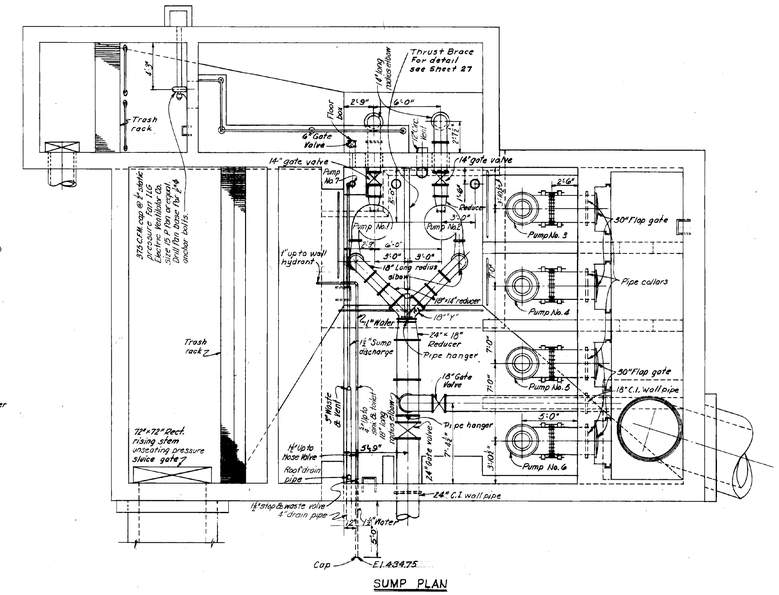
CONCEPT SUBMITTAL

CORPS OF ENGINEERS

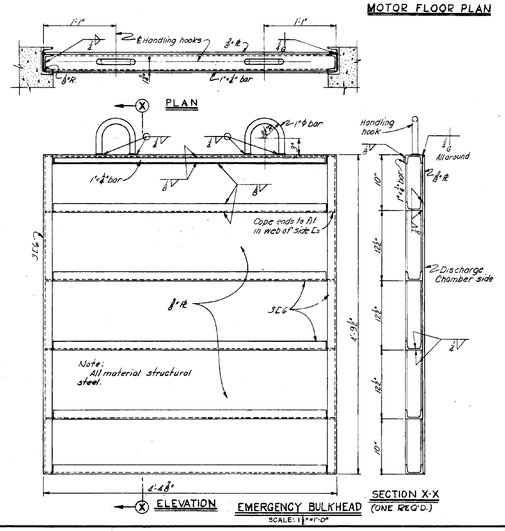
U.S. ARMY



MOTOR FLOOR PLAN



SUMP PLAN



EMERGENCY BULK'HEAD

SCALE: 1" = 1'-0"

Note: Provide 30' extension type aluminum ladder.

GRAPHIC SCALE

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
FLOOD PROTECTION – LOUISVILLE, KY.
THIRTY FOURTH STREET PUMPING PLANT

MECHANICAL EQUIPMENT LAYOUT

DESIGNED BY:
DRAWN BY: J.W.J.
TRACED BY: J.W.J.
CHECKED BY:
SUBMITTED: CHIEF, ENGINEERING DIVISION
APPROVED: CHIEF, DESIGN BRANCH
APPROVED: CHIEF, CIVIL & MEC. DESIGN SECT.
DATE: MAY 5, 1976
APPROVED: CHIEF, CONSTRUCTION DIVISION
DATE: APRIL 1980
SCALE: 1/4" = 1'-0"
DRAWING NUMBER 607-12.4/26

AS BUILT

GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. REPLACE 75 HP PUMPS WITH SUBMERSIBLE COLUMN PUMPS. MOTOR HP VALUES EXPECTED TO INCREASE
2. REPLACE SUMP PUMP IN KIND
3. PUMP CONTROLS WILL BE UPDATED AND INTEGRATED INTO MSD SCADA SYSTEM
4. NOT USED
5. REPLACE 150 HP PUMPS WITH SUBMERSIBLE COLUMN PUMPS. MOTOR HP VALUES EXPECTED TO INCREASE
6. CONTROL SYSTEM INSTRUMENTATION (PRESSURE TRANSDUCER, FLOAT MAST)

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TOE
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

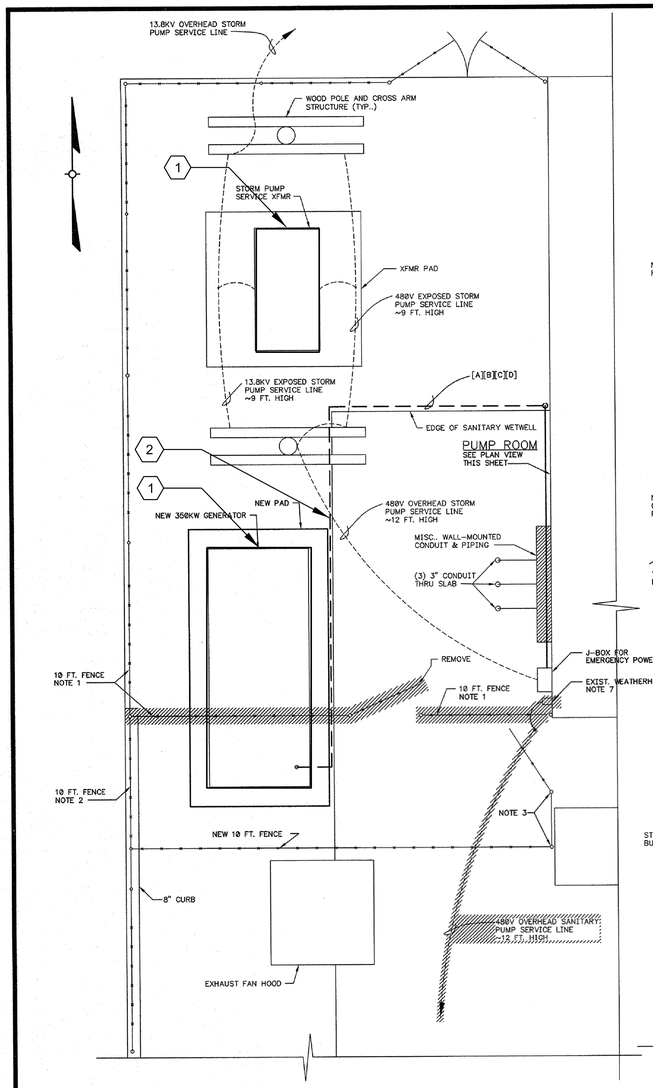
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

THIRTY FOURTH ST PS ELECTRICAL PLAN

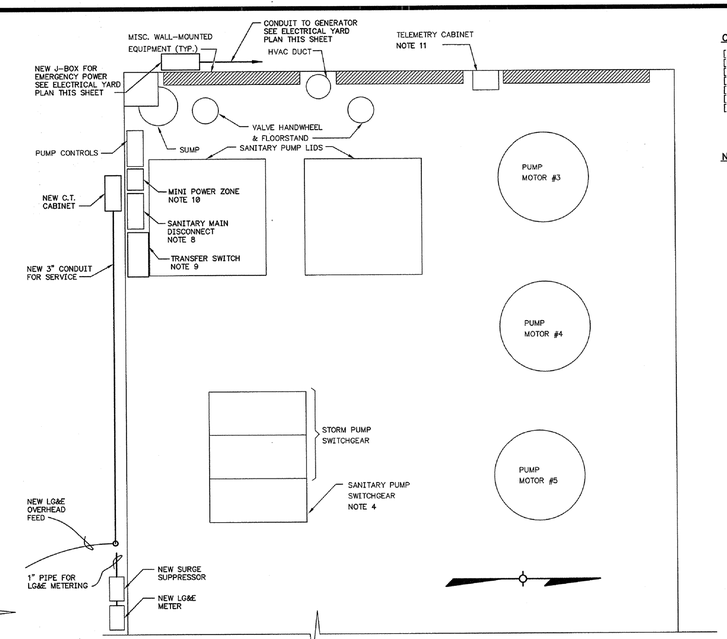
SHEET ID
34-E-101

A1 THIRTY FOURTH ST PS ELECTRICAL PLAN
SCALE: NOT TO SCALE

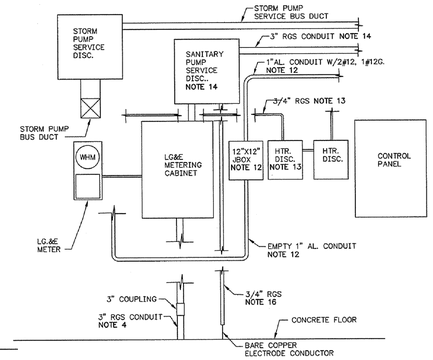
CONCEPT SUBMITTAL



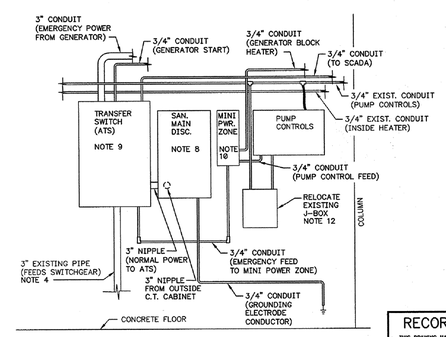
ELECTRICAL YARD PLAN
SCALE: 3/8"=1'-0"



PUMP ROOM PLAN
SCALE: 1/2"=1'-0"



EXISTING SOUTH WALL PARTIAL ELEVATION
SCALE: NONE



NEW SOUTH WALL PARTIAL ELEVATION
SCALE: NONE

CIRCUIT SCHEDULE

[A] = [3#500MCM, 1#3GND., 3"C]
[B] = [4#14(2 SPARE), 3/4"C]
[C] = [8#14(4 SPARE), 3/4"C]
[D] = [3#10, 1#10N, 1#10G, 3/4"C]
[E] = [10#14(5 SPARE), 3/4"C]
[F] = [10#14(9 SPARE), 3/4"C]
[G] = [3#500MCM, 1#3GND., EXIST. 3"C]

NOTES:

1. EXISTING 10 FT. FENCE WITH PVC-COATED, FINE MESH, CHAIN LINK FABRIC AND 3 STRANDS OF BARBED WIRE.
2. REMOVE APPROX.. 8 FT. OF 6 FT. CHAIN LINK FENCE AND INSTALL NEW 10 FT. FENCE TO MATCH EXISTING (SEE NOTE 1).
3. FENCE POST ANCHORED TO TOP OF CONCRETE SLAB OVER WETWELL.
4. REUSE EXISTING CONDUIT FROM LG&E METER BOX TO SANITARY PUMP SWITCHGEAR EMBEDDED IN PUMP ROOM FLOOR SLAB.
5. NOTE NOT USED
6. NOTE NOT USED
7. DEMOLISH AND REMOVE EXIST. LG&E OVERHEAD SERVICE. RE-LOCATE NEW OVERHEAD SERVICE TO SOUTHEAST CORNER OF BUILDING.
8. 600V, 400A, 3-POLE, NEMA 12 SERVICE-RATED DISCONNECT SWITCH FUSED WITH BUSMAN 400A, DUAL ELEMENT, CURRENT-LIMITING, TIME-DELAY LOW PEAK FUSES. INCLUDE CLASS R REJECTION KITS.
9. 480V, 400A, 3-POLE, NEMA 1 CUMMINS-ONAN TRANSFER SWITCH.
10. 10KVA, 480-240/120V, NEMA 3R CUTLER HAMMER MINI POWER ZONE WITH INTEGRAL PRIMARY BREAKER, (1)20A, 2-POLE AND (8)20A, 1-POLE BRANCH BREAKERS.
11. TAG AND COIL TELEMETRY SIGNAL WIRING 10 FT. INSIDE EXIST. TELEMETRY CABINET FOR TERMINATION BY OTHERS.
12. EXISTING 12"X12" TELEMETRY JBOX TO BE RELOCATED TO MAKE ROOM FOR NEW SANITARY PUMP SERVICE DISCONNECT SWITCH. PROVIDE LABOR & MATERIALS NECESSARY TO RE-ROUTE EXIST. CONDUIT TO THE NEW JBOX LOCATION.
13. EXISTING DISC. SWITCH TO BE RELOCATED TO MAKE ROOM FOR NEW SANITARY PUMP SERVICE DISCONNECT SWITCH. PROVIDE LABOR & MATERIALS NECESSARY TO RE-ROUTE EXIST. CONDUIT TO THE NEW DISC. SWITCH LOCATION. PULL APPROX.. 100 FT. OF 8 NEW #12 CONDUCTORS THROUGH RE-ROUTED CONDUIT TO EXIST. TERMINATION PTS.
14. REMOVE & DISPOSE OF EXIST. SANITARY PUMP SERVICE DISC. SWITCH AND EXIST. 3" SERVICE ENTRANCE CONDUIT.
15. NOTE NOT USED
16. INTERCEPT EXISTING GROUNDING ELECTRODE CONDUCTORS AND CONDUIT NEAR FLOOR AND RE-ROUTE TO NEW MAIN DISCONNECT SWITCH. DO NOT GROUND TO ANY LEG OF 3-PHASE SERVICE. SERVICE IS A FLOATING DELTA.
17. PROVIDE AND INSTALL NEMA 4X, 480V, 80KA PER PHASE, 1500V L-L & L-G LET THRU VOLTAGE (PER UL 1449 2ND EDITION) SURGE PROTECTIVE DEVICE. INCLUDE INTEGRAL DISCONNECT AND FUSING FOR CONNECTION TO INCOMING OVERHEAD SERVICE DROP VIA #8 AWG TAPS AT SOUTHWEST CORNER OF BLDG.. MOUNT UNIT APPROX.. 5'-6" ABOVE GRADE. UTILIZE EXIST GROUNDING ELECTRODE CONDUCTOR PRESENTLY CONNECTED TO EXIST. LIGHTING ARRESTORS. PROVIDE EATON INNOVATIVE TECHNOLOGY PROTECTOR OR EQUAL.

RECORD DRAWING
THIS DRAWING HAS BEEN MOVED FROM THE ORIGINAL CONTRACT DRAWING BASED ON DATA SUPPLIED BY THE CONTRACTOR TO SHOW MAJOR CHANGES MADE DURING CONSTRUCTION. NO WARRANTY IS MADE FOR COMPLETE ACCURACY OF THIS DRAWING.
QUEST ENGINEERS, INC.
DATE Dec 8, 2006 BY D. Lorenz
NOTE: THE ORIGINAL CONSTRUCTION DRAWING WITH ISSUE DATE MAY 2005 HAD THE P.E. SEAL OF DARRYL EVANS NUMBER 19128 AFFIXED.

Professional Engineer's Seal
Signature P.E. #

RECORD DWGS:	DWE	12/06
CHECKED BY:	DWE	5/05
DESIGNED BY:	DWE	5/05
DRAWN BY:	DSH	5/05
FILE NAME:	04455-323-E2	
PLOT DATE:	12/06	

Plans Prepared & Submitted By:
CH2M HILL / Quest
CH2M HILL 501 SOUTH FIFTH STREET, SUITE 600 LOUISVILLE, KENTUCKY 40202-1133 PHONE (502) 584-4115 FAX (502) 585-3008

MSD
Louisville and Jefferson County Metropolitan Sewer District
700 West Liberty Street
Louisville, Kentucky 40203

NO.	REVISION	DATE
0	BID SET	5/05
1	RECORD DRAWING	12/06

SHEET TITLE: 34th STREET PLANS & ELEVATIONS
PROJECT TITLE: 34th STREET PUMP STATION & BUCHANAN STREET PUMP STATION BACKUP POWER PROJECT
GRAPHIC SCALE - 1" ON ORIGINAL

BUDGET ID. F05036
CONTRACT NO. 14978
RECORD NO. 14978
DRAWING NO: E-2
4 OF 8

GENERAL SHEET NOTES

1. SUBSTATION EQUIPMENT TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. TOTAL OF 750 KVA PAD-MOUNTED TRANSFORMERS
2. SECONDARY WIRING

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: D. TOTE
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

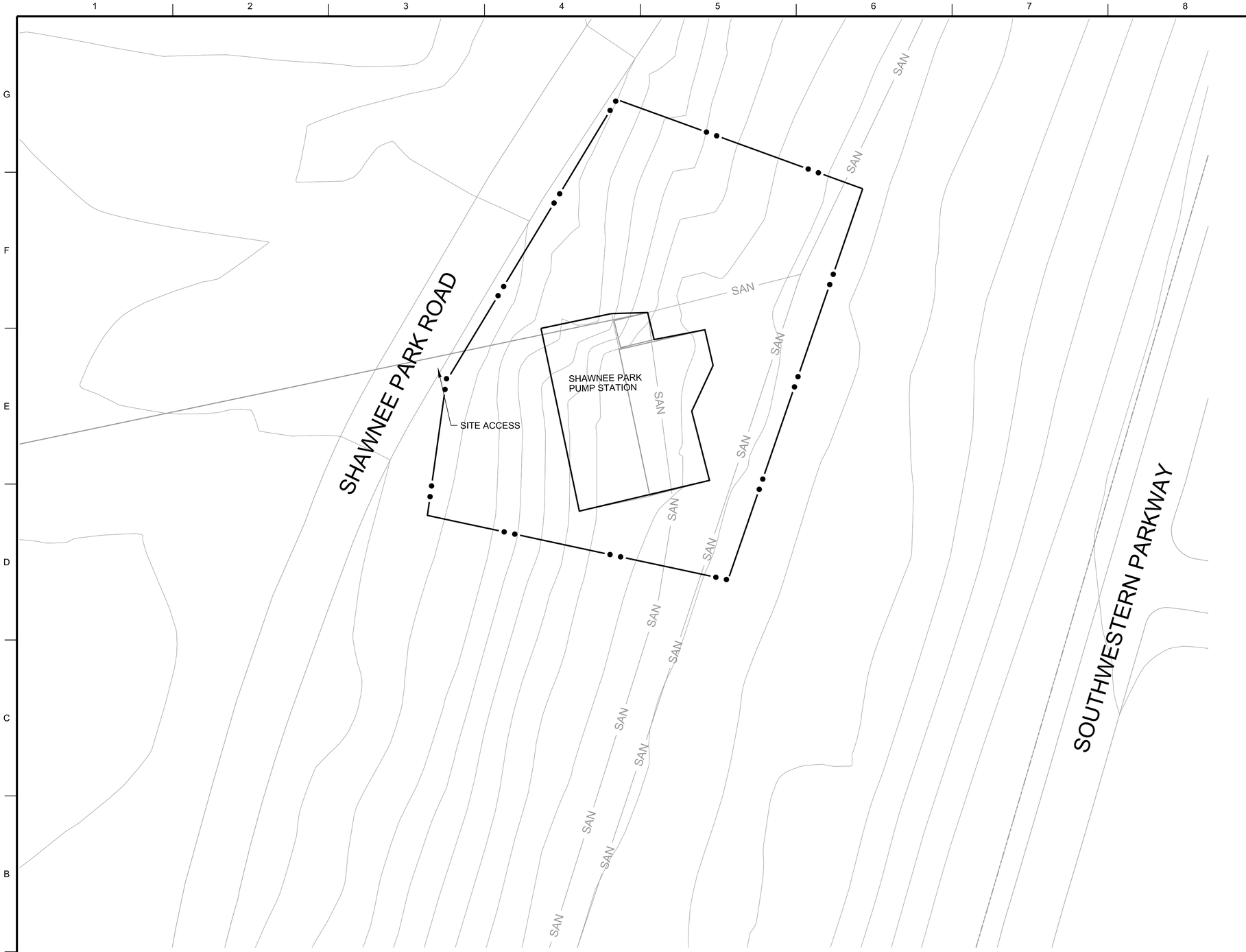
THIRTY FOURTH STREET PS SUBSTATION PLAN

SHEET ID
34-E-102

PLAN VIEW

A1 THIRTY FOURTH STREET PS - SUBSTATION PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL



A1 SHAWNEE PARK PS SITE PLAN
1"=50'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOIE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

SHAWNEE PARK PUMP STATION
SITE PLAN

SHEET ID
SH-C-101

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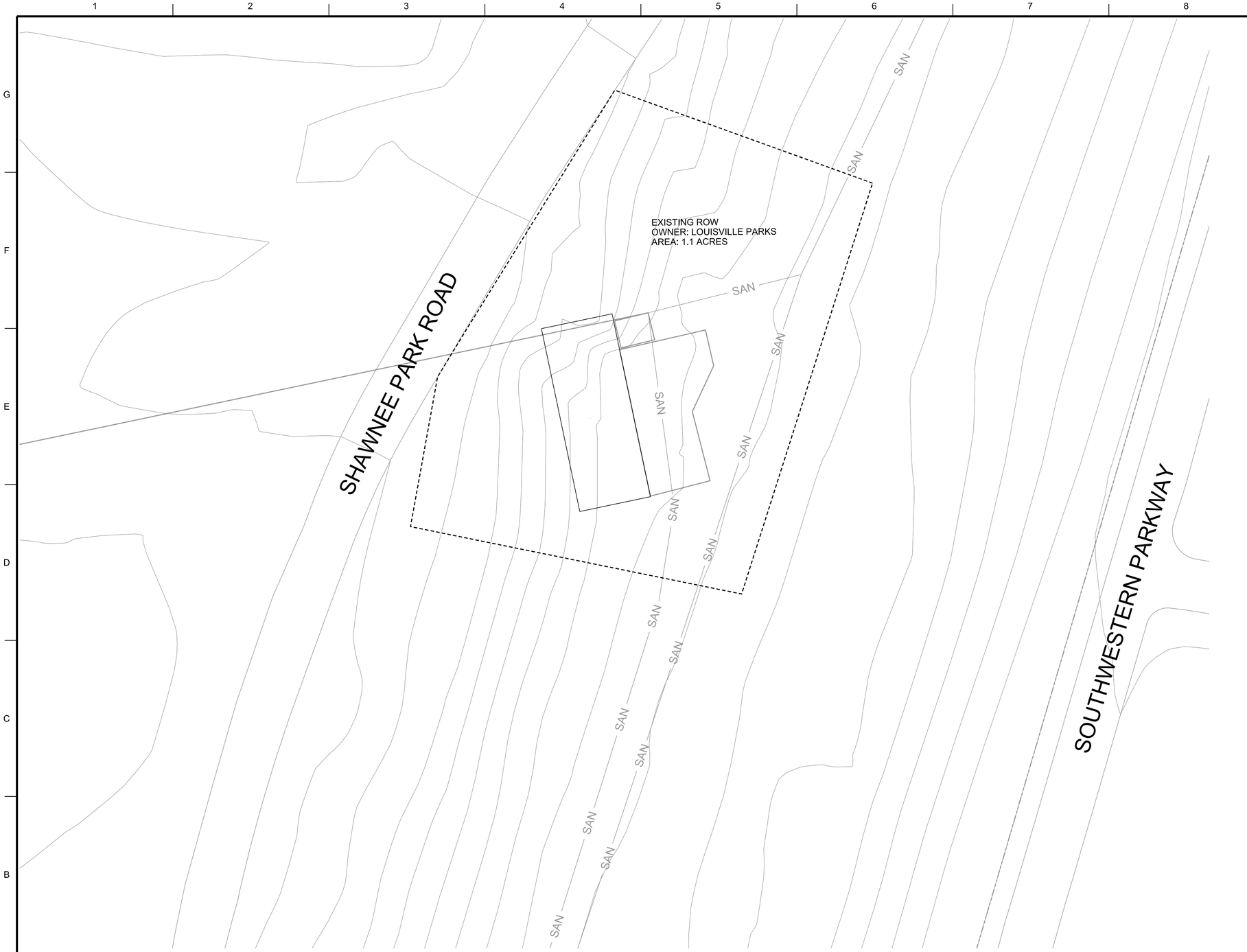
CONCEPT SUBMITTAL



GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

A1 SHAWNEE PARK PS RIGHT OF WAY PLAN
1"=50'

N

0 50' 100'

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

SHAWNEE PARK PS
RIGHT OF WAY

SHEET ID
SH-R-101

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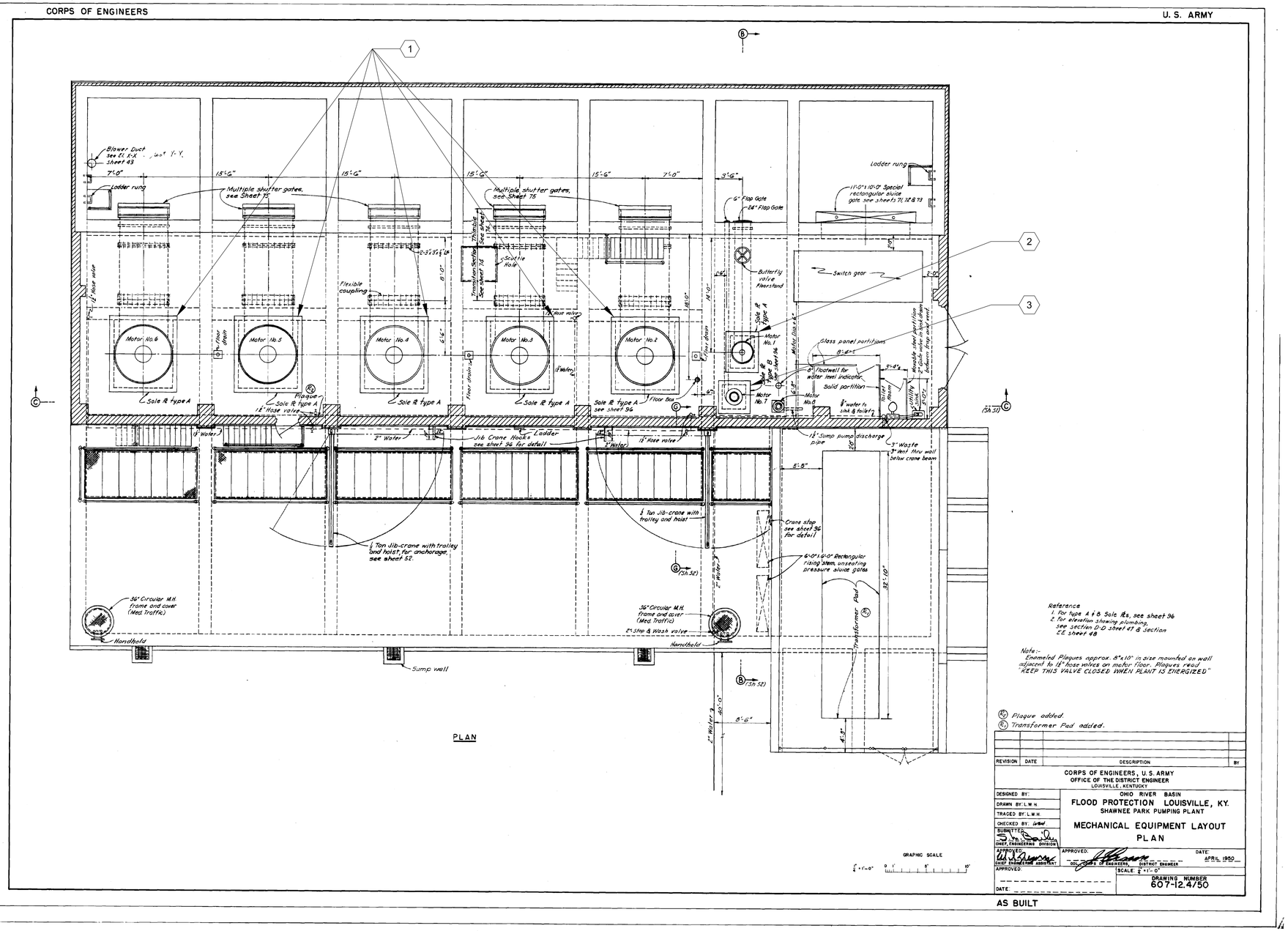
CONCEPT SUBMITTAL



PUMP DATA				
PUMP #	TYPE	DESIGN FLOW (GPM)	TDH (FT OF WATER)	NOTES
1	SUBMERSIBLE	9,000	8.7	NEW PUMP
2	COLUMN PUMP	103,500	20.9	REFURBISH PUMP
3	COLUMN PUMP	103,500	20.9	REFURBISH PUMP
4	COLUMN PUMP	103,500	20.9	REFURBISH PUMP
5	COLUMN PUMP	103,500	20.9	REFURBISH PUMP
6	COLUMN PUMP	103,500	20.9	REFURBISH PUMP
7	SUBMERSIBLE	800	54.0	NEW PUMP

SHEET KEYNOTES

1. REFURBISH PUMPS. DISCONNECT COLUMNS AT FLEXIBLE COUPLINGS. ABRASIVE BLAST COLUMNS TO WHITE METAL AND COAT WITH C200A. INSTALL NEW FLEXIBLE COUPLINGS.
2. REPLACE PUMP WITH SUBMERSIBLE COLUMN PUMP. INSTALL NEW COLUMN AND DISCHARGE ELBOW. CONNECT TO EXISTING DISCHARGE PIPE AT FIRST FLEXIBLE COUPLING. INSTALL NEW FLEXIBLE COUPLING.
3. REPLACE PUMP WITH SUBMERSIBLE SUMP PUMP. INSTALL NEW INTAKE AND DISCHARGE PIPING AS NECESSARY

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX

DESIGNED BY: K. BURNS
DRAWN BY: K. BURNS
CHECKED BY:
SUBMITTED BY: J. TOE
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

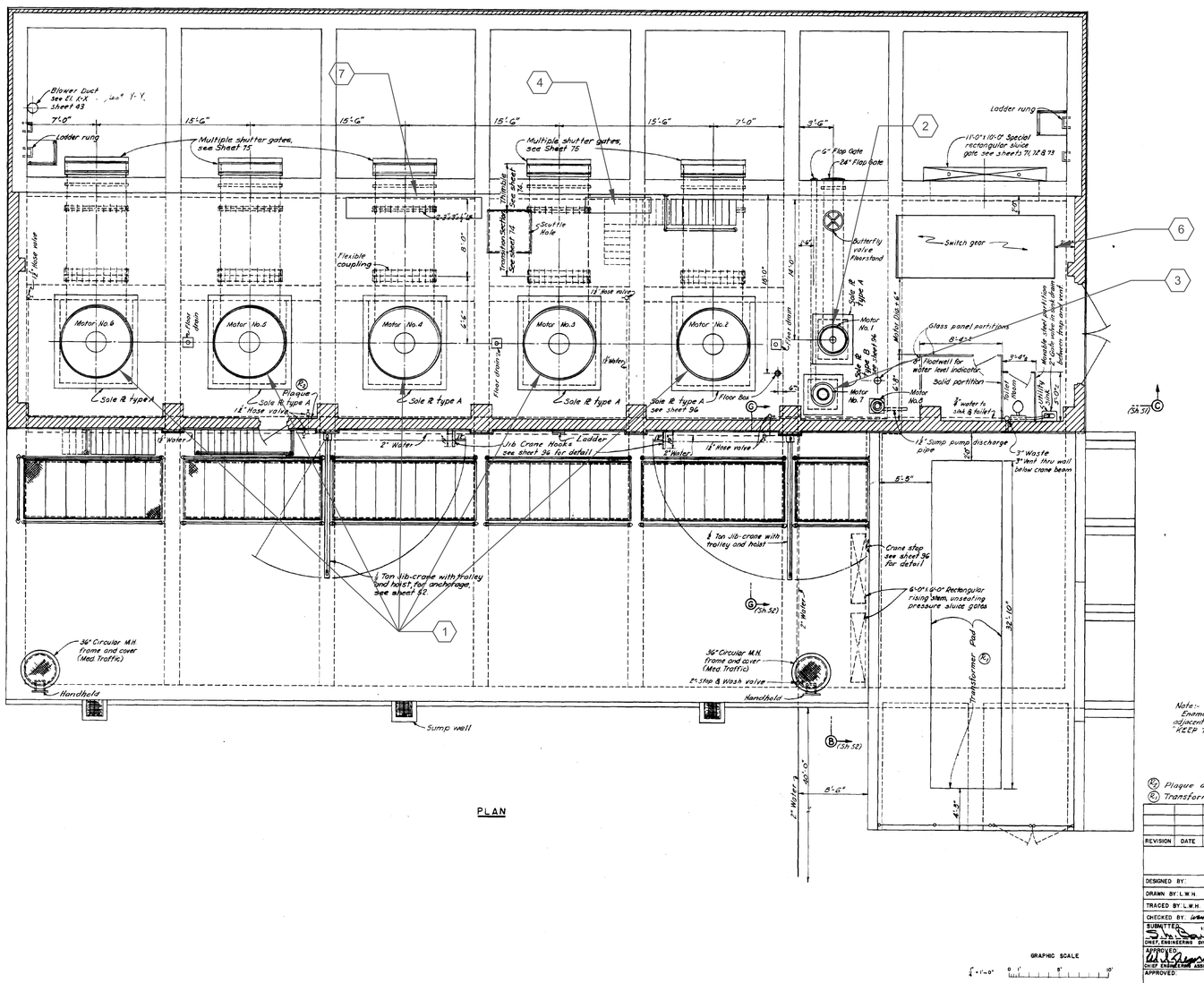
SHAWNEE PS
MECHANICAL PLANS

SHEET ID
SH-M-101

CONCEPT SUBMITTAL

CORPS OF ENGINEERS

U. S. ARMY



Reference
1. For type A & B Sole ℞s, see sheet 96
2. For elevation showing plumbing, see section D-D sheet 47 & Section EE sheet 48

Note:
Enameled Plaques approx. 8"x10" in size mounted on wall adjacent to 12" hose valves on motor floor. Plaques read "KEEP THIS VALVE CLOSED WHEN PLANT IS ENERGIZED"

(6) Plaque added.
(6) Transformer Pad added.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
FLOOD PROTECTION LOUISVILLE, KY.
SHAWNEE PARK PUMPING PLANT

MECHANICAL EQUIPMENT LAYOUT
PLAN

DESIGNED BY:
DRAWN BY: L.W.H.
TRACED BY: L.W.H.
CHECKED BY:
SUBMITTED:
CHIEF, ENGINEERING DIVISION
APPROVED:
CHIEF, ENGINEERING ASSISTANT
APPROVED:
COL., CORPS OF ENGINEERS, DISTRICT ENGINEER
DATE: APRIL 1950
SCALE: 1/4" = 1'-0"
DATE:
DRAWING NUMBER
607-12.4/50

GRAPHIC SCALE

AS BUILT

GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.
3. IN ADDITION TO THE EQUIPMENT INDICATED FOR REPLACEMENT, A 480 VOLT DISTRIBUTION PANEL, WITH A NOMINAL SIZE OF 400 AMPS SHALL BE PROVIDED.

SHEET KEYNOTES

1. REFURBISH 800 HP PUMP MOTORS.
2. REPLACE 75 HP PUMP WITH SUBMERSIBLE COLUMN PUMP. MOTOR HP VALUE EXPECTED TO STAY THE SAME.
3. REPLACE SUMP PUMP IN KIND
4. PUMP CONTROLS WILL BE UPDATED AND INTEGRATED INTO MSD SCADA SYSTEM.
5. NOT USED
6. MOTOR CONTROL CENTER WILL BE REPLACED WITH A MODERN DAY EQUIVALENT.
7. POWER FACTOR CORRECTION SHALL BE INCORPORATED FOR PUMP MOTORS 1 THRU 6.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TOTE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145628

SHAWNEE PS ELECTRICAL PLAN

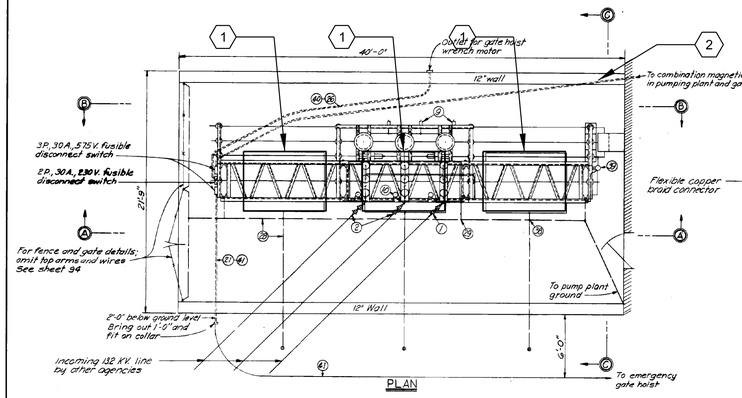
SHEET ID
SH-E-101

A1 SHAWNEE PS ELECTRICAL PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL

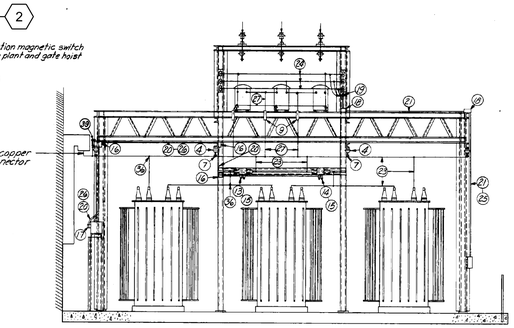
CORPS OF ENGINEERS

U.S. ARMY

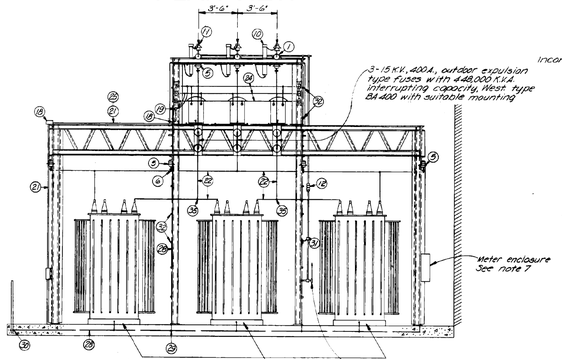


PLAN

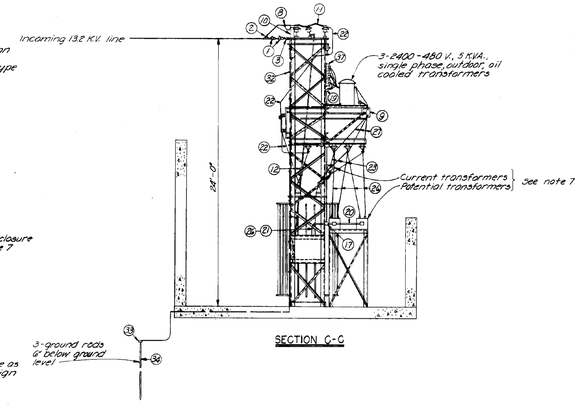
PLAN VIEW



SECTION B-B

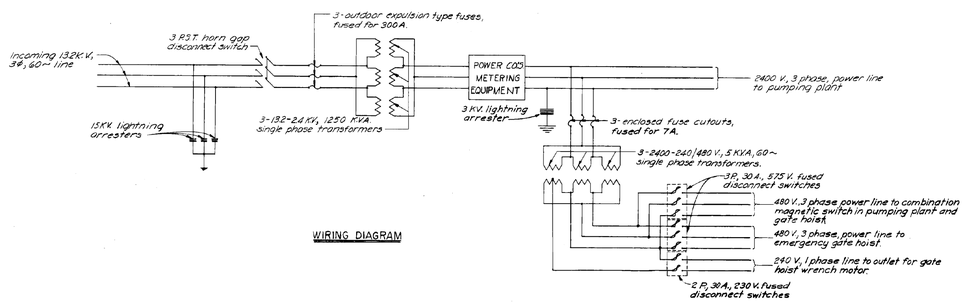


SECTION A-A



SECTION C-C

ELEVATION VIEW



WIRING DIAGRAM

Notes:
1. Figures in circles refer to part number on the Bill of Material.
2. Small parts, fittings, etc., not called for shall be furnished as required.
3. All material shall be of the manufacture, type, and catalog number specified, or its equal.
4. All bolts and screws shall be furnished with a full complement of washers in accordance with best practice.
5. Solderless connectors shall be used for making splices and taps to bus.
6. All fence posts shall be grounded.
7. Current and potential transformers, and meter enclosure will be furnished by other agencies and they shall be installed under this contract.
8. Watthour meter will be furnished and installed by other agencies.

BILL OF MATERIAL

PART NO.	DESCRIPTION	MFG.	CATALOG NO.	QUANTITY REQ'D.
1	6" Strain insulators, 35 KV. min. dry flashover			6
2	Strain clamps	Locke	12926	3
3	Suspension tower fitting, flexible type	Locke	13720	3
4	Insulator units	G.E.	600991GP1	12
5	"	"	600992GP1	7
6	Bus supports	"	600620451	7
7	"	"	600620454	12
8	Hot line clamp			3
9	Enclosed fuse cutouts, 5000 V., 50 A	West	Type E.A	3
10	Lightning arresters, 15 KV.			3
11	3 P.S.T. Horn gap disconnect switch, 15 KV, 400A	West	Type W-2	1
12	Operating rod insulator	Lapp	6393	1
13	Condulet outlet	Crouse-Hinds	C37	1
14	" "	" "	E37	1
15	2 Hole composition cover	" "	3772	2
16	Condulet with cover	" "	LB7	3
17	" " "	" "	TA37	1
18	" " "	" "	LA7	2
19	Service entrance cap, type T, 1½"			1
20	1" Rigid electrical conduit			35'±
21	1½" Rigid electrical conduit			25'±
22	¾" Std iron pipe size copper tubing			115'±
23	1½" " " " " "			145'±
24	#6 Bare solid copper wire			45'±
25	#6 Conductor, insulated			85'±
26	#12 " " "			205
27	#2 Bare solid copper, hard drawn			34'±
28	#4/0 Bare stranded copper cable			200'±
29	"T" connector for #4/0 stranded cable	Burndy	NT2429	5
30	Connector for #4/0 cable and fence post	"	Type GD	3
31	" " " " 1½" pipe	"	GD1429	3
32	" " " " to structural framework	"	GB29	2±
33	" " " " to ¾" ground rod	"	GR6429	3
34	Ground rod, ¾" x 10'-0" lg. copperweld			3
35	"T" connector for ¾" iron pipe size copper tubing	G.E.	61A436053	5
36	" " " " " " "	"	61A436015	6
37	Secondary rack, 3 wire, 8" spacing			2
38	"X" connector for #4/0 stranded cable	G.E.	61A384060	3
39	Lightning arrester 3 K.V.			1
40	¾" Rigid electrical conduit			35'±
41	#8, 3 Conductor cable, insulated for direct burial			1060'±

REVISION	DATE	DESCRIPTION	BY
		Ground wire added, Bill of material revised (Contract Mod.)	

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

DESIGNED BY: C.G. – D.S.
DRAWN BY: C.G.
TRACED BY: H.J.N.
CHECKED BY: D.S.
SUBMITTED: CHIEF, ENGINEERING DIVISION
APPROVED: CHIEF, ENGINEERING ASSISTANT
APPROVED: ---
DATE: ---

OHIO RIVER BASIN
FLOOD PROTECTION LOUISVILLE, KY.
SHAWNEE PARK PUMPING PLANT
SUBSTATION

APPROVED: COL., CORPS OF ENGINEERS, DISTRICT ENGINEER
DATE: APRIL 1950

SCALE: ¼" = 1'-0"
DRAWING NUMBER 607-12.4/56

AS BUILT

GENERAL SHEET NOTES

1. SUBSTATION EQUIPMENT TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. TOTAL OF 3750 KVA PAD-MOUNTED TRANSFORMERS
2. SECONDARY WIRING

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TICE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
SHEET NO.: THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

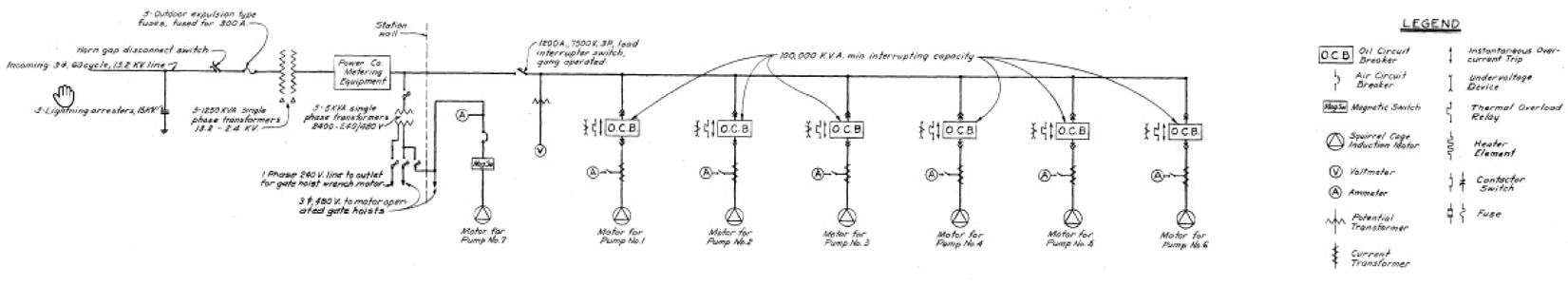
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

SHAWNEE PS SUBSTATION PLAN

SHEET ID
SH-E-102

A1 SHAWNEE PS - SUBSTATION PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL



A1 SHAWNEE PUMP STATION EXISTING ONE LINE DIAGRAM

SCALE: NOT TO SCALE

GENERAL SHEET NOTES

1. SEE SHAWNEE E-101 FOR EXISTING STATION FLOOR PLAN. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. EXISTING ONE LINE DIAGRAM HAS BEEN PROVIDED AS A REFERENCE. SEE FEASIBILITY REPORT APPENDIX D-ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TOE
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ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

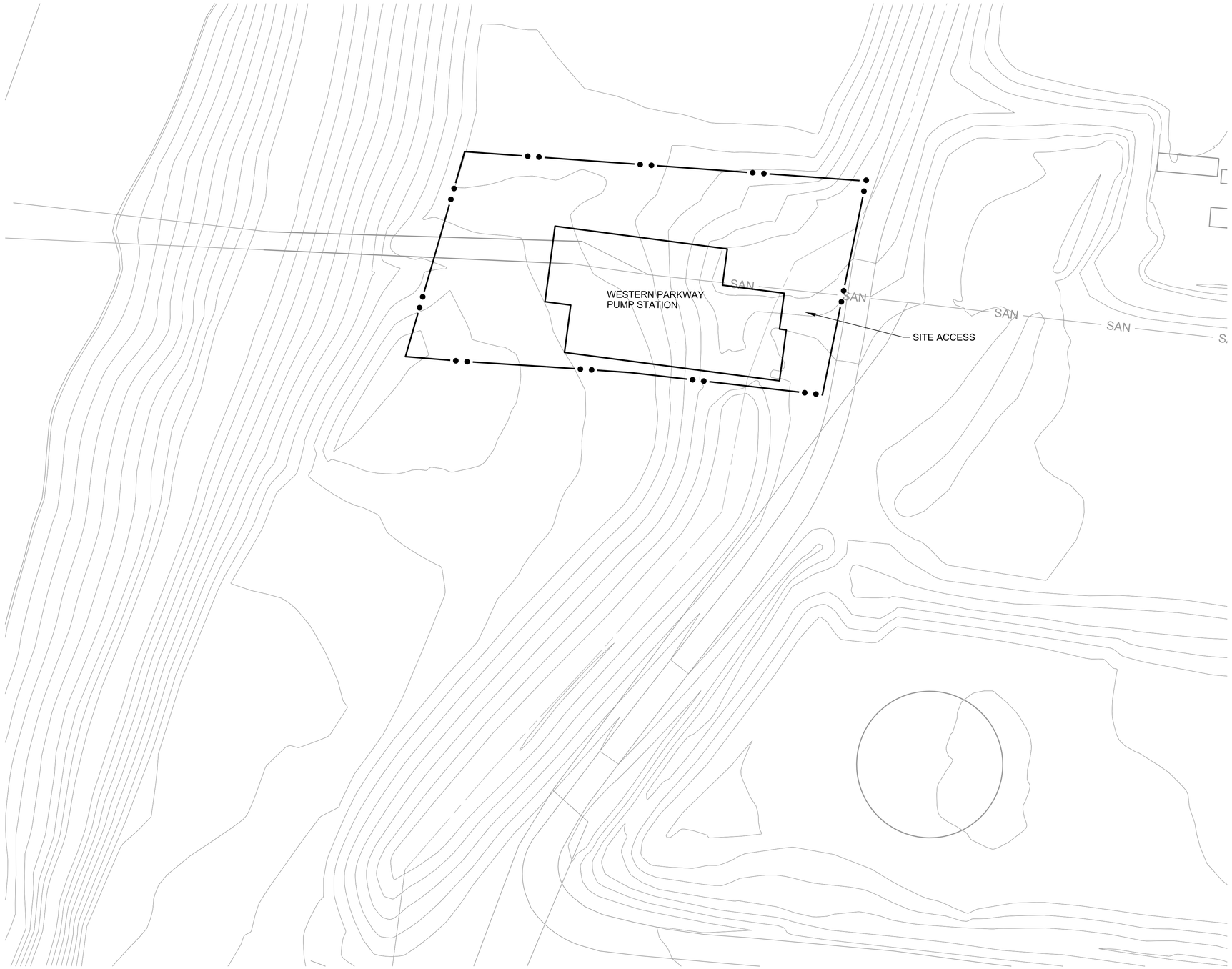
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

SHAWNEE PS EXISTING POWER ONE LINE

SHEET ID
SH-E-601

CONCEPT SUBMITTAL



GENERAL SHEET NOTES

. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

N

0 50' 100'

A1 WESTERN PARKWAY PUMP STATION SITE PLAN
1"=50'

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
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U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2: 145626

WESTERN FPS
SITE PLAN

SHEET ID
W-C-101

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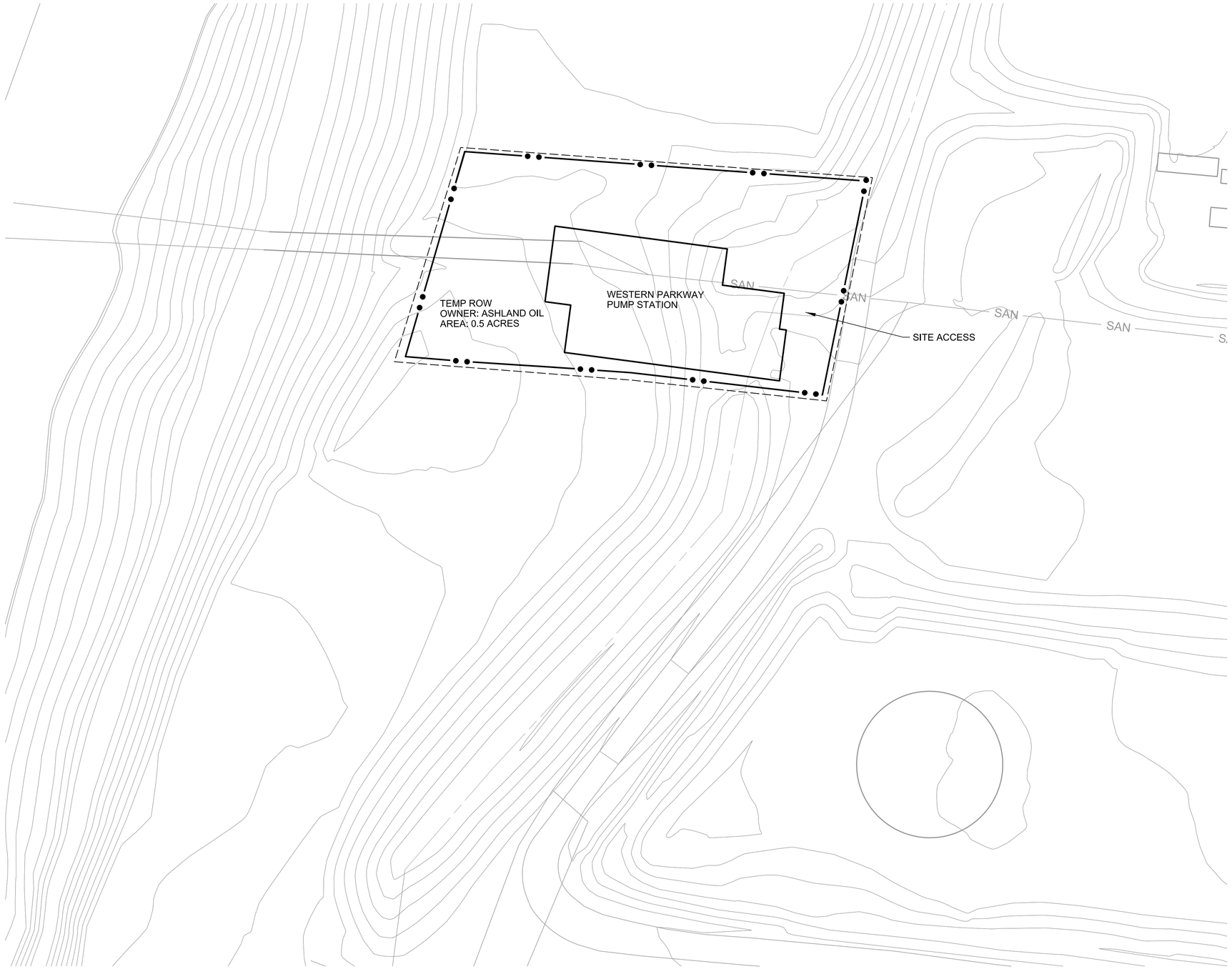

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMEN
- EXISTING RIGHT OF WAY

N

0 50' 100'

A1 WESTERN PARKWAY PUMP STATION RIGHT OF WAY PLAN
1"=50'

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
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U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2: 145626

WESTERN FPS
RIGHT OF WAY

SHEET ID
W-R-101

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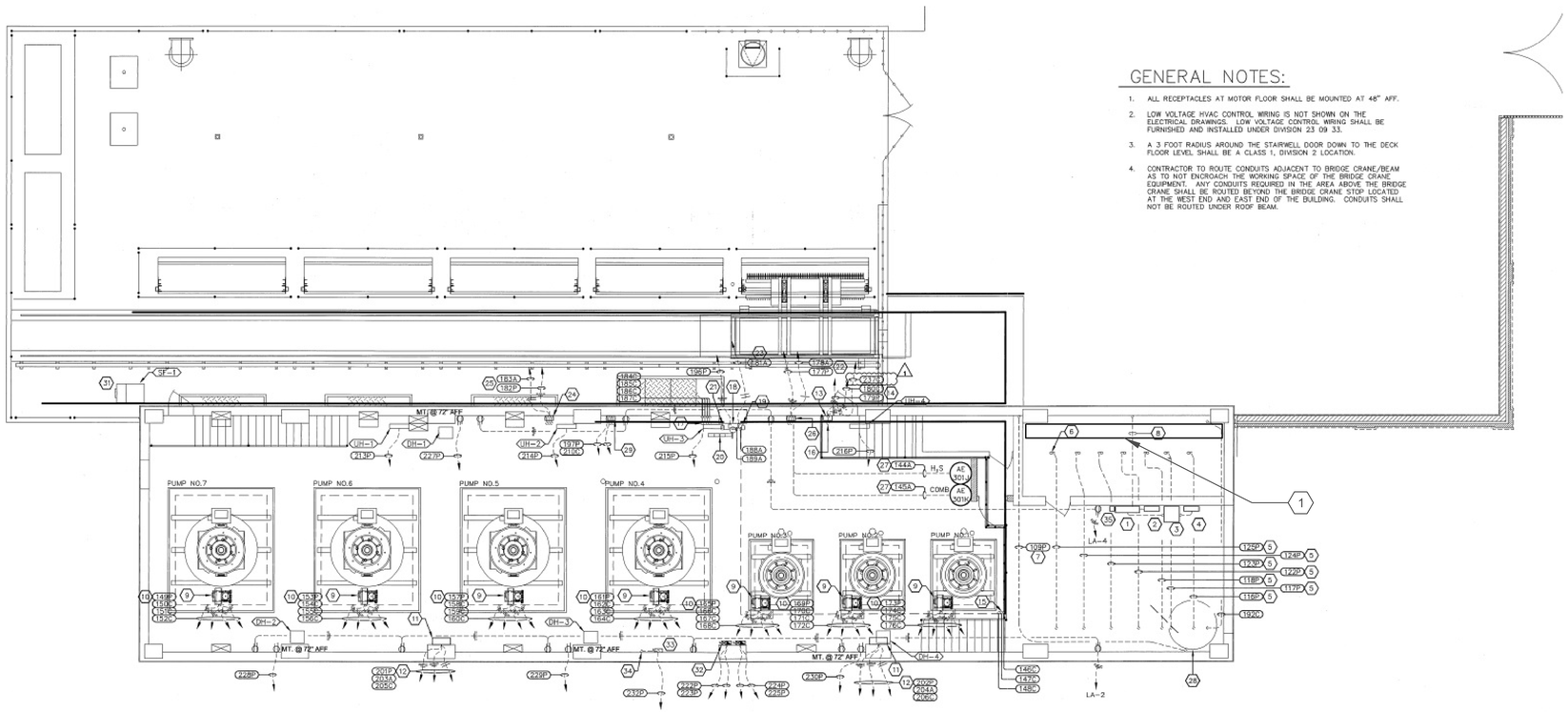
CONCEPT SUBMITTAL



GENERAL NOTES:

1. ALL RECEPTACLES AT MOTOR FLOOR SHALL BE MOUNTED AT 48" AFF.
2. LOW VOLTAGE HVAC CONTROL WIRING IS NOT SHOWN ON THE ELECTRICAL DRAWINGS. LOW VOLTAGE CONTROL WIRING SHALL BE FURNISHED AND INSTALLED UNDER DIVISION 23 09 33.
3. A 3 FOOT RADIUS AROUND THE STAIRWELL DOOR DOWN TO THE DECK FLOOR LEVEL SHALL BE A CLASS 1, DIVISION 2 LOCATION.
4. CONTRACTOR TO ROUTE CONDUITS ADJACENT TO BRIDGE CRANE/BEAM AS TO NOT ENCROACH THE WORKING SPACE OF THE BRIDGE CRANE EQUIPMENT. ANY CONDUITS REQUIRED IN THE AREA ABOVE THE BRIDGE CRANE SHALL BE ROUTED BEYOND THE BRIDGE CRANE STOP LOCATED AT THE WEST END AND EAST END OF THE BUILDING. CONDUITS SHALL NOT BE ROUTED UNDER ROOF BEAM.

POWER PLAN – MOTOR FLOOR LEVEL

SCALE: 3/16"=1'-0"

0 4' 8' 12'

⬡ SHEET KEYNOTES:

1. NEW MAIN DISTRIBUTION PANELBOARD, MDP (480/277V, 500-AMPERE).
2. NEW PANELBOARD HA.
3. NEW 480V x 120/208V, 45 KVA TRANSFORMER.
4. NEW PANELBOARD LA.
5. NEW MOTOR POWER CONDUITS FROM MV MCC TO STORAGE ROOM. CONTRACTOR SHALL INTERCEPT EXISTING MOTOR FEEDER CONDUITS AND RE-USE. ALL CONDUCTORS SHALL BE REPLACED.
6. EXISTING MOTOR FEEDER CONDUITS SHALL REMAIN.
7. NEW FEEDER FROM EXISTING 5 KV SWITCHGEAR TO MCC VIA EXISTING JUNCTION BOX. CONDUITS SHALL BE ROUTED ALONG CEILING AND TURN UP BEHIND THE NEW MCC. FEEDER SHALL ENTER TOP HAT OF MCC.
8. NEW SECONDARY FEEDER FROM 300 KVA TRANSFORMER TO PANELBOARD MDP.
9. PUMP LUBRICATION SYSTEM.
10. CONTROL WIRING TO SCADA SYSTEM PLC;
    120V FROM PANELBOARD LA;
    CONTROL WIRING TO MOTOR STARTER (START/STOP SIGNAL).
    CONTROL WIRING TO PUMP MONITORING SYSTEM.
11. PUMP RTD/VIBRATION MONITORING SYSTEM.
12. COMMUNICATIONS CABLES TO SCADA SYSTEM PLC;
    120V FROM SCADA SYSTEM PLC UPS;
    CONTROL WIRING TO EACH HP MOTOR STARTER (MOTOR SHUTDOWN);
    2 CONDUCTOR SHIELDED CABLE IN 3/4"C FROM EACH PUMP VELOMITER – 2 PER PUMP;
    3 CONDUCTOR SHELDED CABLE IN 3/4"C FROM EACH PUMP/MOTOR RTD – 8 PER PUMP.
13. SAFETY STOP RELAY BOX. SEE SHEET I-501 FOR WIRING DIAGRAM.
14. 120V FROM SCADA SYSTEM PLC UPS;
    CONTROL WIRING TO EACH 450 HP MOTOR STARTER (MOTOR SHUTDOWN).
    3#14, 3/4"C TO PLC.
15. VALVE LIMIT SWITCH WIRING FROM DECK FLOOR BELOW TO 450 HP MOTOR STARTERS.
16. CONTROL WIRING FROM 450 HP WETWELL FLOAT SWITCHES (TYPICAL OF 2 FLOATS) VIA XP WETWELL JUNCTION BOX MOUNTED IN WETWELL.
17. CONTROL WIRING FROM XP WETWELL JUNCTION BOX (FLOAT SWITCH WIRING) TO 1250 HP MOTOR STARTER.
18. EXISTING LEVEL CONTROL PANEL AND SPREAD SPECTRUM RADIO.
19. EXISTING ENDRESS+HAUSER HYDROSTATIC TRANSDUCER – PIT-600.
20. EXISTING LEVEL CONTROL ENCLOSURE AND INDICATOR.
21. NEW ENDRESS+HAUSER HYDROSTATIC TRANSDUCER – PIT-601.
22. 120V FROM SCADA SYSTEM PLC UPS;
    COMMUNICATION CABLE TO SCADA SYSTEM PLC.
23. LEVEL TRANSMITTERS TO SCADA SYSTEM PLC.
24. COMBUSTIBLE GAS CONTROLLER – AIC-301 (FOR PUMP NO.5, 6, AND 7 CHAMBER).
25. 120V FROM SCADA SYSTEM PLC UPS;
    COMMUNICATION CABLES TO SCADA SYSTEM PLC.
26. COMBUSTIBLE GAS CONTROLLER – AIC-301A (FOR PUMP NO.4 CHAMBER, PUMP NO.1,2,3 COMMON CHAMBER AND LOWER LEVEL AREA).
27. SENSOR TRANSMITTER TO COMBUSTIBLE GAS CONTROLLER (AIC-301A).
28. SEWAGE HOLDING TANK PROVIDED WITH HIGH LEVEL ALARM – LSH-501.
29. SUMP PUMP MOTOR STARTER. SEE DRAWING E-502 FOR CONTROL CIRCUIT.
30. CONDUITS TO DECK FLOOR BELOW.
31. EXISTING WETWELL BLOWER.
32. NEMA 4X COMBINATION MOTOR STARTER/CIRCUIT BREAKER FOR ROOFTOP EXHAUST FANS (TYPICAL OF 4). SEE CONTROL CIRCUIT ON SHEET E-502 FOR FURTHER DETAILS.
33. NEMA 12, 60A MOLDED CASE SWITCH FOR BRIDGE CRANE (LOCKABLE IN THE OPEN POSITION).
34. 3#6, 1#10, 1"C FROM DISCONNECT TO RUNWAY TAP CONDUCTOR.
35. TRANSIENT VOLTAGE SURGE SUPPRESSOR.

A1 WESTERN FPS ELECTRICAL PLAN

SCALE: NOT TO SCALE

GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.
3. WATER LEVEL TRANSDUCERS SHALL BE INSTALLED TO MEASURE WATER LEVEL ON UPSTREAM AND DOWNSTREAM SIDES OF MSD GATE #102. TRANSDUCERS WILL BE INTEGRATED INTO REPLACEMENT CONTROLS, AND ARE CURRENTLY NOT SHOWN ON DRAWINGS.

⬡ SHEET KEYNOTES

1. PUMP CONTROLS WILL BE UPDATED AND INTEGRATED INTO MSD SCADA SYSTEM.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

DESIGNED BY: R. MORRISON	ISSUE DATE: AUGUST 2019
DRAWN BY: R. MORRISON	SOLICITATION NO.: XXXXXX-XX-X-XXXX
CHECKED BY: J. TIMBAS	CONTRACT NO.: XXXXXXXXXXXXXX
SUBMITTED BY: J. TOTE	THRU 0023
SIZE: ANSI D	

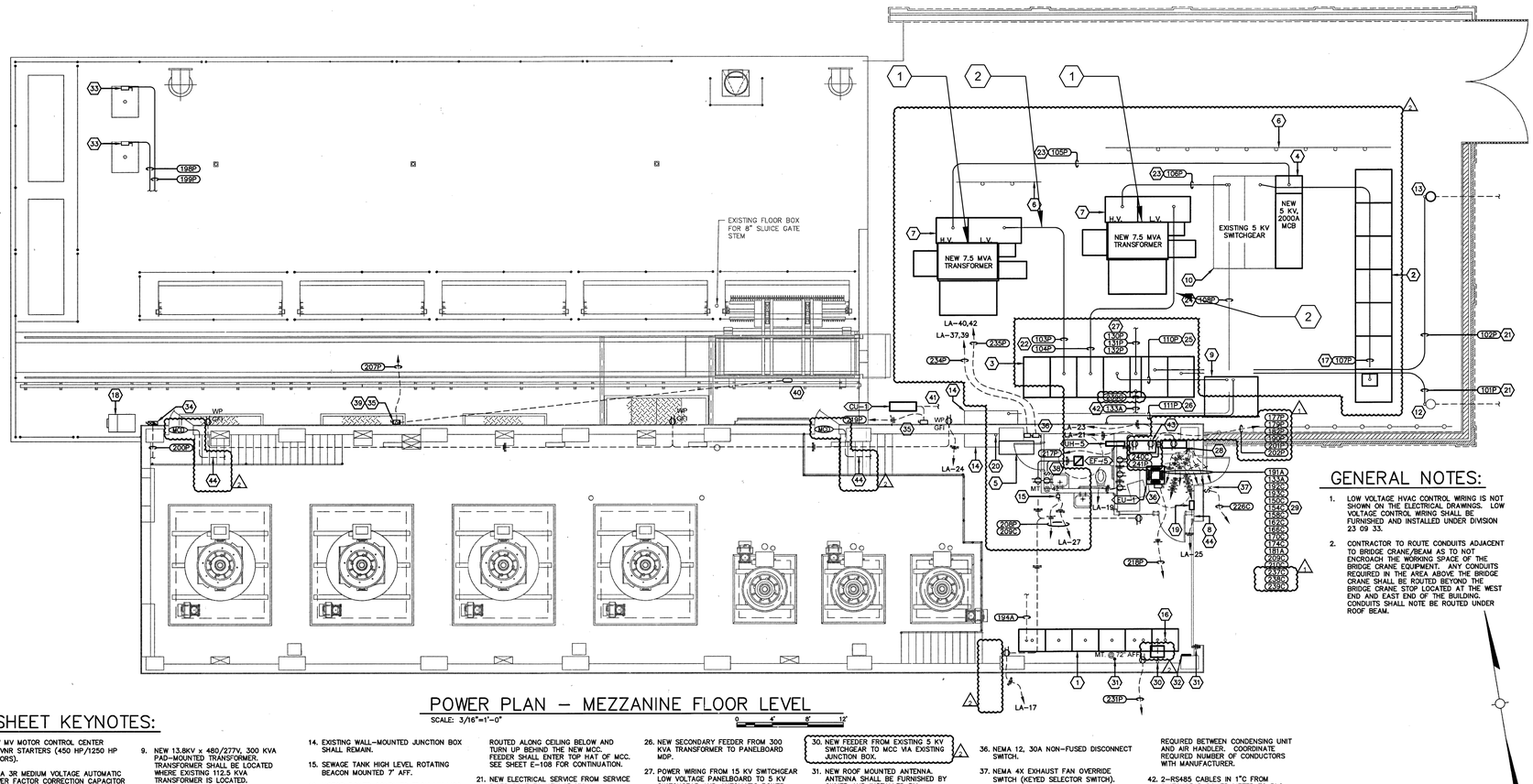
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

WESTERN FPS ELECTRICAL PLAN

SHEET ID

W-E-101

CONCEPT SUBMITTAL



POWER PLAN – MEZZANINE FLOOR LEVEL

SCALE: 3/16"=1'-0"

GENERAL NOTES:

1. LOW VOLTAGE HVAC CONTROL WIRING IS NOT SHOWN ON THE ELECTRICAL DRAWINGS. LOW VOLTAGE CONTROL WIRING SHALL BE FURNISHED AND INSTALLED UNDER DIVISION 23 09 33.
2. CONTRACTOR TO ROUTE CONDUITS ADJACENT TO BRIDGE CRANE/BEAM AS TO NOT ENCROACH THE WORKING SPACE OF THE BRIDGE CRANE EQUIPMENT. ANY CONDUITS REQUIRED IN THE AREA ABOVE THE BRIDGE CRANE SHALL BE ROUTED BEYOND THE BRIDGE CRANE STOP LOCATED AT THE WEST END AND EAST END OF THE BUILDING. CONDUITS SHALL NOTE BE ROUTED UNDER ROOF BEAM.

SHEET KEYNOTES:

1. NEW MV MOTOR CONTROL CENTER W/FVNR STARTERS (450 HP/1250 HP MOTORS).
2. NEMA 3R MEDIUM VOLTAGE AUTOMATIC POWER FACTOR CORRECTION CAPACITOR BANK – 3,300 KVAR.
3. NEW 15 KV SWITCHGEAR LINEUP (PRIMARY SELECTIVE SWITCHGEAR).
4. NEW 5 KV, 2000A BREAKER.
5. NEW 5 KV PULLBOX
6. NEW GUARDRAIL.
7. NEW 13.8 KV x 4,160V, 7.5 MVA PAD-MOUNTED TRANSFORMER.
8. NEW OVERHEAD DOOR PUSHBUTTON STATION.
9. NEW 13.8KV x 480/277V, 300 KVA PAD-MOUNTED TRANSFORMER. TRANSFORMER SHALL BE LOCATED WHERE EXISTING 112.5 KVA TRANSFORMER IS LOCATED.
10. EXISTING 5 KV SWITCHGEAR LINEUP TO REMAIN.
11. NOT USED.
12. EXISTING SERVICE RISER POLE & METER SHALL REMAIN FOR PRIMARY ELECTRICAL SERVICE.
13. NEW SERVICE RISER POLE & METER SHALL BE FURNISHED AND INSTALLED FOR REDUNDANT ELECTRICAL SERVICE. COORDINATE FINAL LOCATION WITH LG&E.
14. EXISTING WALL-MOUNTED JUNCTION BOX SHALL REMAIN.
15. SEWAGE TANK HIGH LEVEL ROTATING BEACON MOUNTED 7' AFF.
16. MOTOR POWER CONDUITS FROM MV MCC TO STORAGE ROOM. SEE SHEET E-108 FOR CONTINUATION (TYPICAL OF 7).
17. NEW FEEDER TO AUTOMATIC CAPACITOR BANK.
18. EXISTING BLOWER FOR WETWELL VENTILATION.
19. EXISTING SECURITY SYSTEM RELOCATED TO THIS LOCATION.
20. NEW FEEDER FROM EXISTING 5 KV SWITCHGEAR TO MCC VIA EXISTING JUNCTION BOX. CONDUITS SHALL BE ROUTED ALONG CEILING BELOW AND TURN UP BEHIND THE NEW MCC. FEEDER SHALL ENTER TOP HAT OF MCC. SEE SHEET E-108 FOR CONTINUATION.
21. NEW ELECTRICAL SERVICE FROM SERVICE RISER POLE TO NEW 15 KV SWITCHGEAR.
22. NEW PRIMARY FEEDER FROM 15 KV SWITCHGEAR TO 7.5 MVA TRANSFORMER.
23. NEW SECONDARY FEEDER FROM 7.5 MVA TRANSFORMER TO 5 KV SWITCHGEAR.
24. NEW FEEDER IN EXISTING CONDUITS FROM EXISTING 5 KV SWITCHGEAR TO MCC JUNCTION BOX.
25. NEW PRIMARY FEEDER FROM 15 KV SWITCHGEAR TO 300 KVA TRANSFORMER.
26. NEW SECONDARY FEEDER FROM 300 KVA TRANSFORMER TO PANELBOARD MDP.
27. POWER WIRING FROM 15 KV SWITCHGEAR LOW VOLTAGE PANELBOARD TO 5 KV SWITCHGEAR AND AUTOMATIC POWER FACTOR CORRECTION CAPACITOR (ENCLOSURE HEATERS).
28. SCADA SYSTEM PLC CABINET.
29. 120V FROM PANELBOARD LA; COAXIAL CABLE IN 1"C; RS485 CABLE IN 1"C; CONTROL WIRING TO SEWAGE TANK ALARM; CONTROL WIRING TO MOTOR STARTERS; CONTROL WIRING TO GREASE SYSTEMS; SIGNAL CABLES TO HYDROSTATIC LEVEL TRANSMITTERS;
30. NEW FEEDER FROM EXISTING 5 KV SWITCHGEAR TO MCC VIA EXISTING JUNCTION BOX.
31. NEW ROOF MOUNTED ANTENNA. ANTENNA SHALL BE FURNISHED BY OWNER AND INSTALLED BY CONTRACTOR.
32. EXISTING TELEPHONE BACKBOARD RELOCATED TO THIS LOCATION.
33. NEMA 4X, 30A NON-FUSED DISCONNECT SWITCH FOR GATE ACTUATOR. INSTALL WITHIN EXISTING ACTUATOR ENCLOSURE. PLEASE NOTE A CPT MAY BE REQUIRED.
34. NEW NEMA 4X, COMBINATION MOTOR STARTER FOR EXISTING WETWELL BLOWER.
35. NEMA 4X, 30A NON-FUSED DISCONNECT SWITCH.
36. NEMA 12, 30A NON-FUSED DISCONNECT SWITCH.
37. NEMA 4X EXHAUST FAN OVERRIDE SWITCH (KEYED SELECTOR SWITCH).
38. PILOT LIGHT TOGGLE SWITCH FOR CONTROL OF RESTROOM EXHAUST FAN.
39. NEMA 4X JUNCTION BOX W/POWER BLOCKS FOR CONVERSION OF CABLE REEL CONDUCTORS TO SINGLE CONDUCTORS. BOX SHALL BE INSTALLED AT 10' AFG. FURNISH AND INSTALL STAINLESS STEEL CABLE GRIP FOR REEL CABLE AT BOX.
40. CABLE REEL FURNISHED WITH TRASH RAKE SYSTEM.
41. LOW VOLTAGE WIRING IN 3/4"C REQUIRED BETWEEN CONDENSING UNIT AND AIR HANDLER. COORDINATE REQUIRED NUMBER OF CONDUCTORS WITH MANUFACTURER.
42. 2-RS485 CABLES IN 1"C FROM SWITCHGEAR POWER METER TO PLC.
43. SCADA SYSTEM PLC UPS PANEL.
44. WIRING FROM DOOR CONTACT TO SECURITY SYSTEM.

NAME	DATE
DRAWN BY:	MDR
DESIGNED BY:	MDR
CHECKED BY:	MDR
RECORD DWG:	MDR

NO.	DATE	REVISION	CHK'D	APPR'D	DATE
2	12/2014	RECORD DOCUMENTS			
1	2/18/11	CHANGE ORDER			

MSD APPROVALS

Professional Engineer's Seal

PLANS PREPARED AND SUBMITTED BY:
HALL Contracting of Kentucky, Inc.
GRW ENGINEERS - ARCHITECTS - PLANNERS
www.grwinc.com
Design Consultant

CONSTRUCTED BY:
HALL CONTRACTING — Company Name — 2-23-15 — Date

FINAL RECORD DRAWING BY:
GRW ENGINEERS, INC.
Todd L. Solomon — Signature — 2-23-15 — Date
Final Record Drawing

FINAL RECORD DRAWINGS

MSD — Louisville and Jefferson County Metropolitan Sewer District, 700 W. Liberty St., Louisville, KY. 40203-1911

WESTERN FLOOD PUMP STATION

POWER PLAN – MEZZANINE FLOOR LEVEL

SCALE: 3/16" = 1'-0" Date: 2-23-15

Budget I.D. No. H09233 Record No. 15,509 E-109

PLAN VIEW

A1 WESTERN PS - SUBSTATION PLAN

SCALE: NOT TO SCALE

GENERAL SHEET NOTES

1. SUBSTATION EQUIPMENT TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. TWO 7500 KVA TRANSFORMERS
2. SECONDARY WIRING

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SIZE: ANSI D	

U.S. ARMY CORPS OF ENGINEERS
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600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
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WESTERN FPS SUBSTATION PLAN

SHEET ID
W-E-102

CONCEPT SUBMITTAL

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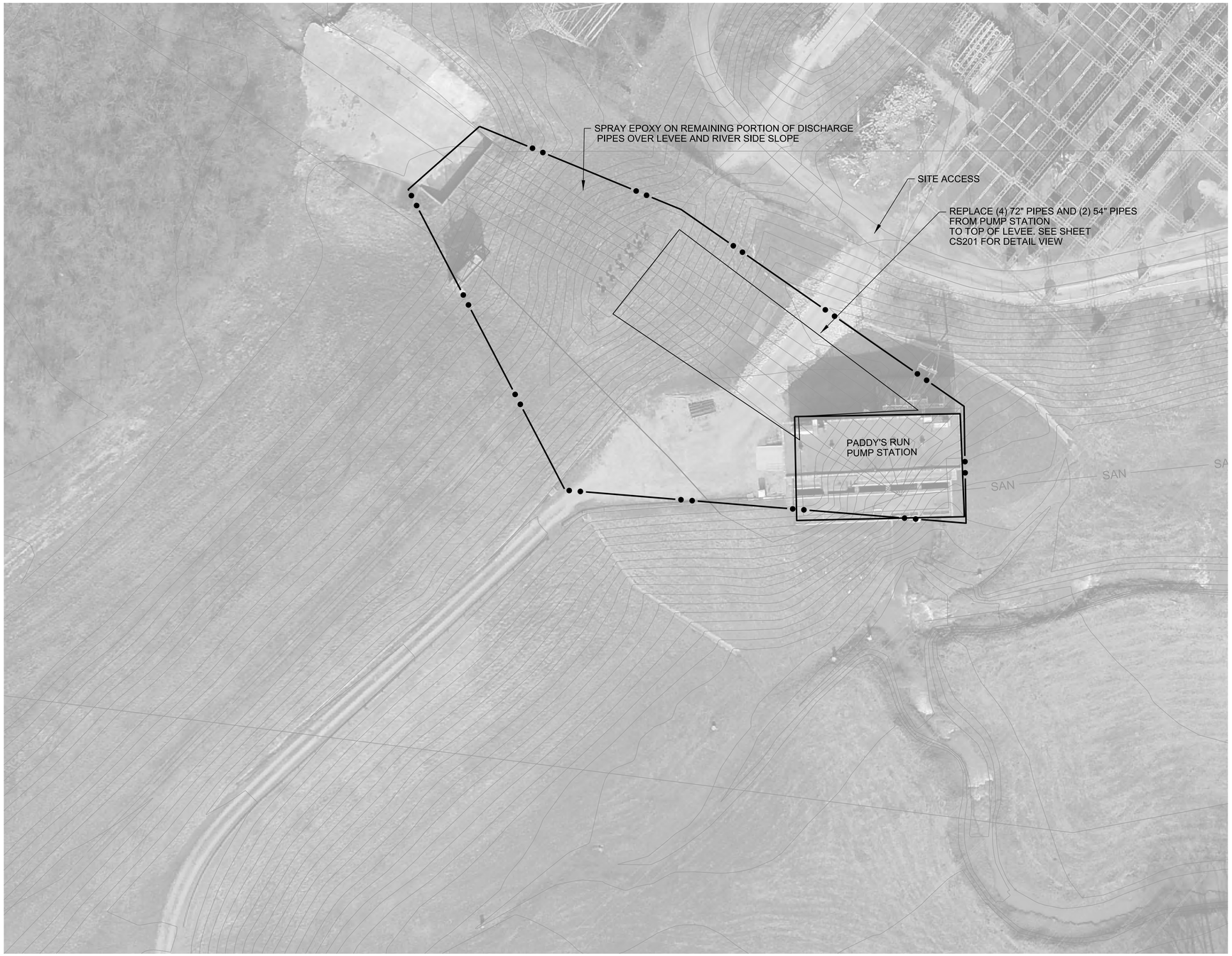

A1 PADDY'S RUN PUMP STATION SITE PLAN
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET. DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

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DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

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PADDY'S RUN PS SITE PLAN

SHEET ID
PR-C-101

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CONCEPT SUBMITTAL

A1 PADDY'S RUN PUMP STATION SITE PLAN ALTERNATIVE
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET. DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

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CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:

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LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
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PADDY'S RUN PS SITE PLAN
ALTERNATIVE NOT SELECTED

SHEET ID
PR-C-102

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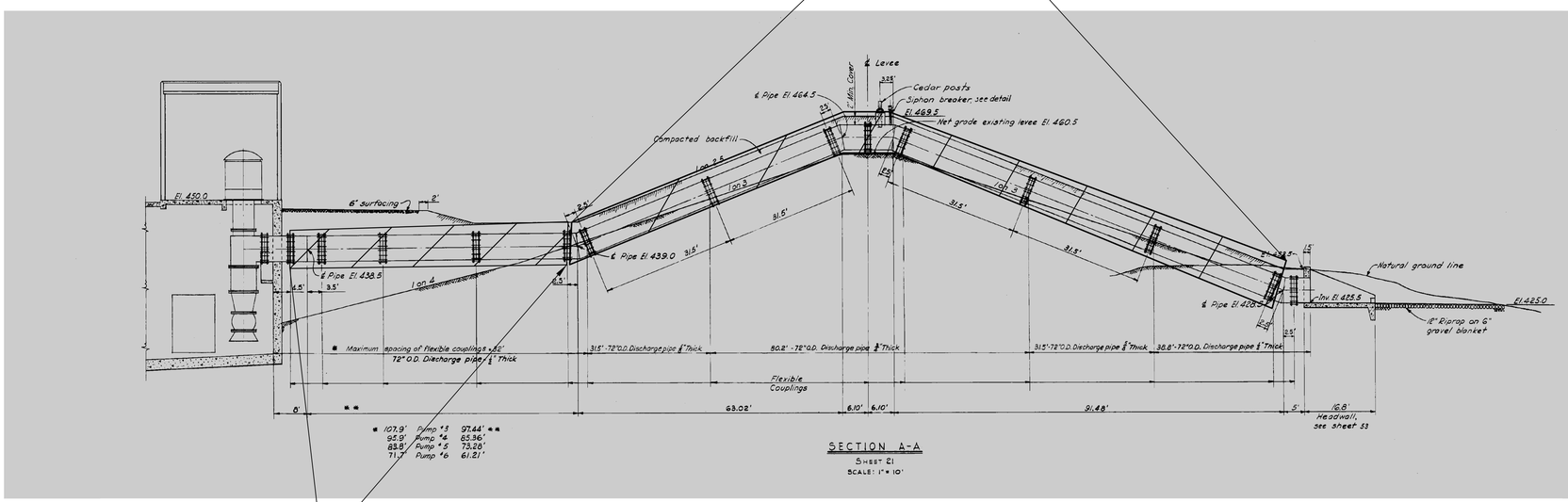
CONCEPT SUBMITTAL

SPRAY EPOXY COATING ON DISCHARGE PIPES
OVER LEVEE AND RIVER SIDE SLOPE



SECTION A-A
Sheet 21
SCALE: 1" = 10'

REPLACE (4) 72" PIPES AND (2) 54" PIPES
FROM PUMP STATION TO LEVEE TOE

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

A1 DETAIL SHEET- PADDY'S RUN PUMP STATION
1"=30'

N

0 30' 60'

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SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
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600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

PADDY'S RUN DETAIL SHEET

SHEET ID
PR-C-201

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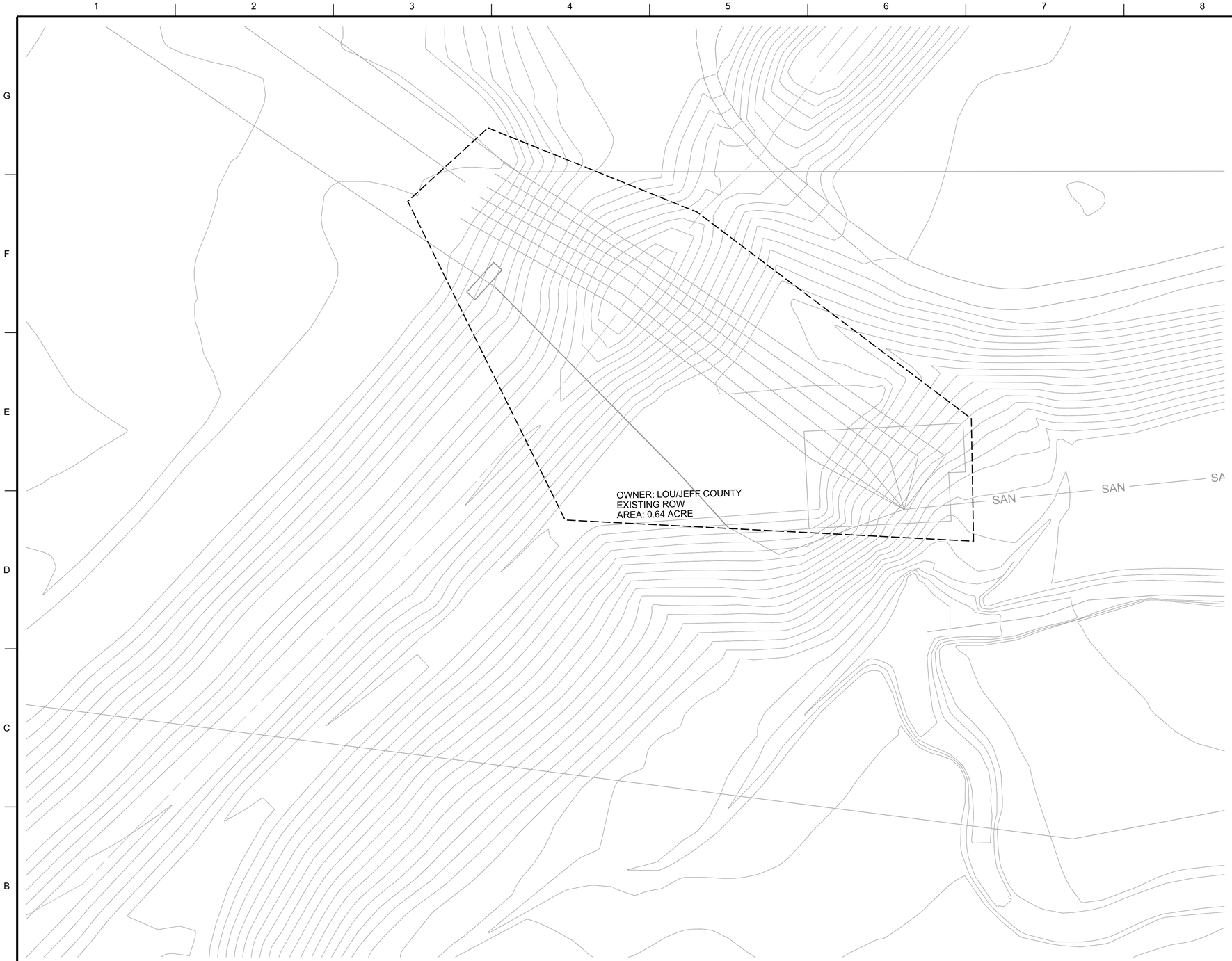

A1 PADDY'S RUN PS RIGHT OF WAY PLAN
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

— — — — — — — —	TEMPORARY WORK EASEMENT
— · — · — · — · —	PROPOSED PERMANENT EASEMENT
- - - - - - - - - -	EXISTING RIGHT OF WAY

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LOUISVILLE DISTRICT
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LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
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ISSUE DATE: AUGUST 2019
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OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

PADDY'S RUN PS
RIGHT OF WAY

SHEET ID
PR-R-101

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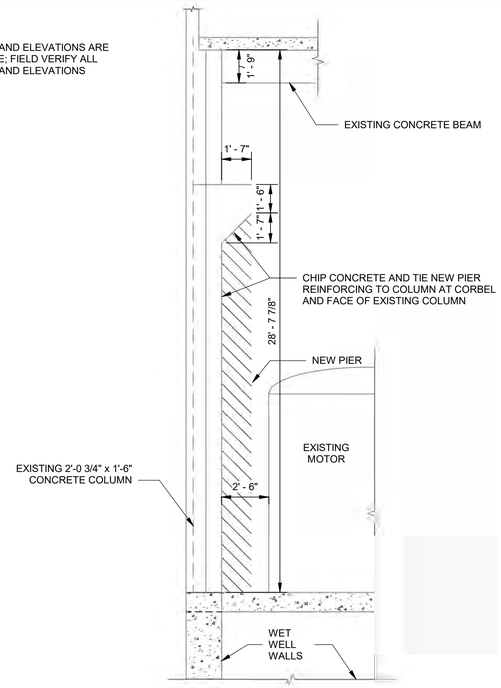
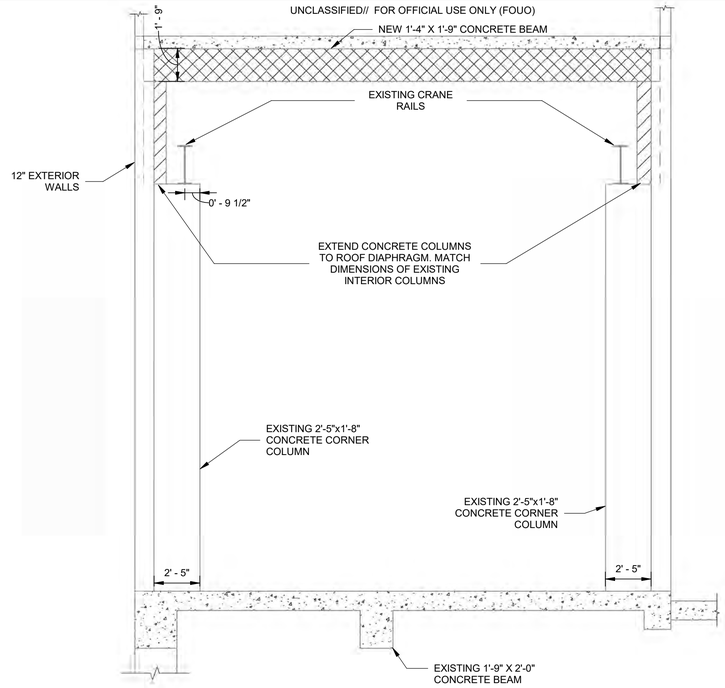
CONCEPT SUBMITTAL

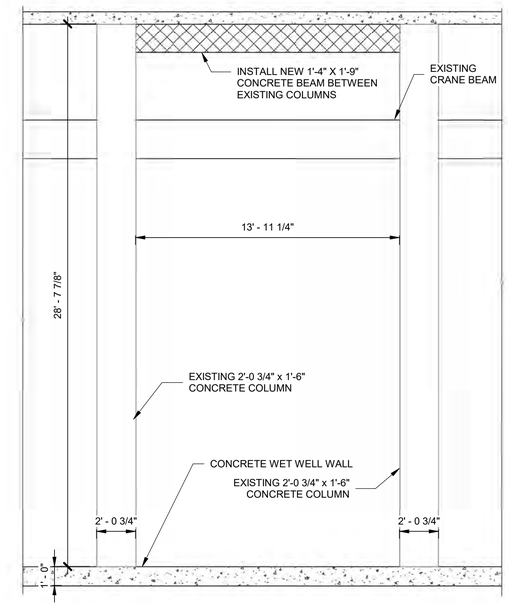
DIMENSIONS AND ELEVATIONS ARE APPROXIMATE; FIELD VERIFY ALL DIMENSIONS AND ELEVATIONS



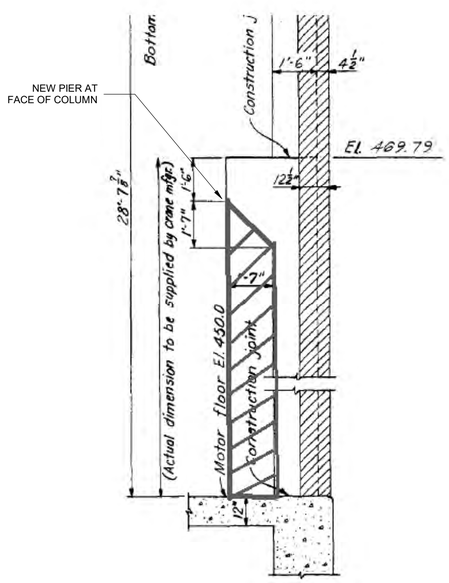
1 INTERIOR COLUMN MODIFICATION
1/4" = 1'-0"



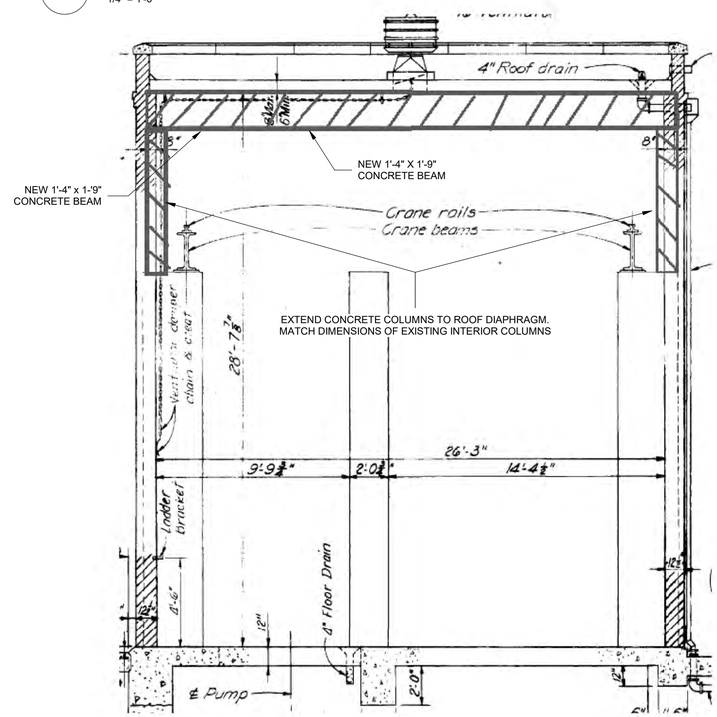
3 END COLUMN MODIFICATION
1/4" = 1'-0"



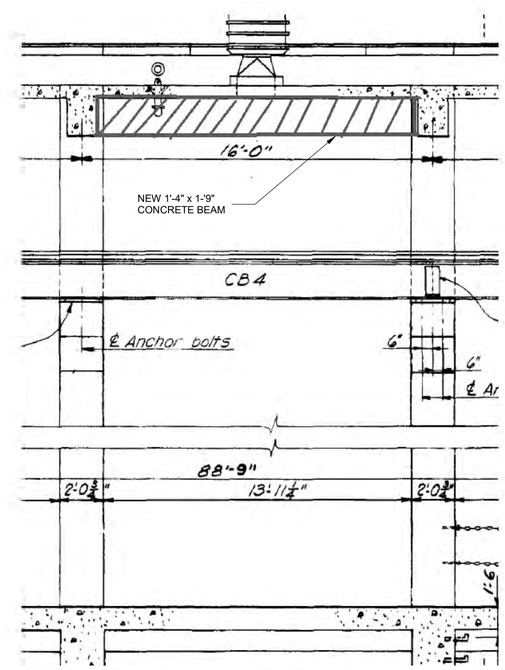
5 INTERIOR ELEVATION VIEW
1/4" = 1'-0"



2 INTERIOR COLUMN MODIFICATION AS BUILTS



4 END COLUMN MODIFICATION AS BUILTS



6 INTERIOR COLUMN ELEVATIONS AS BUILTS

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DESIGNED BY: B. EVANS
DRAWN BY: C. KERBY
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOCE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
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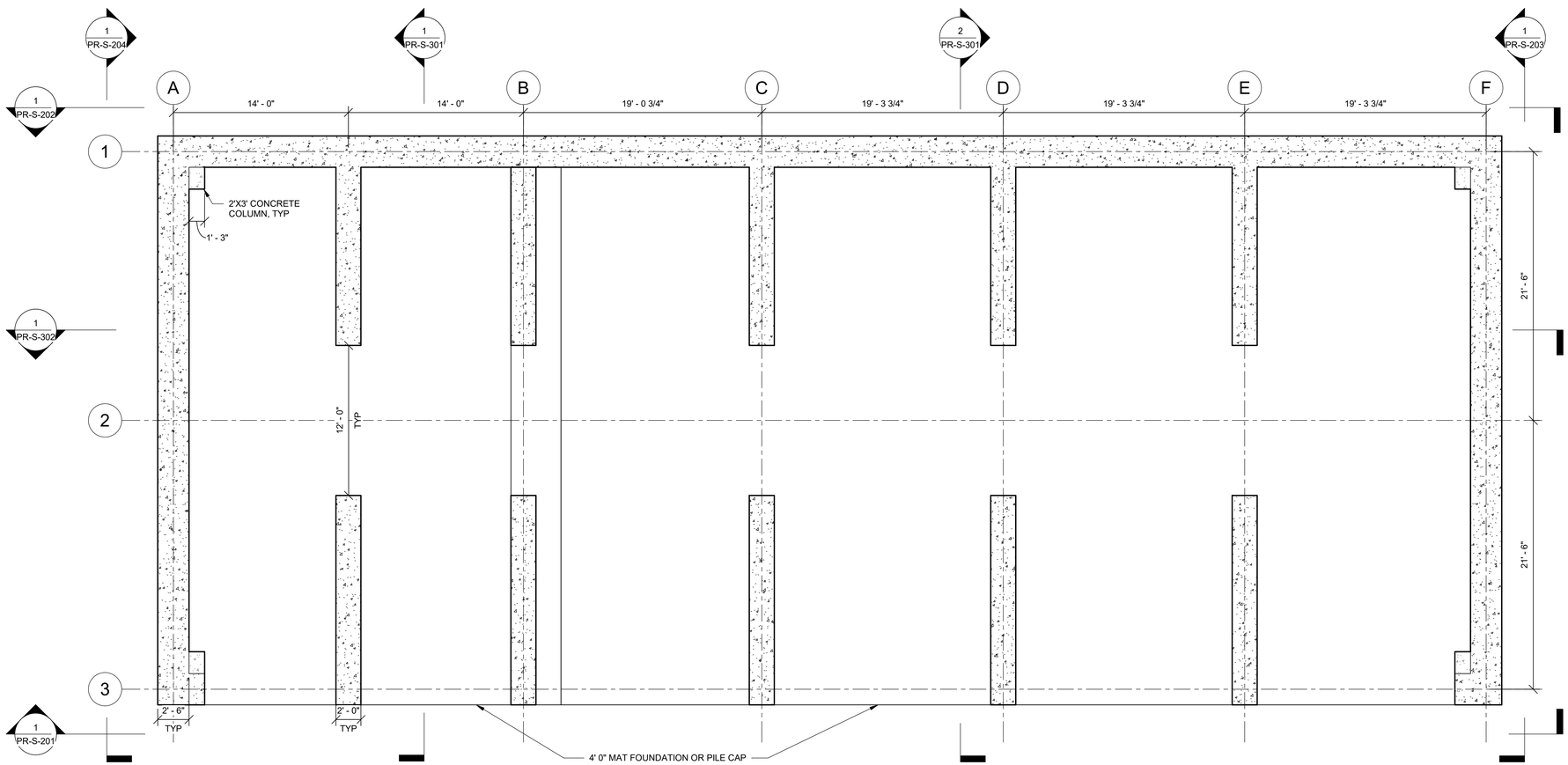
US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR MARTIN LUTHER KING JR PLACE

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

PADDY'S RUN COLUMN MODIFICATION-ALTERNATE 1

SHEET ID
ALT 1
PR-S-201



1 PR-S-201 FOUNDATION PLAN

3/16" = 1'-0"

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DESIGNED BY: B. EVANS
DRAWN BY: B. EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOYE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

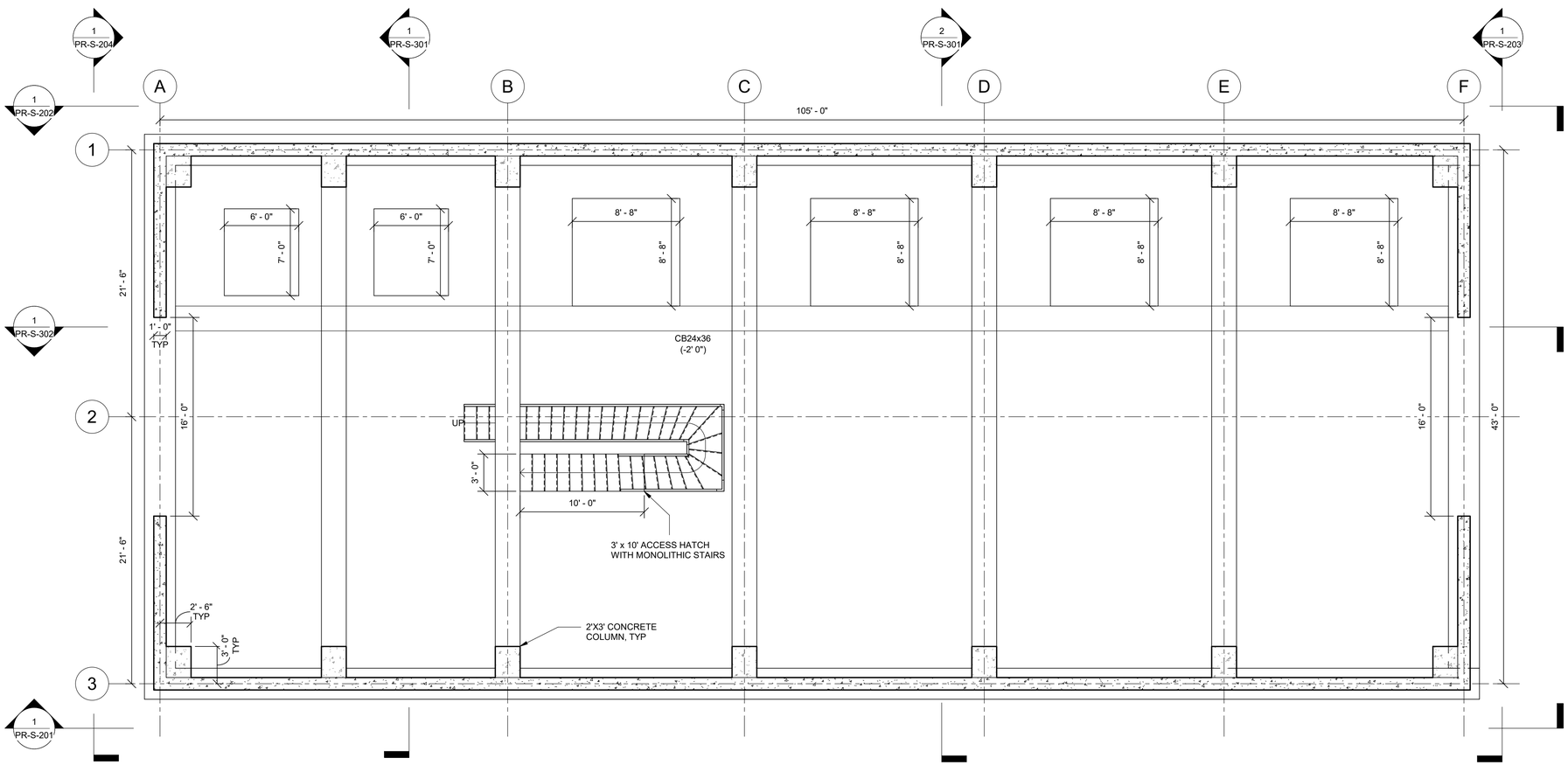
US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRIC
600 DR MARTIN LUTHER KING JR PLACE

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

PADDY'S RUN FOUNDATION PLAN- ALTERNATE 2

SHEET ID
ALT 2
PR-S-101

CONCEPT SUBMITTAL



1 PR-S-201 MOTOR FLOOR PLAN

3/16" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
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DESIGNED BY: B. EVANS
DRAWN BY: B. EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOTE
SIZE: ANSI D

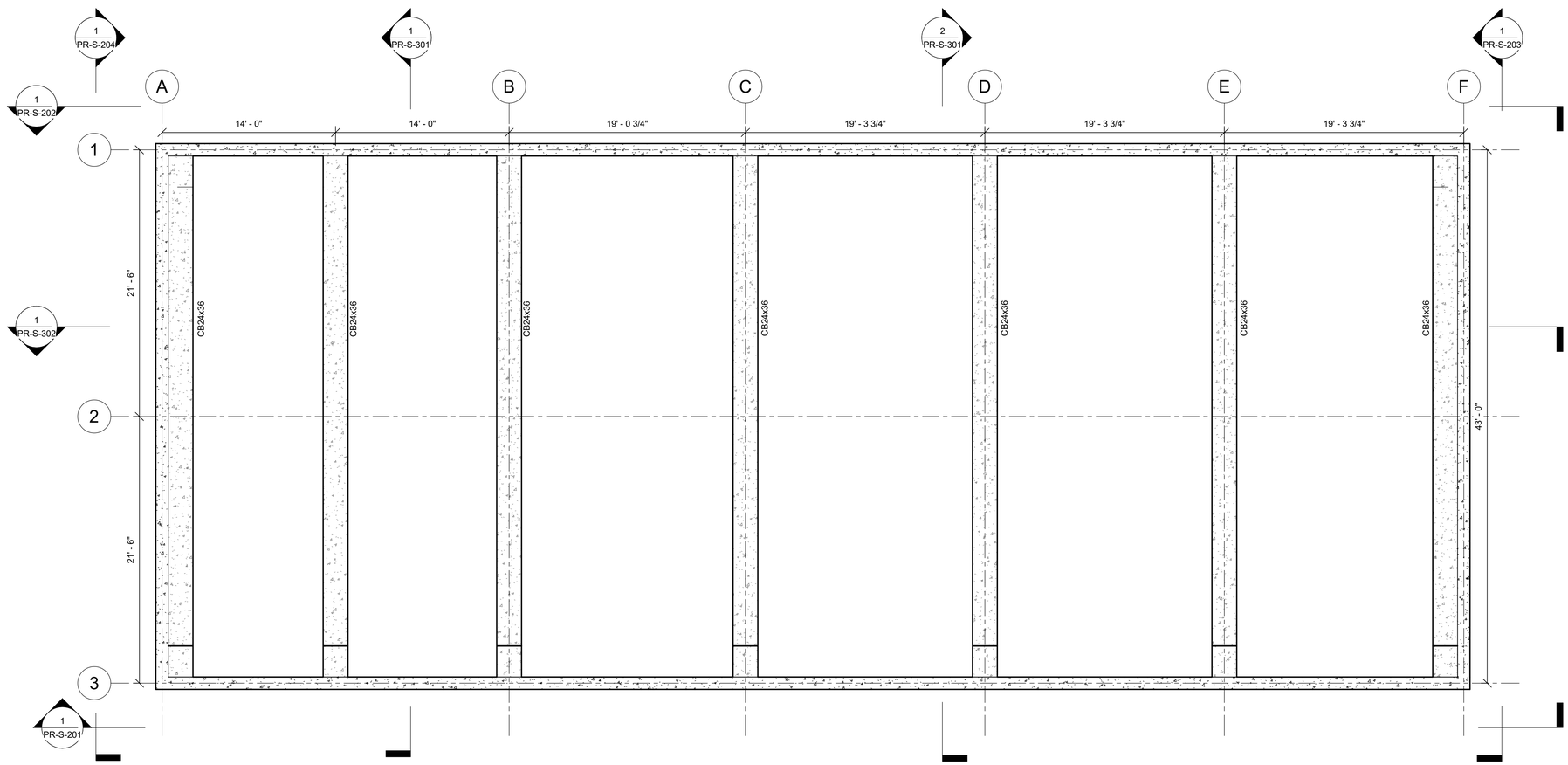
US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRIC
600 DR MARTIN LUTHER KING JR PLACE

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

PADDY'S RUN MOTOR FLOOR PLAN- ALTERNATE 2

SHEET ID
ALT 2
PR-S-102

CONCEPT SUBMITTAL



1 PR-S-201 ROOF FRAMING PLAN

3/16" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRIC
600 DR MARTIN LUTHER KING JR PLACE

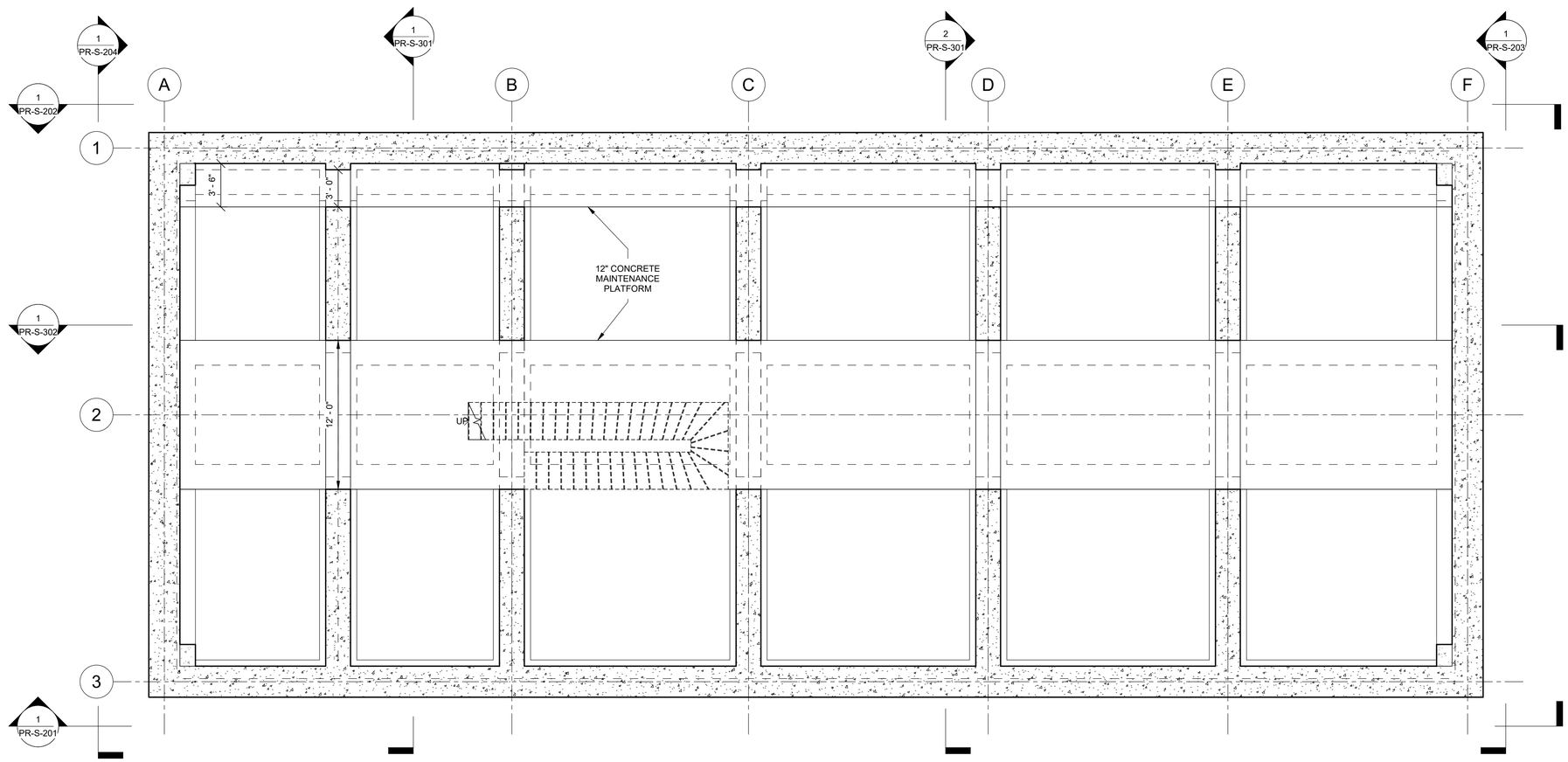
DESIGNED BY: B. EVANS
DRAWN BY: B. EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TYDE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

PADDY'S RUN ROOF FRAMING PLAN- ALTERNATE 2

SHEET ID
ALT 2
PR-S-103

CONCEPT SUBMITTAL



1 PR-S-201 WALKWAY FRAMING LEVEL

3/16" = 1'-0"

US Army Corps of Engineers ®

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LOUISVILLE DISTRIC
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CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
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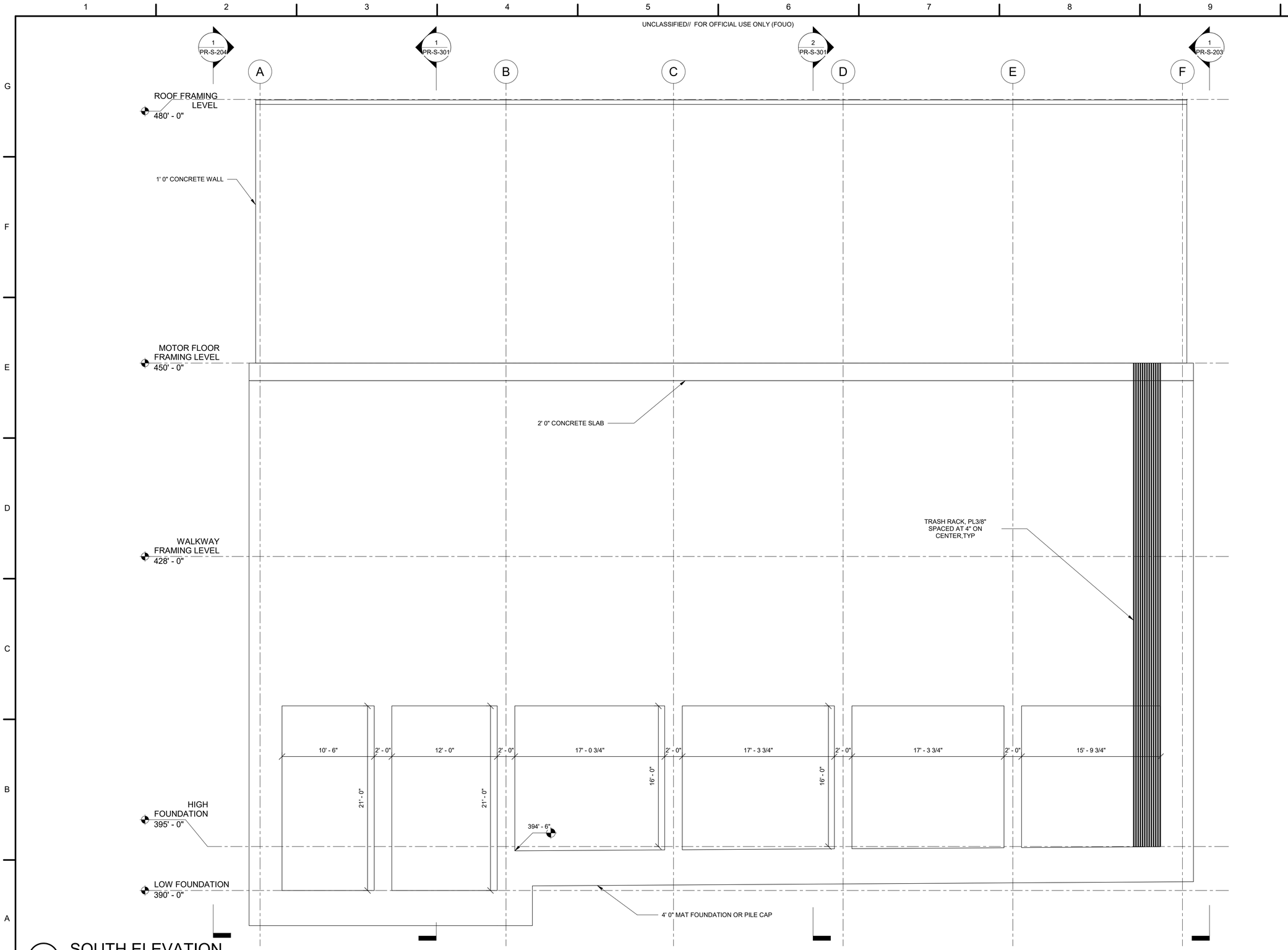
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

PADDY'S RUN WALKWAY PLAN- ALTERNATE 2

SHEET ID
ALT 2
PR-S-104

CONCEPT SUBMITTAL



1 PR-S-101

SOUTH ELEVATION

3/16" = 1'-0"

US Army Corps of Engineers ®

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CHECKED BY: C. YOUNG	CONTRACT_NO.:
SUBMITTED BY: J. LYONS	DRAWING CODE:
SIZE: ANSI D	

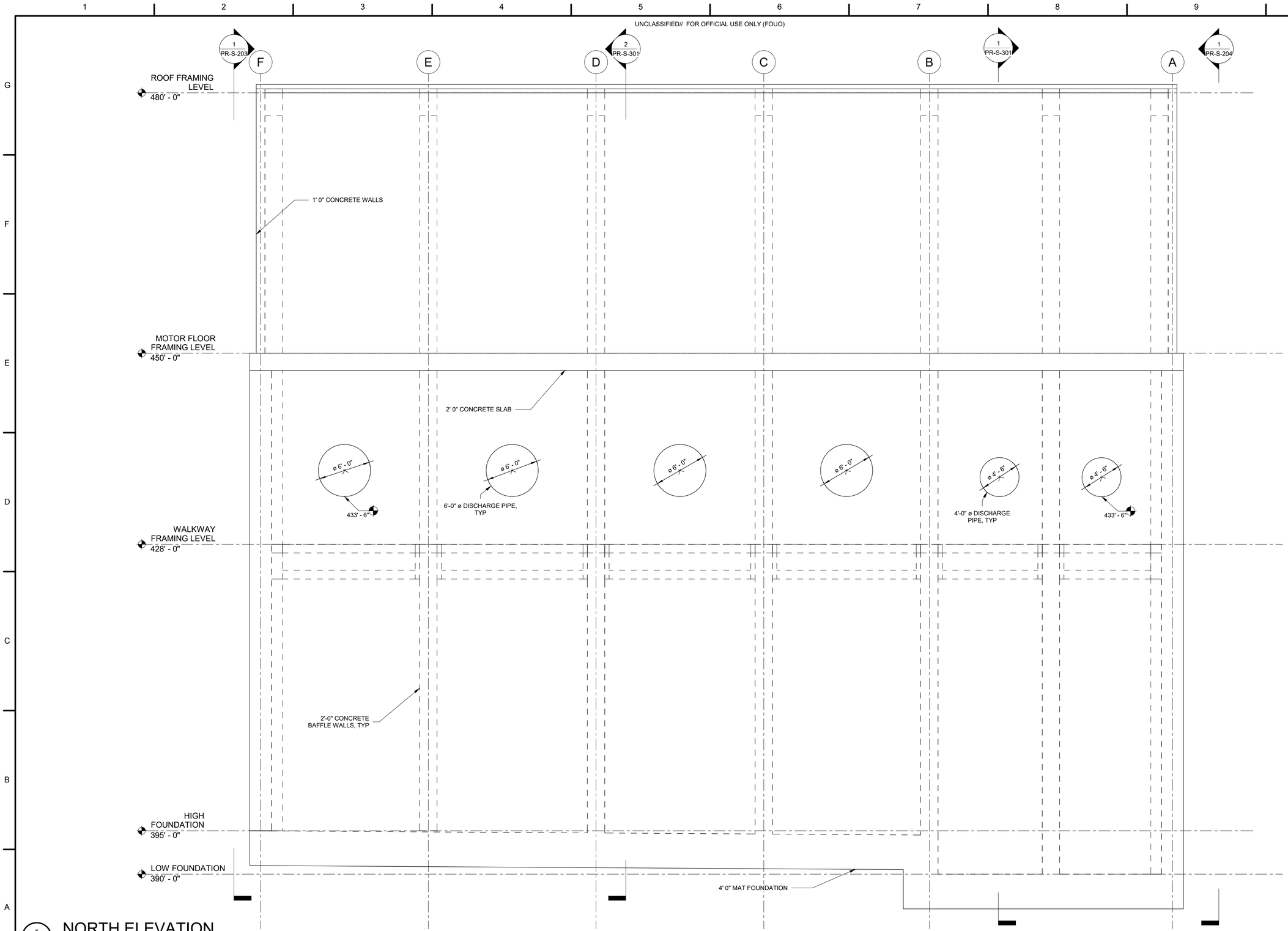
US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRIC
600 DR MARTIN LUTHER KING JR PLACE

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

PADDY'S RUN EXTERIOR ELEVATIONS-
ALTERNATE 2

SHEET ID
ALT 2
PR-S-201

CONCEPT SUBMITTAL



1
PR-S-101

NORTH ELEVATION

3/16" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

DESIGNED BY: B. EVANS
DRAWN BY: B. EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TYDE
SIZE: ANSI D

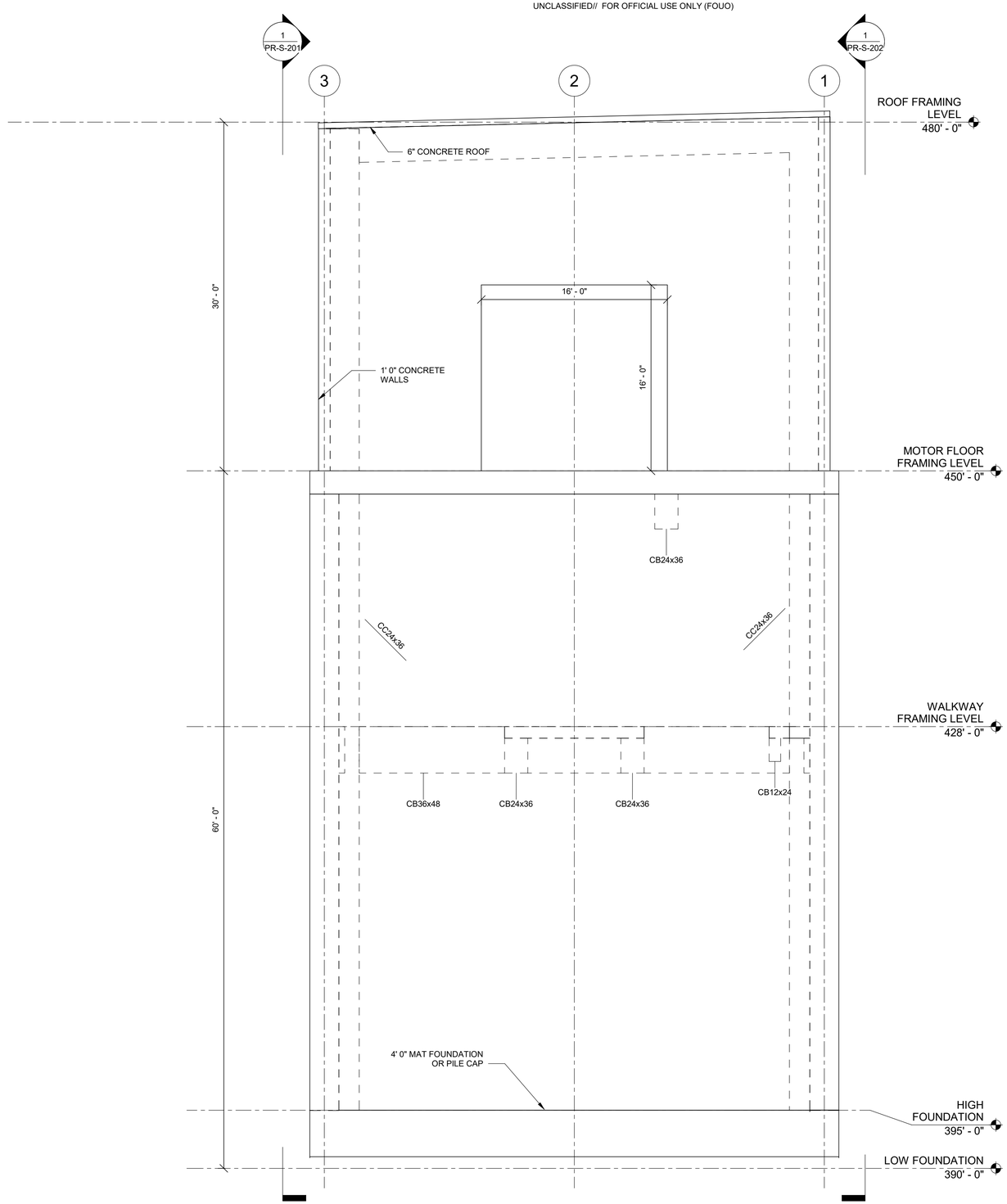
US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRIC
600 DR MARTIN LUTHER KING JR PLACE

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

PADDY'S RUN EXTERIOR ELEVATIONS-
ALTERNATE 2

SHEET ID
ALT 2
PR-S-202

CONCEPT SUBMITTAL



1 PR-S-101

EAST ELEVATION

3/16" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRIC
600 DR MARTIN LUTHER KING JR PLACE

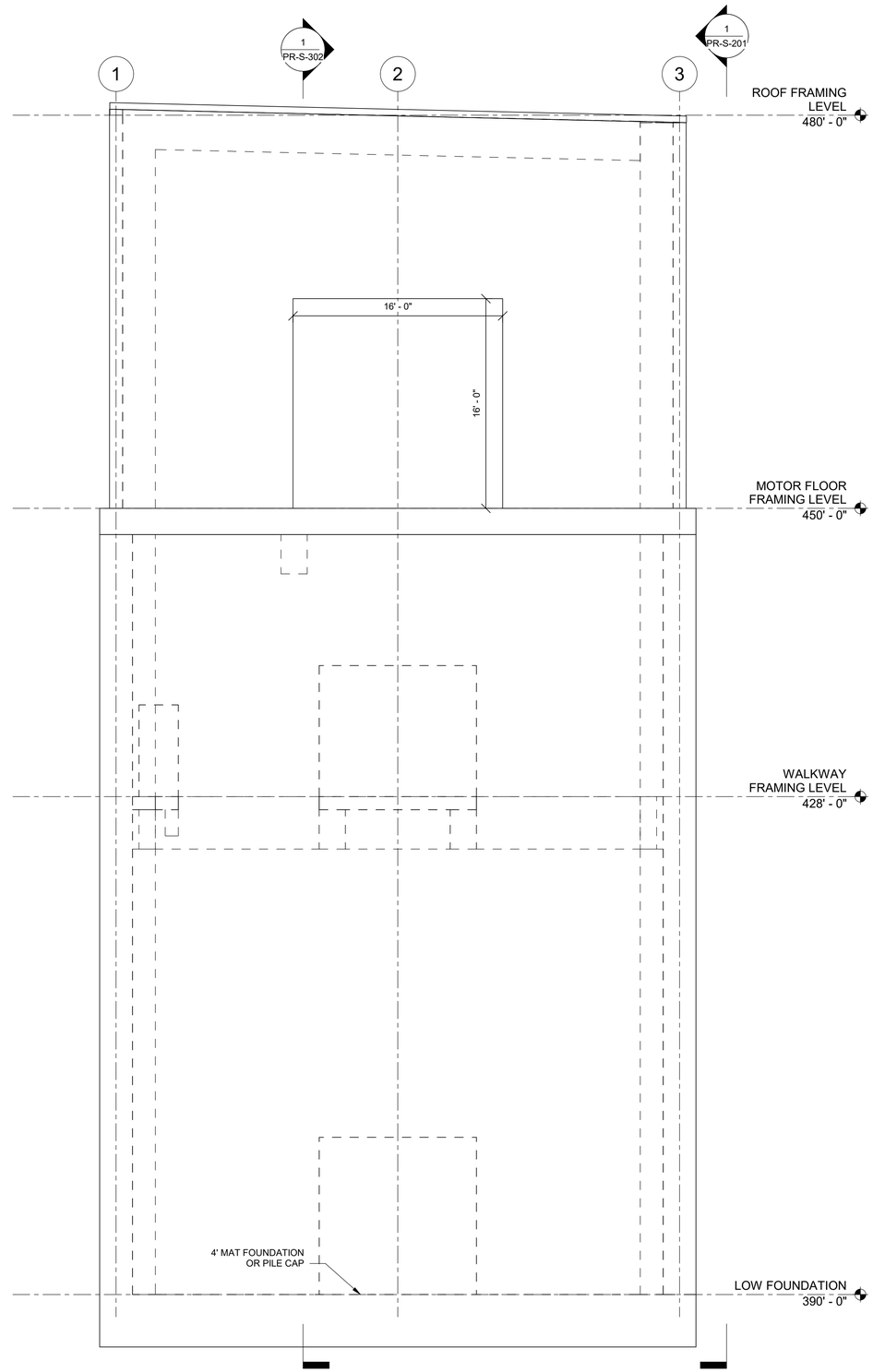
DESIGNED BY: B. EVANS
DRAWN BY: B. EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

PADDY'S RUN EXTERIOR ELEVATIONS-
ALTERNATE 2

SHEET ID
ALT 2
PR-S-203

CONCEPT SUBMITTAL



1 PR-S-101

WEST ELEVATION

3/16" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRIC
600 DR MARTIN LUTHER KING JR PLACE

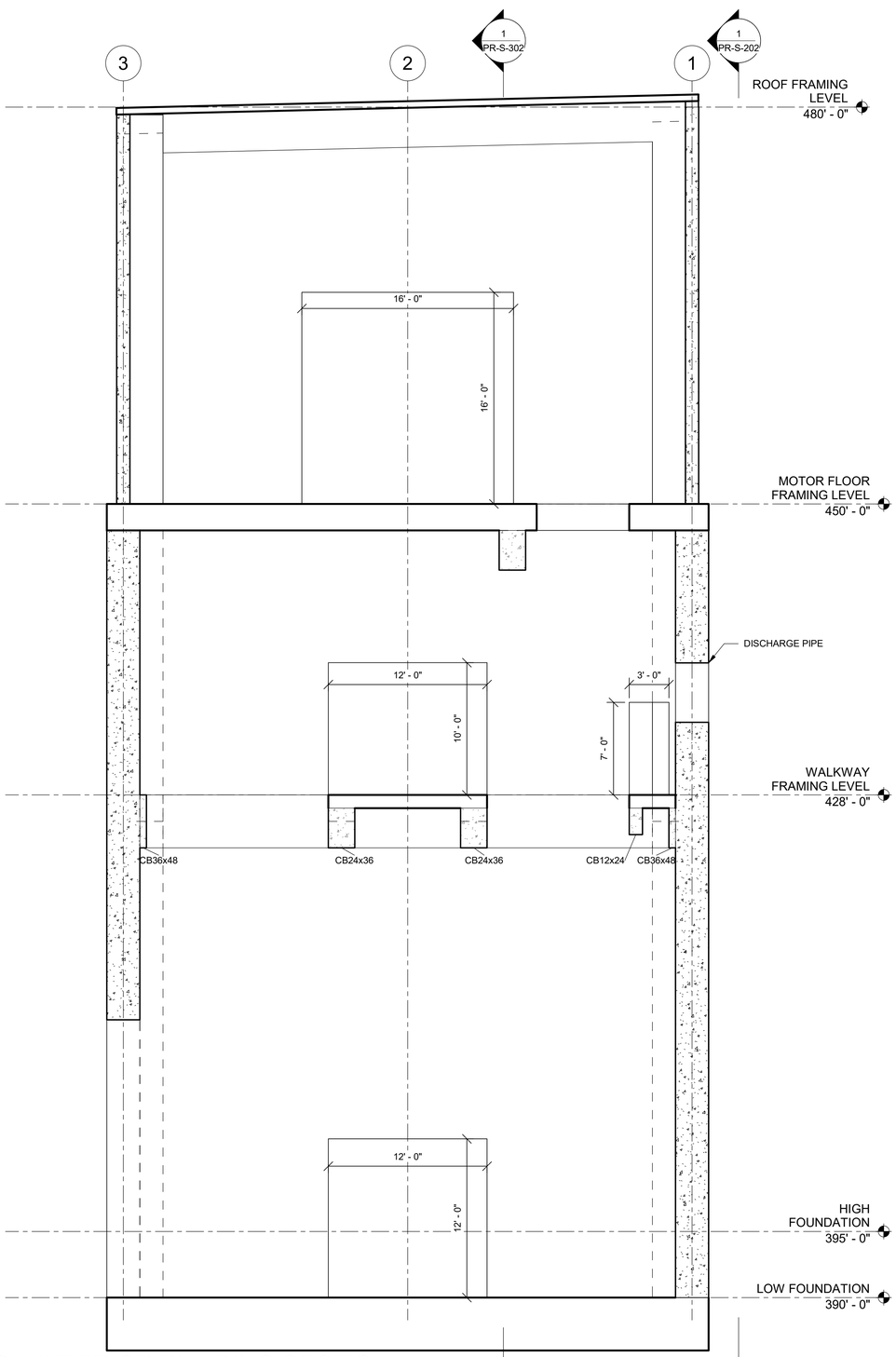
DESIGNED BY: B. EVANS
DRAWN BY: B. EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TYDE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

PADDY'S RUN EXTERIOR ELEVATIONS-
ALTERNATE 2

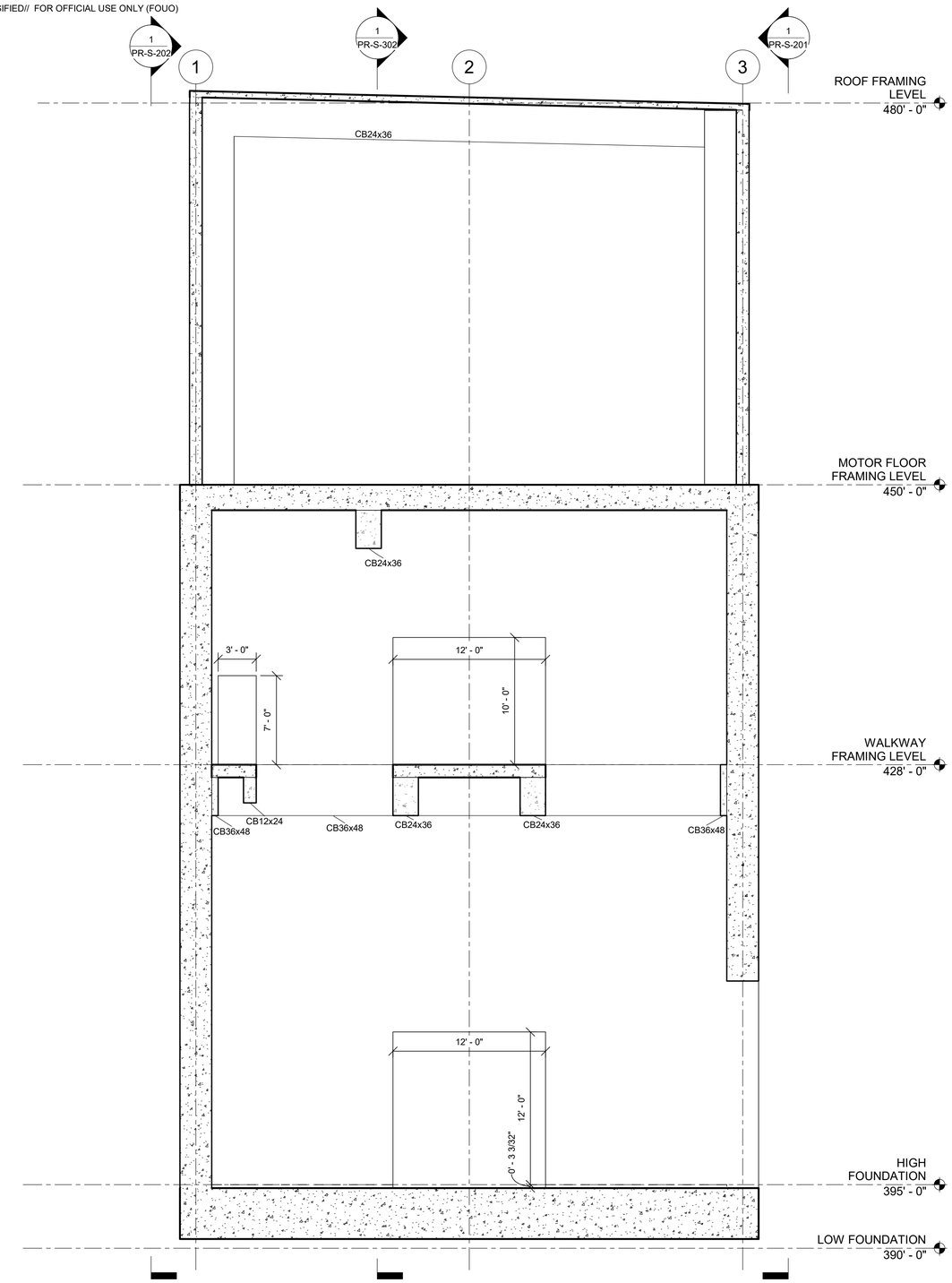
SHEET ID
ALT 2
PR-S-204

CONCEPT SUBMITTAL



1 PR-S-101 INTERIOR BUILDING SECTION

3/16" = 1'-0"



2 PR-S-101 INTERIOR BUILDING SECTION

3/16" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

DESIGNED BY: B. EVANS
DRAWN BY: B. EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOE
SIZE: ANSI D

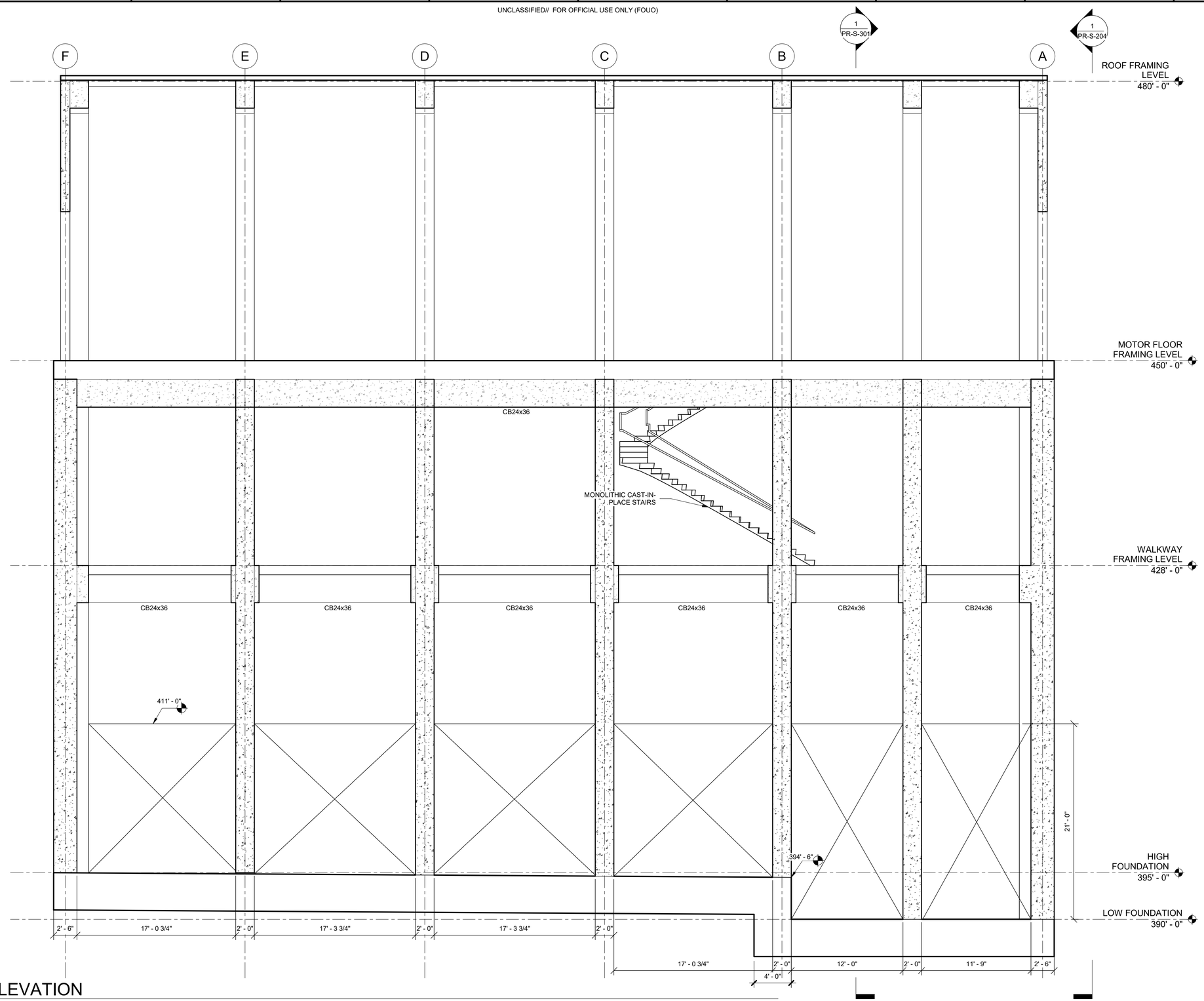
US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRIC
600 DR MARTIN LUTHER KING JR PLACE

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
'FEASIBILITY STUDY'

PADDY'S RUN INTERIOR SECTIONS- ALTERNATE 2

SHEET ID
ALT 2
PR-S-301

CONCEPT SUBMITTAL



1
PR-S-101

WALK WAY ELEVATION

3/16" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRIC
600 DR MARTIN LUTHER KING JR PLACE

DESIGNED BY: B. EVANS
DRAWN BY: B. EVANS
CHECKED BY: Checker
SUBMITTED BY: J. TYDE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

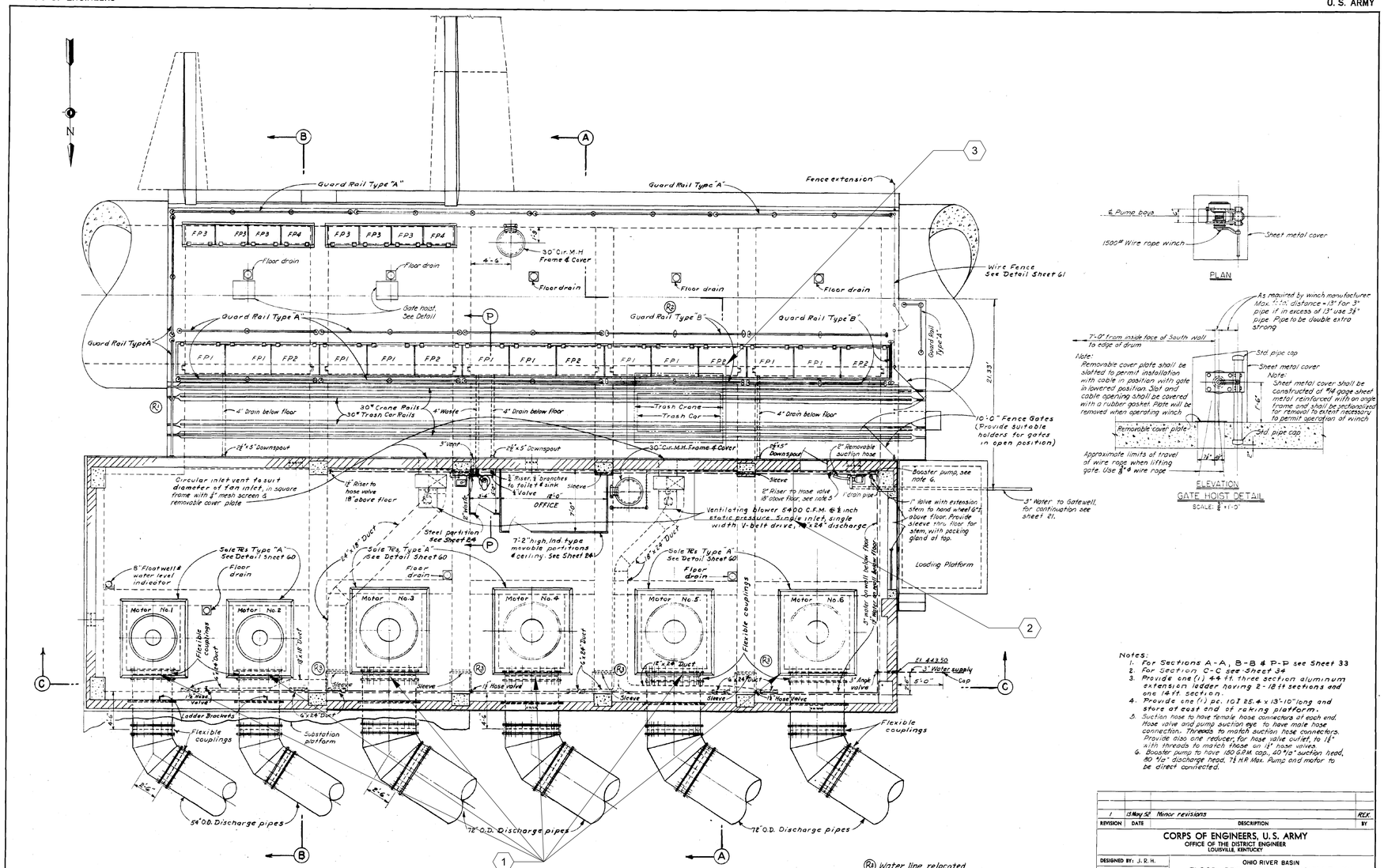
PADDY'S RUN INTERIOR ELEVATIONS-ALTERNATE 2

SHEET ID
ALT 2
PR-S-302

CONCEPT SUBMITTAL

CORPS OF ENGINEERS

U. S. ARMY



PLAN - MOTOR FLOOR

Notes:

1. For Sections A-A, B-B & P-P see Sheet 33
2. For Section C-C see Sheet 34
3. Provide one (1) 44 ft. three section aluminum extension ladder having 2-18 ft sections and one 14 ft. section.
4. Provide one (1) pr. 10 I 25.4 x 13'-10" long and store at east end of raking platform.
5. Suction hose to have female hose connectors at each end. Hose valve and pump suction eye to have male hose connection. Threads to match suction hose connectors. Provide also one reducer for hose valve outlet, to 1" with threads to match those on 1" hose valves.
6. Booster pump to have 150 G.P.M. cap., 40 1/2" suction head, 80 1/2" discharge head, 71 H.P. Max. Pump and motor to be direct connected.

(R2) Water line relocated
(R3) Guard rail type changed (Contract Mod. No. 3)
(R4) Extension of gantry crane rail (Contract Mod. No. 15)

REVISION	DATE	DESCRIPTION	BY
1	13 May 52	Minor revisions	REK.

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
FLOOD PROTECTION LOUISVILLE, KY.
PADDY'S RUN PUMPING PLANT
MECHANICAL EQUIPMENT LAYOUT
PLAN - MOTOR FLOOR

DESIGNED BY: J. R. H.
DRAWN BY: C.E.C.-R.S.V.
TRACED BY: C.E.C.-R.S.V.
CHECKED BY: S. R. F.
SUBMITTED: CHIEF, ENGINEERING DIVISION
APPROVED: CHIEF, INVESTIGATIONS ASSISTANT
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER
DATE: 21 MARCH 1952
SCALE: ½" = 1'-0"
DRAWING NUMBER 613-12.5/32

AS BUILT

PUMP DATA				
PUMP #	TYPE	DESIGN FLOW (GPM)	TDH (FT OF WATER)	NOTES
1	SUBMERSIBLE	60,750	55.3	NEW PUMP
2	SUBMERSIBLE	60,750	55.3	NEW PUMP
3	SUBMERSIBLE	121,500	29.9	NEW PUMP
4	SUBMERSIBLE	121,500	29.9	NEW PUMP
5	SUBMERSIBLE	121,500	29.9	NEW PUMP
6	SUBMERSIBLE	121,500	29.9	NEW PUMP

SHEET KEYNOTES

1. REPLACE ALL COLUMN PUMPS WITH NEW.
2. INSTALL NEW GREASE LUBRICATION SYSTEM WITH CENTRALIZED PUMP AND FILL STATION TO FEED ALL PUMPS. SEE LINCOLN INDUSTRIAL SYSTEM AT SHAWNEE.
3. REPLACE TRASH RAKE (TRASH CRANE) WITH NEW.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX

DESIGNED BY: K. BURNS
DRAWN BY: K. BURNS
CHECKED BY:
SUBMITTED BY: J. TICE
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

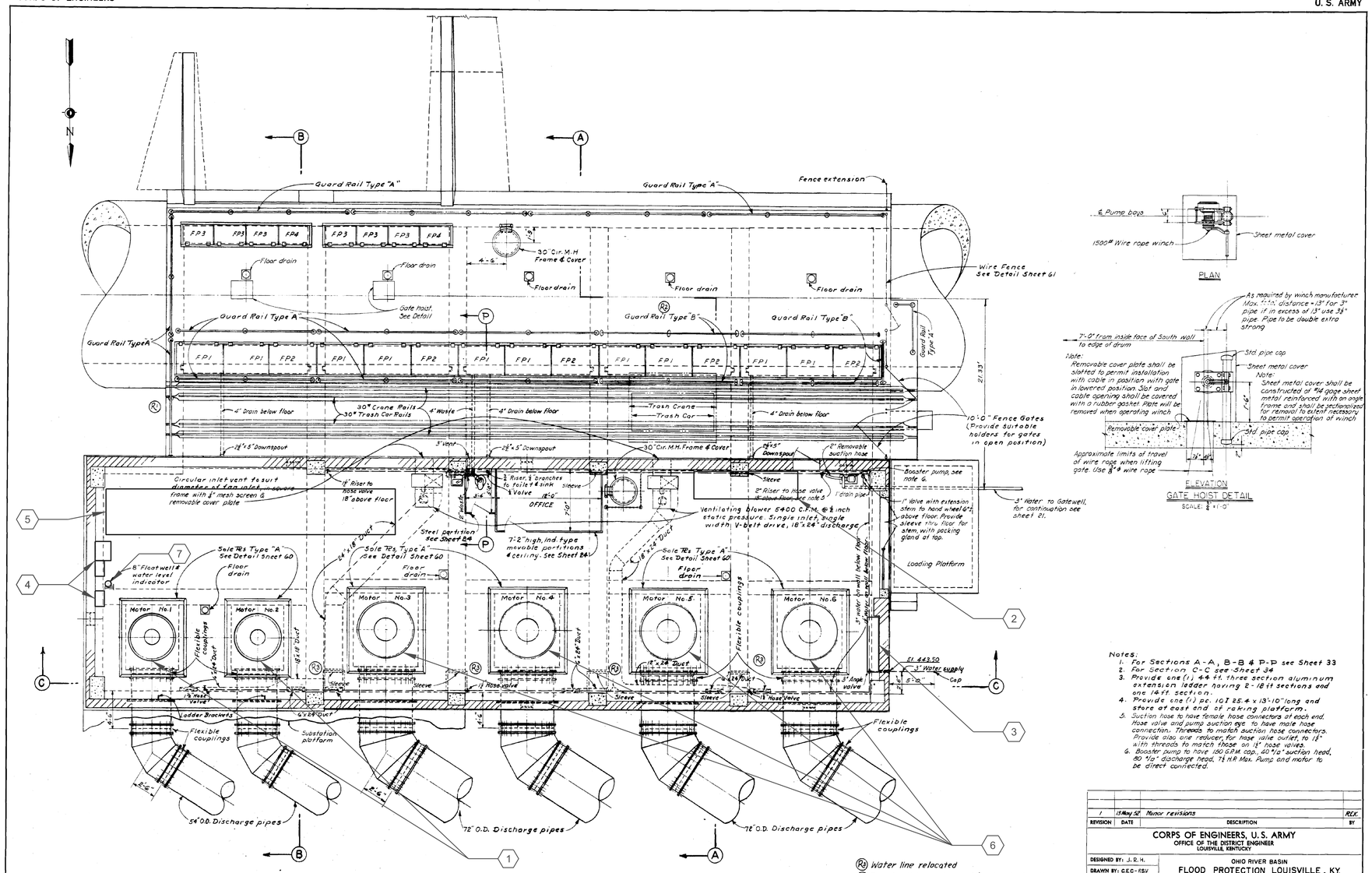
PADDY'S RUN PS
MECHANICAL PLANS

SHEET ID
PR-M-101

CONCEPT SUBMITTAL

CORPS OF ENGINEERS

U. S. ARMY



PLAN - MOTOR FLOOR

Notes:
1. For Sections A-A, B-B & P-P see Sheet 33
2. For Section C-C see Sheet 34
3. Provide one (1) 44 ft. three section aluminum extension ladder having 2-18 ft sections and one 14 ft. section.
4. Provide one (1) pc. 10 I 25.4 x 13'-10" long and store at east end of raking platform.
5. Suction hose to have female hose connectors at each end. Hose valve and pump suction eye to have male hose connection. Threads to match suction hose connectors. Provide also one reducer for hose valve outlet, to 18" with threads to match those on 1" hose valves.
6. Booster pump to have 150 G.P.M. cap., 40 ft/lb suction head, 80 ft/lb discharge head, 7½ H.P. Max. Pump and motor to be direct connected.

REVISION	DATE	DESCRIPTION	BY
1	13 May 52	Minor revisions	RCK

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

DESIGNED BY: J. R. H.
DRAWN BY: C.E.C.-F.S.V.
TRACED BY: C.E.C.-F.S.V.
CHECKED BY: S. F. F.
SUBMITTED: CHIEF, ENGINEERING DIVISION
APPROVED: CHIEF ENGINEERING ASSISTANT
APPROVED: DATE:

OHIO RIVER BASIN
FLOOD PROTECTION LOUISVILLE, KY.
PADDY'S RUN PUMPING PLANT
MECHANICAL EQUIPMENT LAYOUT
PLAN-MOTOR FLOOR

APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER
DATE: 21 MARCH 1952
SCALE: 1/4" = 1'-0"
DRAWING NUMBER 613-12.5/32

GRAPHIC SCALE

AS BUILT

GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. REFURBISH 750 HP PUMP MOTORS.
2. INSTALL GREASE LUBRICATION SYSTEM. SEE LINCOLN INDUSTRIAL SYSTEM FOR ADDITIONAL INFORMATION REGARDING LUBRICATION PUMP MOTOR.
3. PUMP CONTROLS WILL BE UPDATED AND INTEGRATED INTO MSD SCADA SYSTEM.
4. FUTURE 480V SERVICE SHALL BE INSTALLED AT LOCATION. A 100 KVA, 480V-208/120V DRY TYPE TRANSFORMER AND TWO 208 VAC PANELS SHALL BE INSTALLED FOR LIGHTING LOADS.
5. MOTOR CONTROL CENTER WILL BE REPLACED WITH A MODERN DAY EQUIVALENT.
6. REFURBISH 1250 HP PUMP MOTORS.
7. NEW CONTROL SYSTEM INSTRUMENTATION (PRESSURE TRANSDUCER, FLOAT MAST)

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: S. JOYCE
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

PADDYS RUN PS ELECTRICAL PLAN

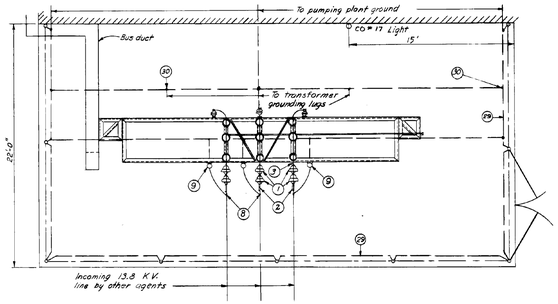
SHEET ID
PR-E-101

A1 PADDYS RUN PS ELECTRICAL PLAN
SCALE: NOT TO SCALE

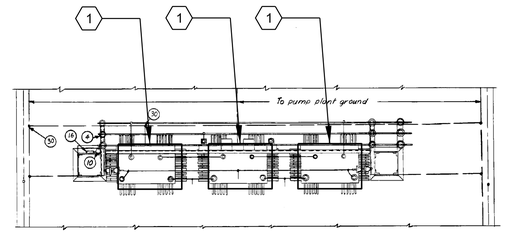
CONCEPT SUBMITTAL

CORPS OF ENGINEERS

U. S. ARMY

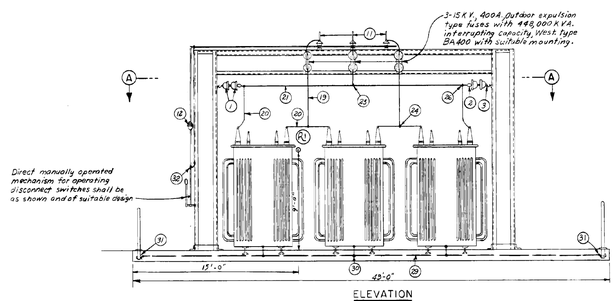


PLAN

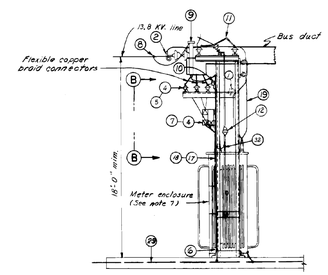


SECTION PLAN A-A

PLAN VIEW

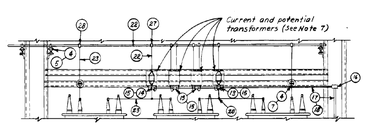


ELEVATION

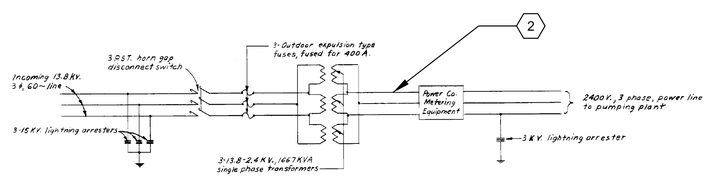


SIDE ELEVATION

ELEVATION VIEW



SECTION B-B



WIRING DIAGRAM

Notes:
1. Figures in circles refer to part numbers on the Bill of Material.
2. Small parts, fittings, etc., not called for shall be furnished as required.
3. All material shall be of the manufacture, type, and catalog number specified, or its equal.
4. All bolts and screws shall be furnished with a full complement of washers in accordance with best practice.
5. Solderless connectors shall be used for making splices and taps to bus.
6. All fence posts shall be grounded.
7. Current and potential transformers, and meter enclosure will be furnished by other agencies, and they shall be installed under this contract.
8. Watt hour meter will be furnished and installed by other agencies.

(R) Light added (Contract Mod. No. 17)

BILL OF MATERIAL

PART NO.	DESCRIPTION	MFG.	CATALOG NO.
1	5" Strain insulator, 55 K.V. min. dry flashover		
2	Strain clamp	Locke	12926
3	Hooks	Locke	2563
4	Insulator unit	G.E.	60899(W)
5	Bus Support	G.E.	6239940G19
6	Connector for #4/0 cable to structural framework	Burndy	GR29
7	Bus Support	G.E	60820G65
8	Hot line clamp		
9	Lightning arrester, 15 KV.		
10	Lightning arrester, 3KV.		
11	3P.S.T. horn gap disconnect switch, 15 KV., 400A.	West.	Type RH2
12	Operating rod insulator	Lapp	6393
13	Condulet outlet	Crouse-Hinds	C47
14	Condulet outlet	Crouse-Hinds	C47
15	2 Hole composition cover	Crouse-Hinds	3712
16	Condulet with cover	Crouse-Hinds	LB47
17	1½" Rigid electrical conduit		
18	#12 Conductor, insulated		
19	#4/0 Bare solid copper conductor		
20	#2 Bare solid copper conductor		
21	#2 Bare stranded copper conductor		
22	3" I.P.S. copper tubing		
23	1" I.P.S. copper tubing		
24	Tee connector for #4/0 to #2 bare solid conductor		
25	Tee connector for #4/0 bare solid to #2 bare stranded conductor		
26	Tee connector for #2 bare solid to #2 bare stranded conductor		
27	Tee connector for 3" I.P.S. copper tubing	Burndy	CT2020
28	Tee connector for 3" to 1" I.P.S. copper tubing	Burndy	CT2015
29	#4/0 Bare stranded copper cable		
30	Tee connector for #4/0 stranded cable	Burndy	NT2629
31	Connector for #4/0 cable to fence post	Burndy	Type GD
32	Connector for #4/0 cable to 1½" pipe	Burndy	GK120

REVISION	DATE	DESCRIPTION	BY
1	13 May 52	Minor revisions	R.E.K.

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
FLOOD PROTECTION LOUISVILLE, KY.
PADDY'S RUN PUMPING PLANT

SUBSTATION

DESIGNED BY: C.G.
DRAWN BY: C.G.
TRACED BY: K.P.R.
CHECKED BY: D.S.
SUBMITTED: CHIEF, ENGINEERING DIVISION
APPROVED: CHIEF ENGINEERING ASSISTANT
APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER
DATE: 21 MARCH 1952
SCALE: 1/4" = 1'-0"
DRAWING NUMBER 613-12.5/38
DATE

GRAPHIC SCALE 1/4" = 1'-0" 0 1' 5' 10'

AS BUILT

GENERAL SHEET NOTES

1. SUBSTATION EQUIPMENT TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. TOTAL OF 6000 KVA PAD-MOUNT TRANSFORMERS
2. SECONDARY WINDINGS

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. ZIE
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

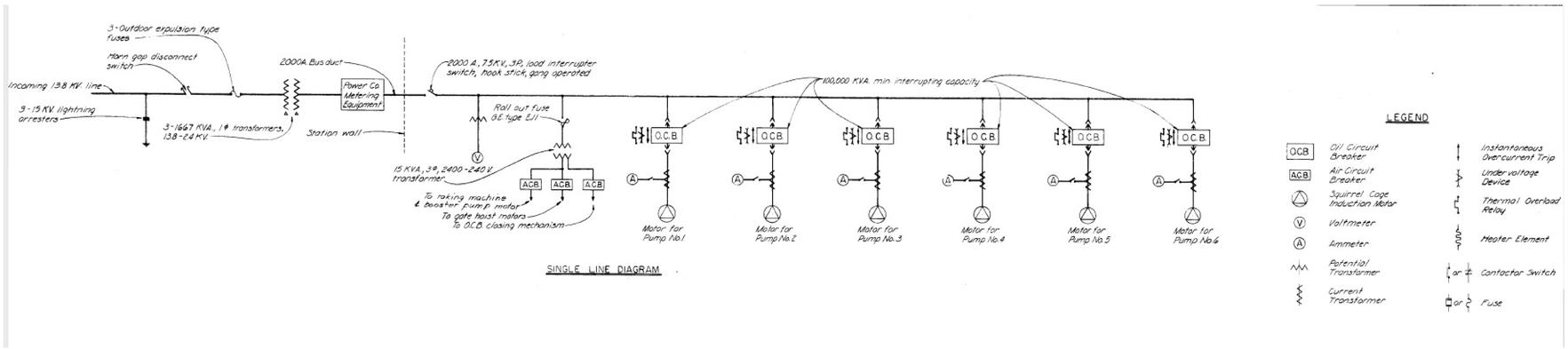
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

PADDYS RUN PS SUBSTATION PLAN

SHEET ID
PR-E-102

A1 PADDYS RUN PS - SUBSTATION PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL



SINGLE LINE DIAGRAM

GENERAL SHEET NOTES

1. SEE PADDYS RUN E-101 FOR EXISTING STATION FLOOR PLAN. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. EXISTING ONE LINE DIAGRAM HAS BEEN PROVIDED AS A REFERENCE. SEE FEASIBILITY REPORT APPENDIX D-ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXX
THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

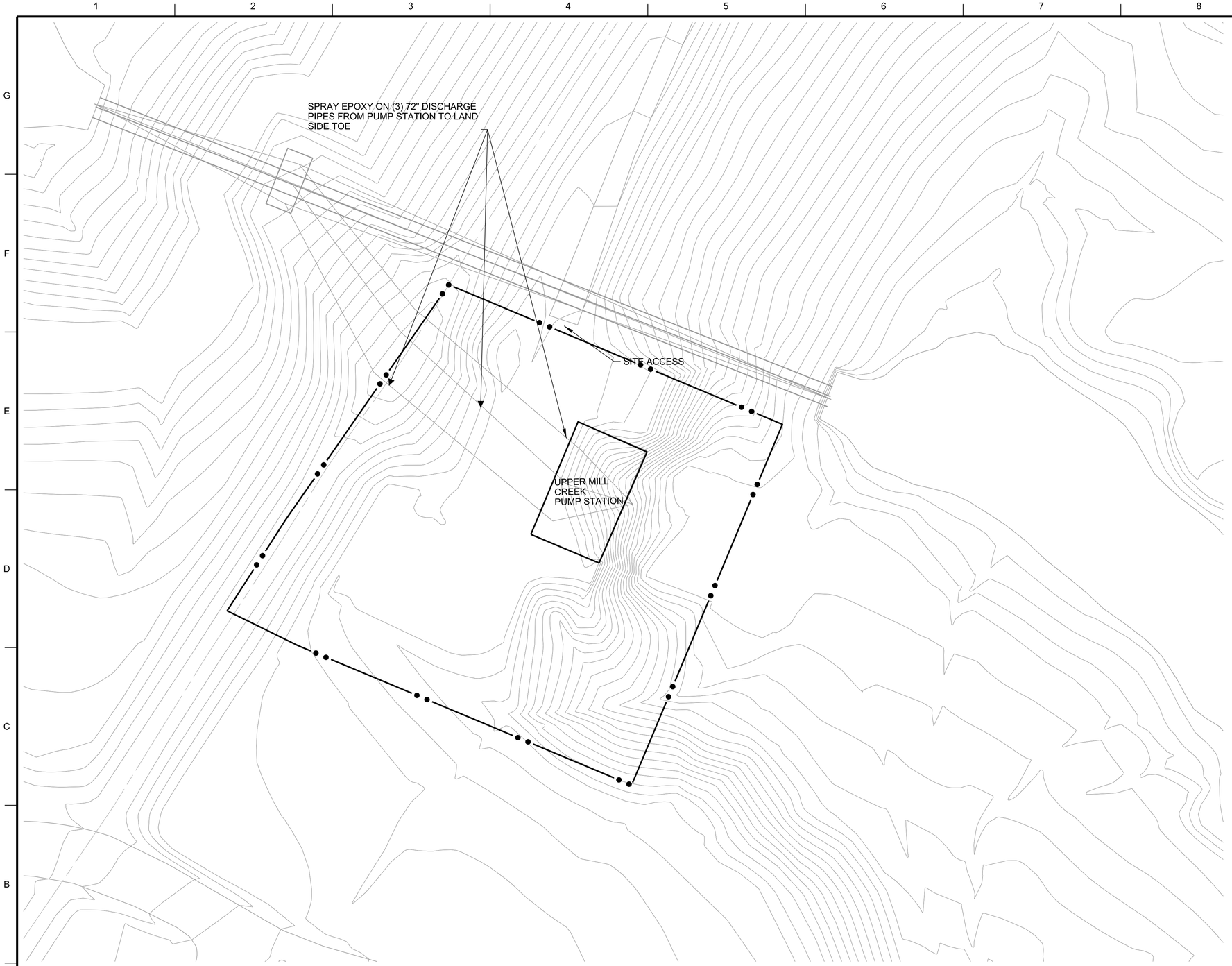
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

PADDYS RUN PS EXISTING POWER ONE LINE

SHEET ID
PR-E-601

A1 PADDYS RUN PUMP STATION EXISTING ONE LINE DIAGRAM
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL



A1 UPPER MILL CREEK SITE PLAN
1"=50'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET. DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

UPPER MILL CREEK PS
SITE PLAN

SHEET ID
UC-C-101

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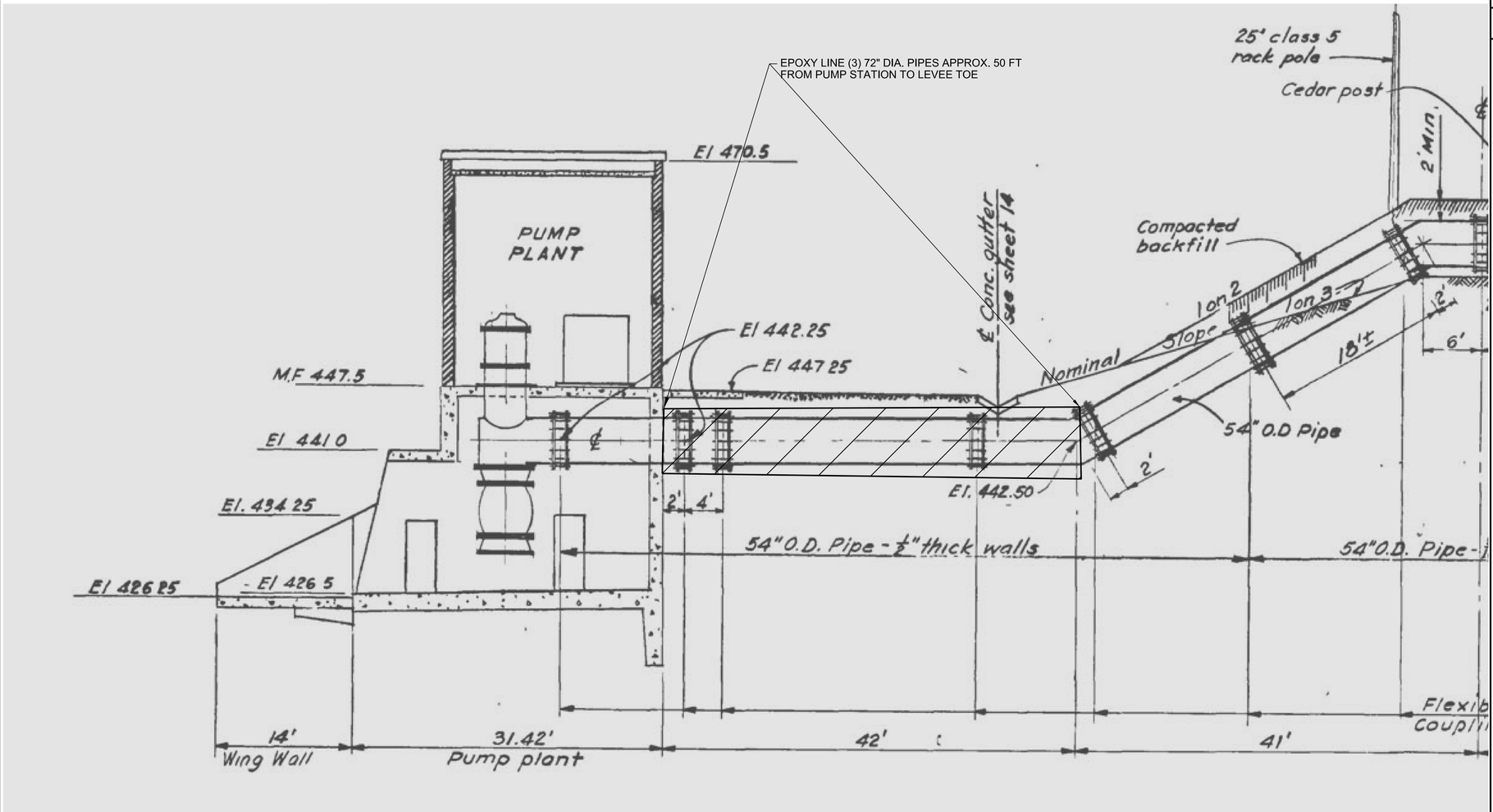
1:13:00 PM 8/27/2019 LRL_pdf.pltcfg LRL_Screen.dscript

CONCEPT SUBMITTAL

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES



LEGEND

A1 DETAIL SHEET- UPPER MILL CREEK PUMP STATION
1"=30'

N

0 30' 60'

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

UPPER MILL CREEK DETAIL

SHEET ID
UC-C-201

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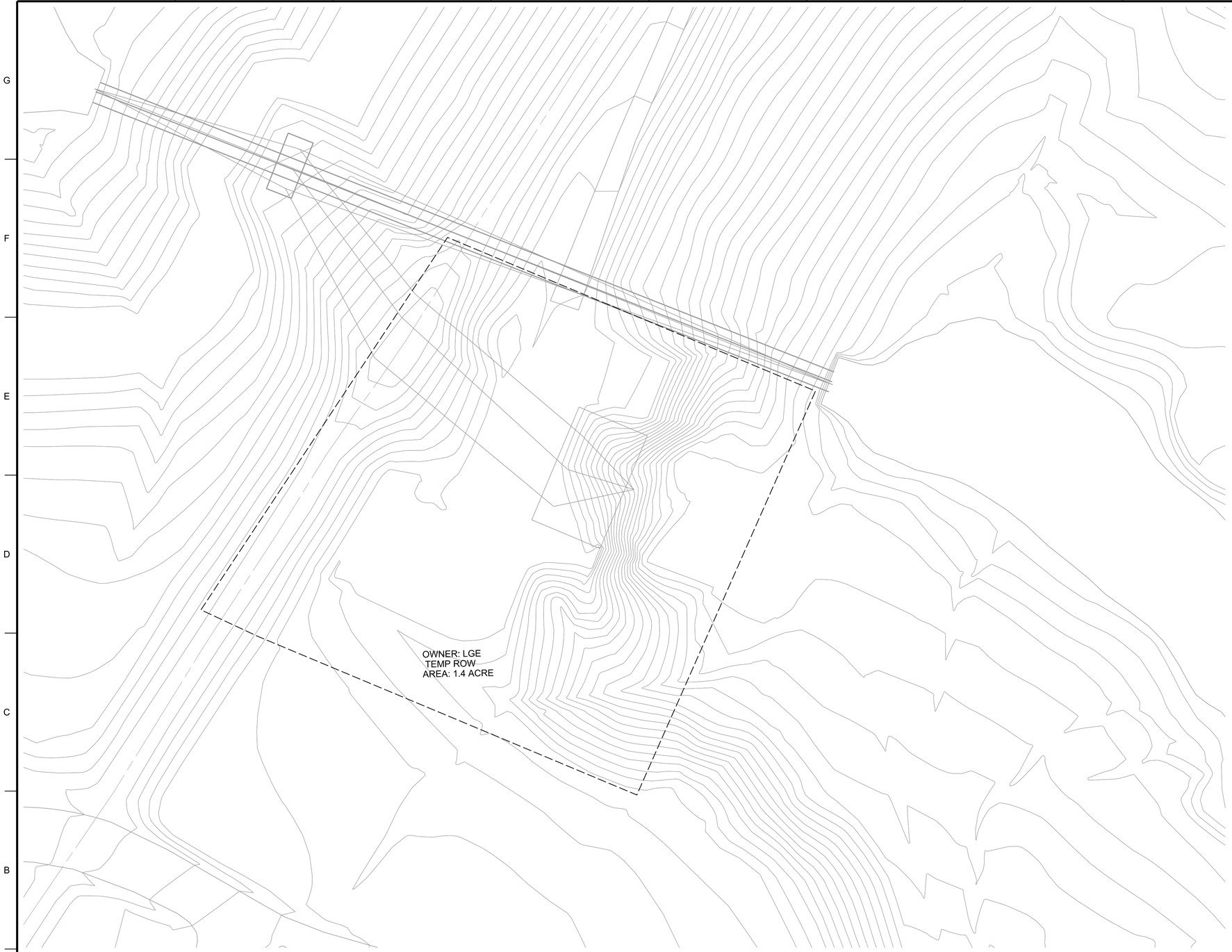
CONCEPT SUBMITTAL



A1 UPPER MILL CREEK PS RIGHT OF WAY PLAN
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. COYE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

UPPER MILL CREEK PS
RIGHT OF WAY

SHEET ID
UC-R-101

CONCEPT SUBMITTAL

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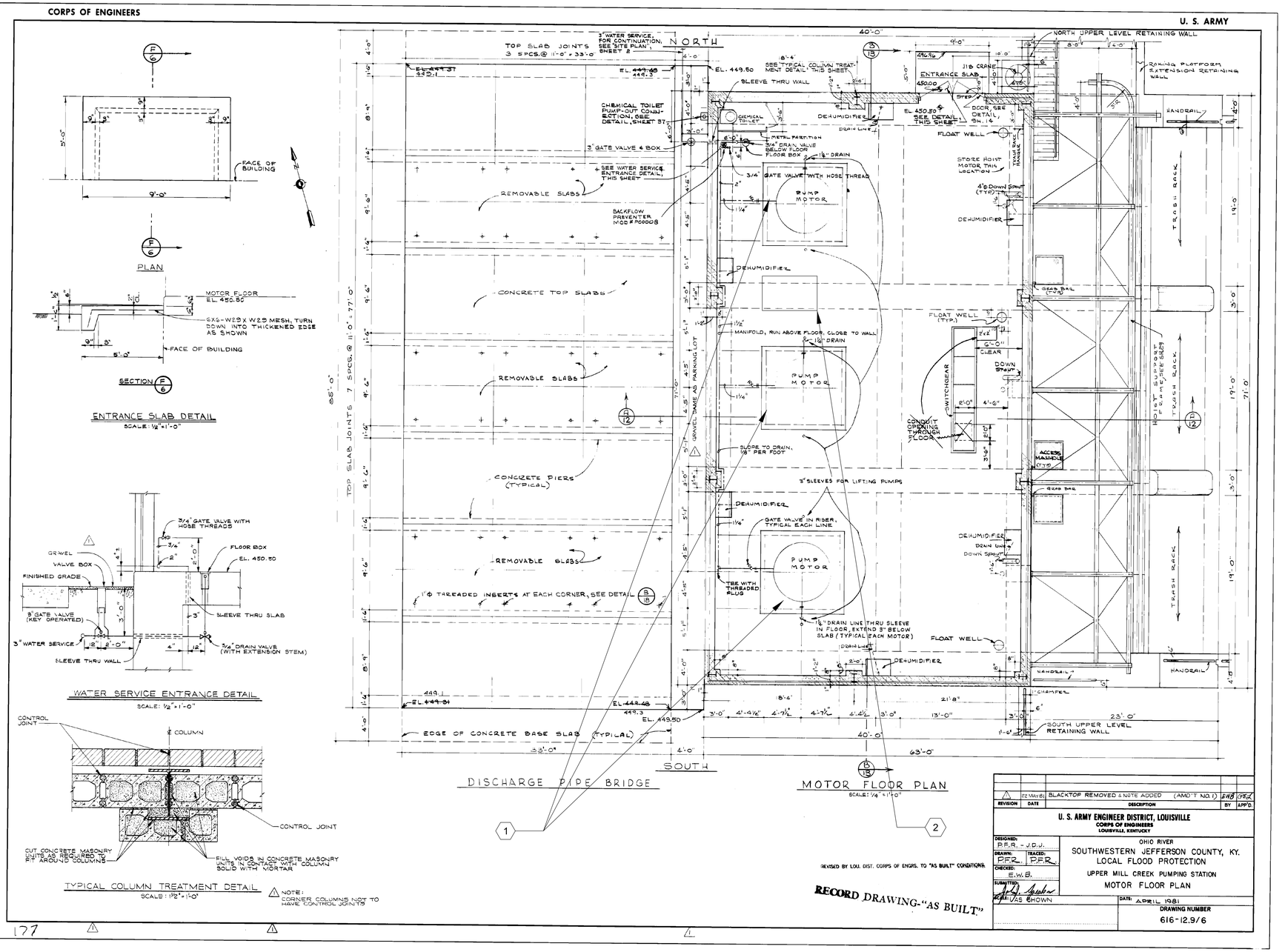


PUMP DATA				
PUMP #	TYPE	DESIGN FLOW (GPM)	TDH (FT OF WATER)	NOTES
1	COLUMN PUMP	173,000	48.6	REFURBISH PUMP
2	COLUMN PUMP	173,000	48.6	REFURBISH PUMP
3	COLUMN PUMP	173,000	48.6	REFURBISH PUMP

SHEET KEYNOTES

1. REFURBISH ALL PUMPS TO MANUFACTURER'S SPECIFICATIONS. DISCONNECT COLUMNS AT FLEXIBLE COUPLINGS. ABRASIVE BLAST COLUMNS TO WHITE METAL AND COAT WITH C200A. INSTALL NEW FLEXIBLE COUPLINGS.
2. INSTALL NEW GREASE LUBRICATION SYSTEM WITH CENTRALIZED PUMP AND FILL STATION TO FEED ALL PUMPS. SEE LINCOLN INDUSTRIAL SYSTEM AT SHAWNEE.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXX

DESIGNED BY: K. BURNS
DRAWN BY: K. BURNS
CHECKED BY:
SUBMITTED BY: J. TOE
SIZE: ANSI D

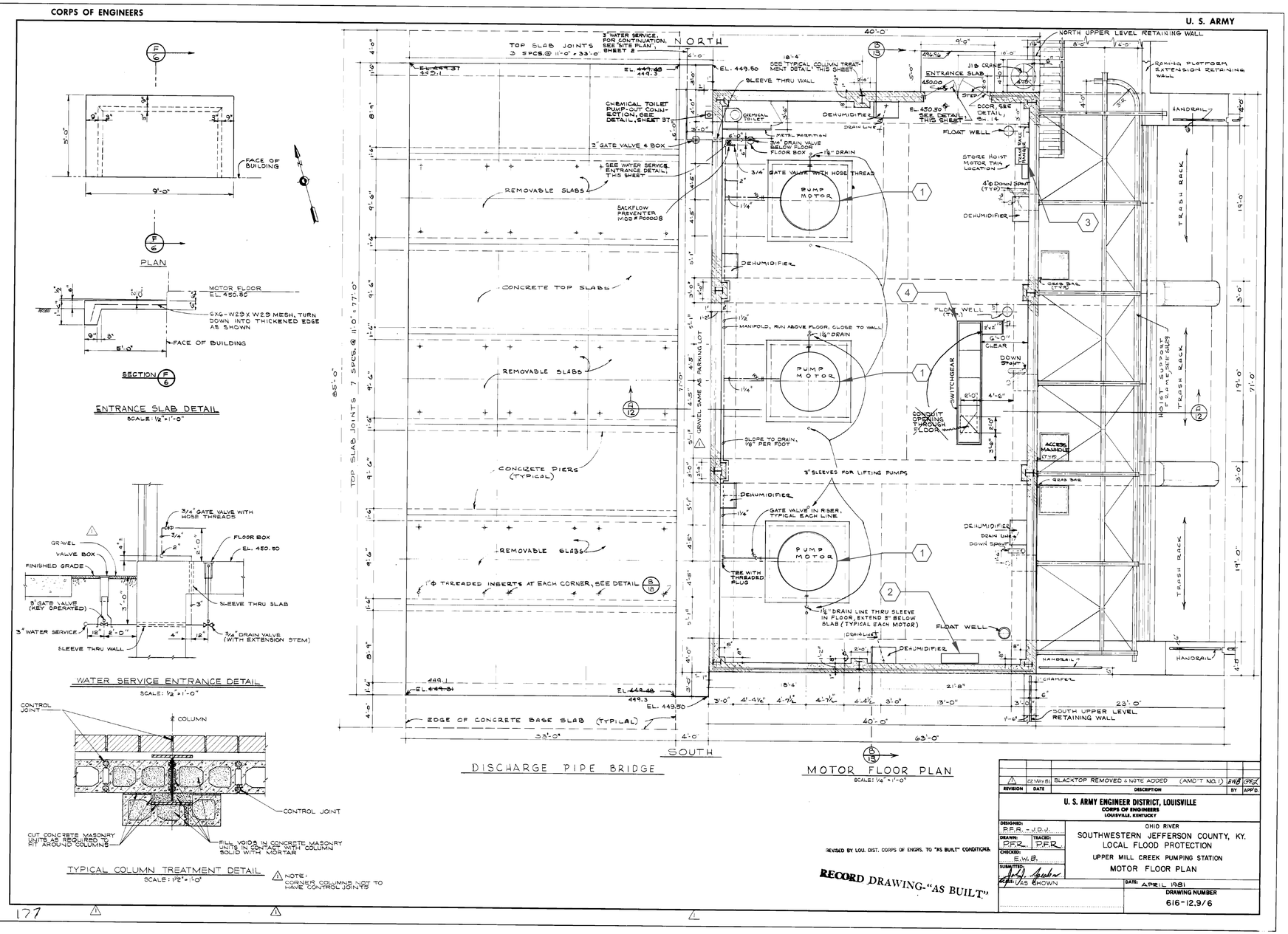
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145026

UPPER MILL CREEK PS
MECHANICAL PLANS

SHEET ID
UMC-M-101

CONCEPT SUBMITTAL



GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. 3000 HP PUMP MOTOR LOCATIONS. PUMP MOTORS 1 AND 3 HAVE UPDERGONE RECENT REFURBISHMENT AND WILL NOT REQUIRE UPGRADES. PUMP MOTOR 2 WILL REQUIRE REFURBISHMENT.
2. PUMP CONTROLS WILL BE UPDATED AND INTEGRATED INTO MSD SCADA SYSTEM.
3. A 112.5 KVA TRANSFORMER WILL BE INSTALLED FOR BUILDING SUPPORT SYSTEMS. PUMP CONTROLS, LIGHTING, 208/120 VAC POWER, HVAC, ETC.
4. MOTOR CONTROL CENTER WILL BE REPLACED WITH A MODERN DAY EQUIVALENT.
5. CONTROL SYSTEM INSTRUMENTATION (PRESSURE TRANSDUCER, FLOAT MAST)

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXX THRU 0023

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TOLE
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

UPPER MILL CREEK PS ELECTRICAL PLAN

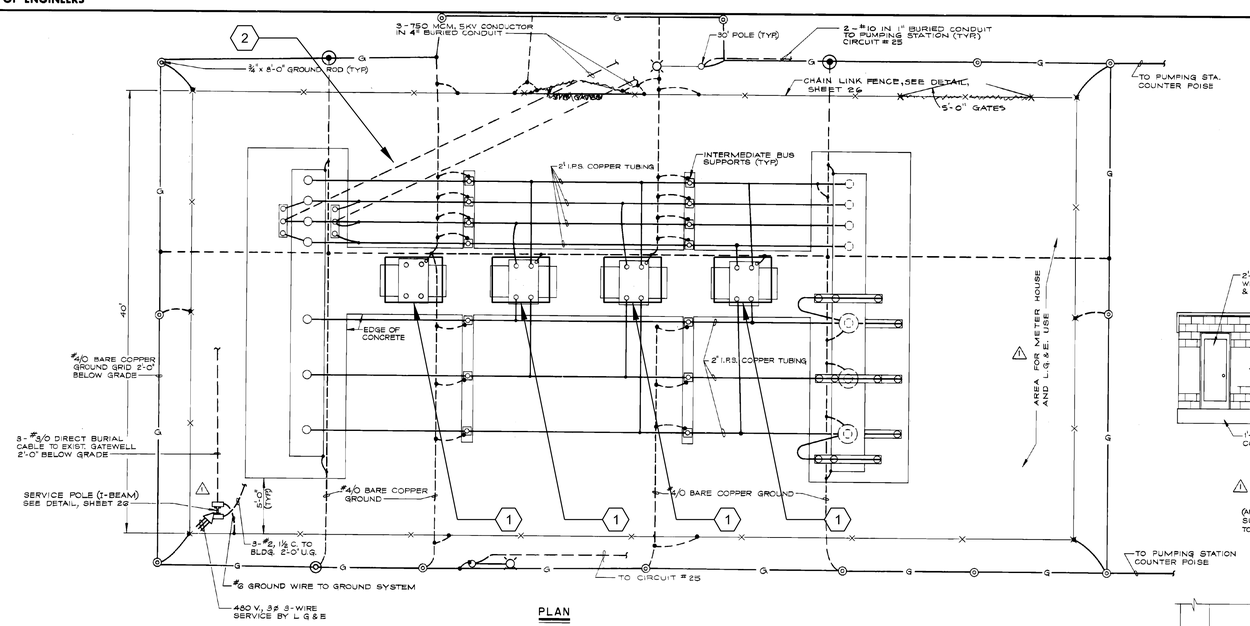
SHEET ID
UMC-E-101

A1 UPPER MILL CREEK PS ELECTRICAL PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL

CORPS OF ENGINEERS

U. S. ARMY

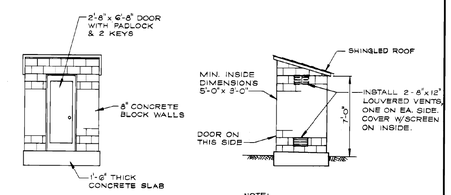


PLAN

PLAN VIEW

NOTES:

1. THE 4th TRANSFORMER LOCATED AT THE LEFT END OF THE SUBSTATION IS A SPARE. IT SHALL BE INSTALLED IN THE SAME MANNER AS THE OTHER TRANSFORMERS EXCEPT THAT NO CONNECTIONS ARE TO BE MADE TO THE PRIMARY AND SECONDARY BUSSES.
2. IN ADDITION TO THE LENGTH OF SUBSTATION GROUND GRID SHOWN, THE CONTRACTOR SHALL FURNISH AND INSTALL APPROX. 800' OF #4/0 COPPER CABLE ARRANGED SYMETRICALLY WITH THE CABLE SHOWN TO FORM A UNIFORM GROUND GRID BENEATH THE SUBSTATION. THE CONTRACTOR SHALL FURNISH A LAYOUT OF HIS GROUNDING GRID FOR APPROVAL.

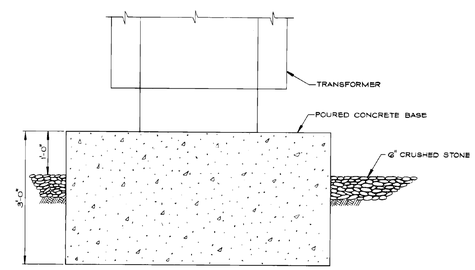


NOTE:
MOUNT 5'-0" WIDE x 3'-0" HIGH x ½" THICK PLYWOOD BOARD 3'-4" ABOVE FLOOR ON BACK WALL.

METER HOUSE

NO SCALE

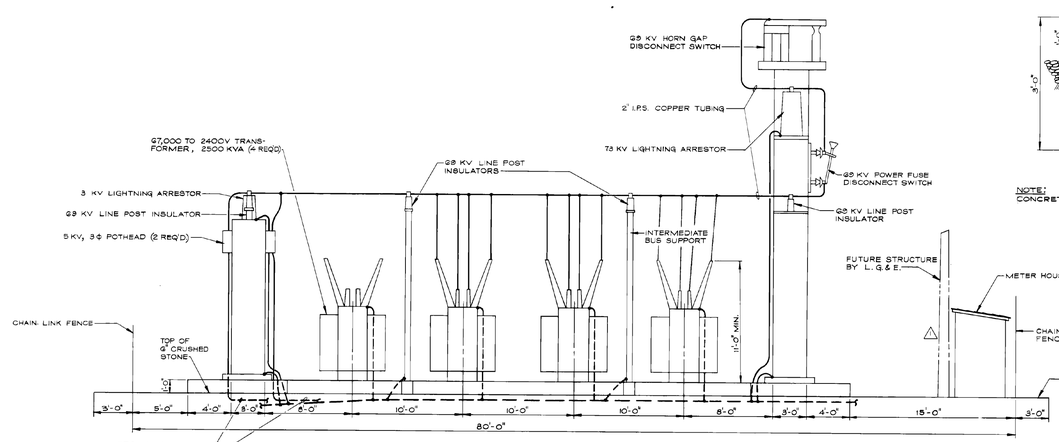
(APPROX. LOCATION IS INSIDE SUBSTATION. EXACT LOCATION TO BE COORDINATED WITH L.G.&E.)



NOTE:
CONCRETE SHALL EXTEND A MINIMUM OF 12" BEYOND BASE OF TRANSFORMER

FOUNDATION DETAIL UNDER TRANSFORMER

NO SCALE



ELEVATION VIEW

ELEVATION

NOTE:
FOUNDATION & ALL SUPPORT STRUCTURES SHALL BE DESIGNED BY CONTRACTOR AND DESIGN CALCULATIONS SUBMITTED FOR APPROVAL. DESIGN SHALL BE IN ACCORDANCE WITH NEMA SG-2. ALL DIMENSIONS ARE MINIMUM REQUIRED.

REVISED BY LOCAL DIST. CORPS OF ENGRS. TO "AS BUILT" CONDITIONS.

REVISION	DATE	DESCRIPTION	BY	APP'D.
1	JULY 82	ENLARGED SUBSTATION AREA & REV'D. METER HOUSE (CONT. MOD)	WAF	JRC

U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

OHIO RIVER
SOUTHWESTERN JEFFERSON COUNTY, KY.
LOCAL FLOOD PROTECTION
UPPER MILL CREEK PUMPING STATION
ELECTRICAL SUBSTATION

DESIGNED: SFB
DRAWN: GBH-DSK TRACED: D.S.K.
CHECKED: W.A.F.
SUBMITTED: [signature]
SCALE: 1/4" = 1'-0", UNLESS SHOWN
DATE: APRIL 1981
DRAWING NUMBER 616-12.9/28

RECORD DRAWING-"AS BUILT"

199

GENERAL SHEET NOTES

1. SUBSTATION EQUIPMENT TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. TOTAL OF 10000 KVA TRANSFORMERS
2. SECONDARY WIRING

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TICE
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

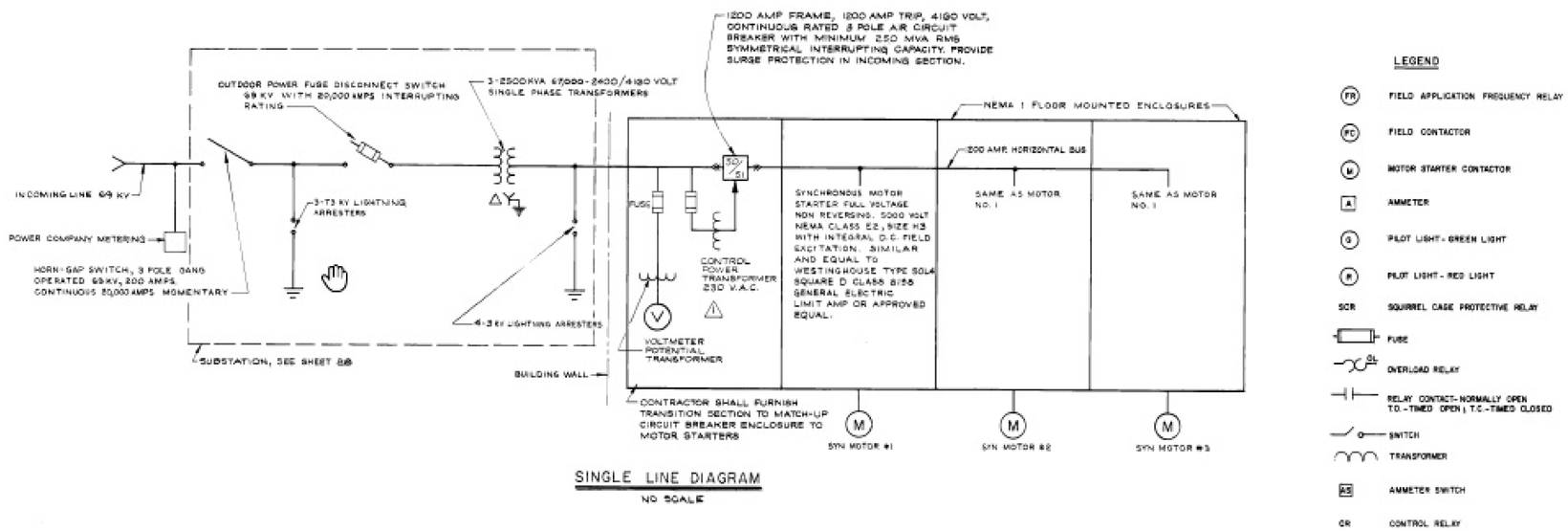
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

UPPER MILL CREEK PS SUBSTATION PLAN

SHEET ID
UMC-E-102

A1 UPPER MILL CREEK PS - SUBSTATION PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL



SINGLE LINE DIAGRAM

NO SCALE

LEGEND

FR	FIELD APPLICATION FREQUENCY RELAY
FC	FIELD CONTACTOR
M	MOTOR STARTER CONTACTOR
A	AMMETER
G	PILOT LIGHT - GREEN LIGHT
R	PILOT LIGHT - RED LIGHT
SCR	SQUIRREL CAGE PROTECTIVE RELAY
	FUSE
OL	OVERLOAD RELAY
	RELAY CONTACT - NORMALLY OPEN T.D.-TIMED OPEN ; T.C.-TIMED CLOSED
	SWITCH
	TRANSFORMER
AS	AMMETER SWITCH
CR	CONTROL RELAY

GENERAL SHEET NOTES

1. SEE UPPER MILL CREEK E-101 FOR EXISTING STATION FLOOR PLAN. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. EXISTING ONE LINE DIAGRAM HAS BEEN PROVIDED AS A REFERENCE. SEE FEASIBILITY REPORT APPENDIX D-ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON	ISSUE DATE: AUGUST 2019
DRAWN BY: R. MORRISON	SOLICITATION NO.: XXXXXX-XX-X-XXXX
CHECKED BY: J. TIMBAS	CONTRACT NO.: XXXXXXXXXXXXXX
SUBMITTED BY: J. TOE	THRU 0023
SIZE: ANSI D	

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

UPPER MILL CREEK PUMP STATION
EXISTING ONE LINE DIAGRAM

SHEET ID

UMC-E-601

A1 UPPER MILL CREEK PUMP STATION EXISTING ONE LINE DIAGRAM

SCALE: NOT TO SCALE

CONCEPT SUBMITTAL

A1 RIVERPORT PS SITE PLAN
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET. DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

RIVERPORT PS SITE PLAN

SHEET ID
RP-C-101

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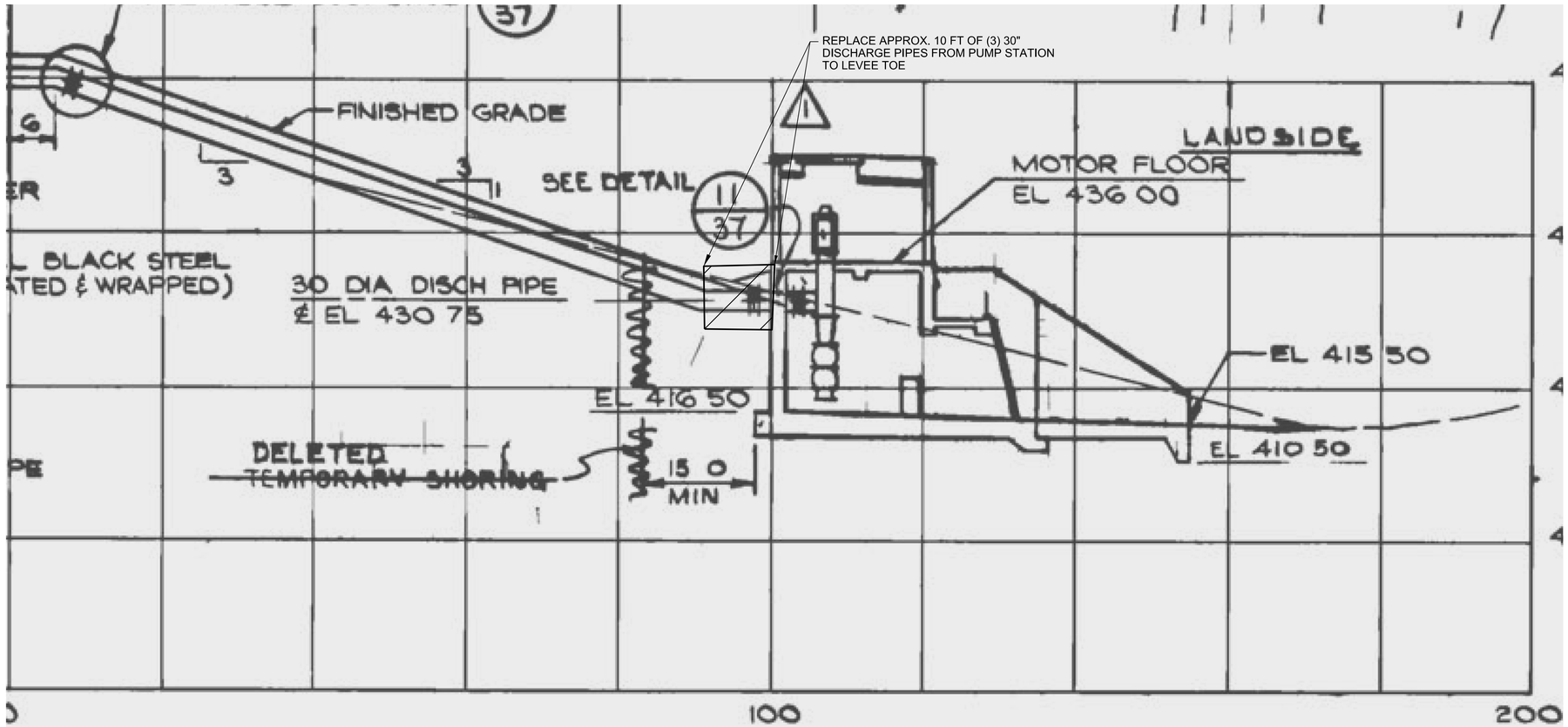

A1 DETAIL SHEET- RIVERPORT PUMP STATION
1"=30'

N
0 30' 60'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. COE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

RIVERPORT PUMP STATION
DETAIL

SHEET ID
RP-C-201

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CONCEPT SUBMITTAL

A1 RIVERPORT PS RIGHT OF WAY PLAN
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

RIVERPORT PS
RIGHT OF WAY

SHEET ID
RP-R-101

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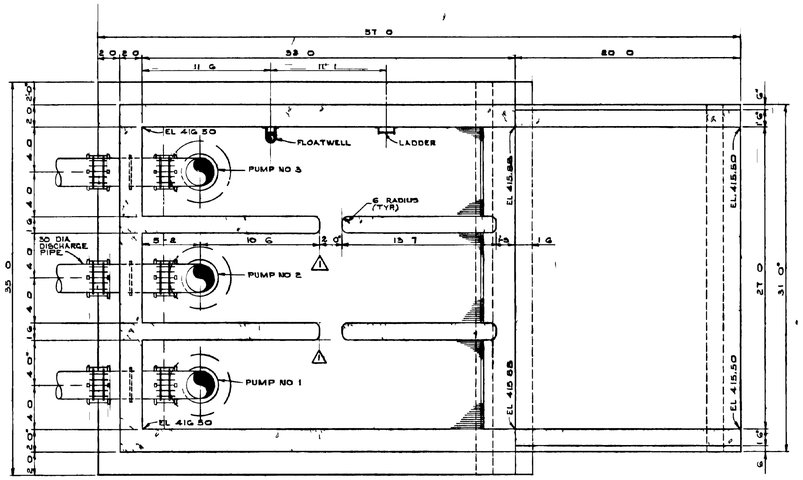
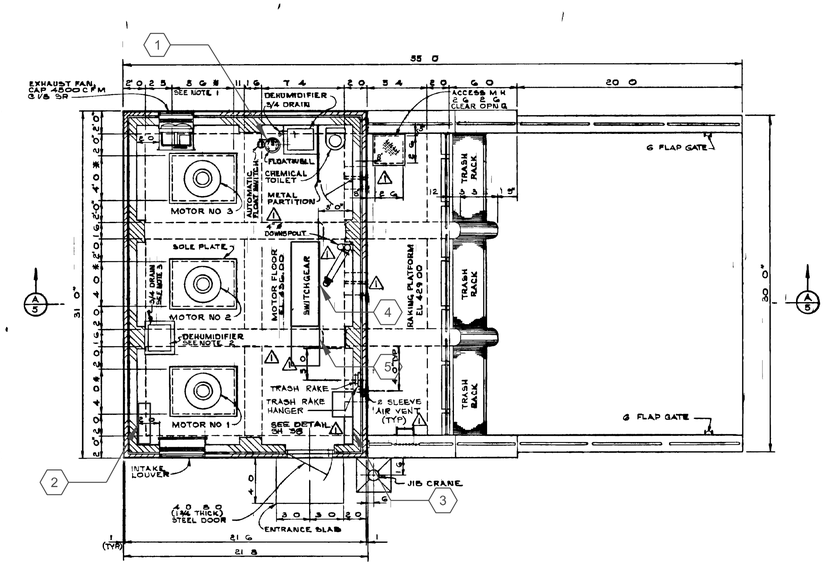
CONCEPT SUBMITTAL

CORPS OF ENGINEERS

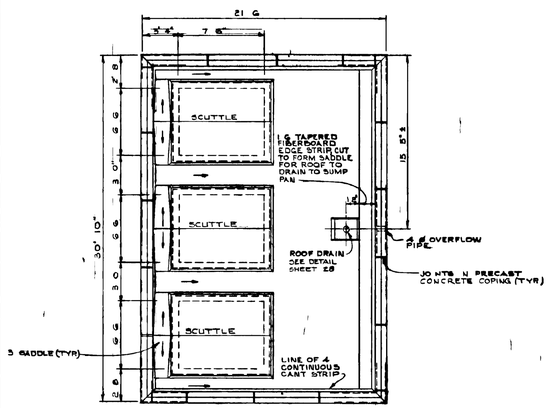
U S ARMY



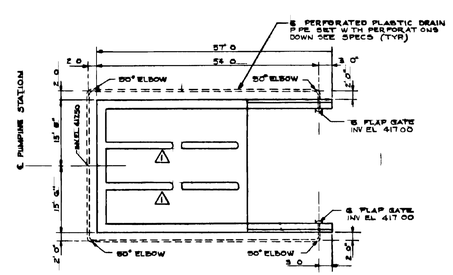
SUMP PLAN



MOTOR FLOOR PLAN



ROOF PLAN



PLAN OF GRANULAR BACKFILL DRAINAGE SYSTEM

SCALE 1/4" = 1'-0"

NOTES

1. DIMENSIONS OF OPENINGS THROUGH FLOOR SLAB PRECEDED BY AN ASTERISK (*) ARE APPROXIMATE. ACTUAL DIMENSIONS TO BE DETERMINED BY PUMP MANUFACTURER.

2. REFRIGERATION TYPE DEHUMIDIFIER WITH AUTOMATIC NO-ICING MINIMUM CAPACITY OF 4 GALLON OF WATER/DAY AT 60% RELATIVE HUMIDITY AT 80 F DBT WITH PROVIDE HEATING CABLE ON DRAIN LINE. CAPACITY EACH UNIT VIFIGRA FOR 2 LOCATIONS (MOUNT 2'-0" MIN ABOVE FLOOR)

3. DRAIN THROUGH FLOOR, 3/4 DIA PIPE 2" DIA HEXONE SHEILD.

4. PILASTERS SHALL BE LOCATED AS SHOWN ON ROOF FRAMING PLAN SHEET E9

REVISION	DATE	DESCRIPTION	BY	APPD
1	4 MAY 79	WALLS DOWNSPOUT GUARDRAIL & AIR VENT REV (AMD'T NO 1)		

U S ARMY ENGINEER DISTRICT LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE KENTUCKY

DESIGNED: JAL
DRAWN: DLC
TRACED:
CHECKED:
SUBMITTED:
SCALE: 1/4" = 1'-0"

OHIO RIVER
SOUTHWESTERN JEFFERSON COUNTY KY
LOCAL FLOOD PROTECTION
RIVERPORT & LOWER MILL CREEK PUMPING STATIONS
RIVERPORT
PLANS

DATE APRIL 1979

DRAWING NUMBER
616-12 6/4

RECORD DRAWING 'AS BUILT

GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. REPLACEMENT CONTROL SYSTEM INSTRUMENTATION (PRESSURE TRANSDUCER, FLOAT MAST)
2. PUMP CONTROLS WILL BE UPDATED AND INTEGRATED INTO MSD SCADA SYSTEM
3. A 112.5 KVA TRANSFORMER WILL BE INSTALLED FOR BUILDING SUPPORT SYSTEMS. PUMP CONTROLS, LIGHTING, 208/120 VAC POWER, HVAC, ETC.
4. MOTOR CONTROL CENTER WILL BE REPLACED WITH A MODERN DAY EQUIVALENT
5. POWER FACTOR CORRECTION FOR PUMP MOTORS

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXX
THRU 0023

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY:
SIZE: ANSI D

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

RIVERPORT PS ELECTRICAL PLAN

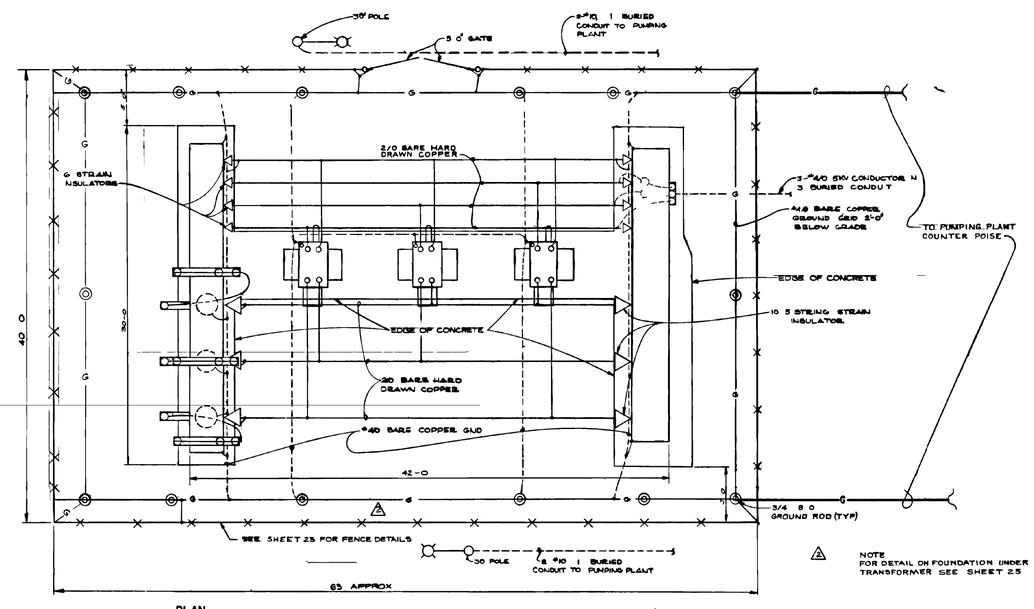
SHEET ID
RP-E-101

A1 RIVERPORT PS ELECTRICAL PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL

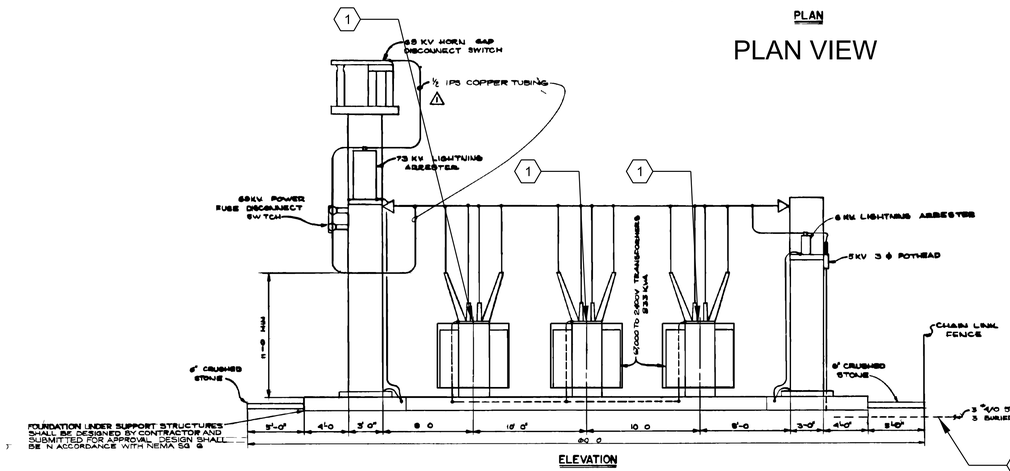
CORPS OF ENGINEERS

U S ARMY



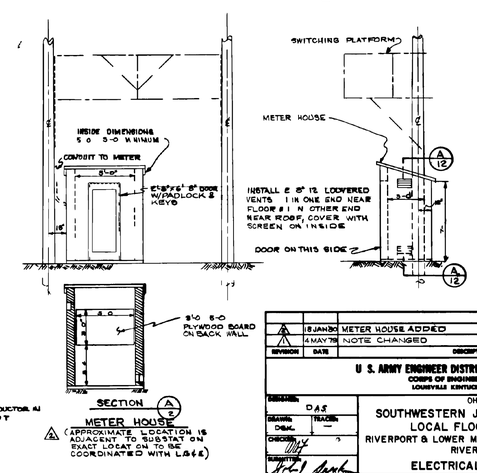
PLAN

PLAN VIEW



ELEVATION

ELEVATION VIEW



SECTION A/2

METER HOUSE

(APPROXIMATE LOCATION IS ADJACENT TO SUBSTAT ON EXACT LOCAT ON TO BE COORDINATED WITH L&E)

REVISION	DATE	DESCRIPTION	BY	APP'D
2	18JAN80	METER HOUSE ADDED (CONT MOD.)		
1	4MAY79	NOTE CHANGED (AMDT NO 1)	DAS	

U. S. ARMY ENGINEER DISTRICT LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE KENTUCKY

DESIGNED: DAS
DRAWN: DAS
TRACED: —
CHECKED:
SUBMITTED:
SCALE: 1/4" = 1'-0"

OHIO RIVER
SOUTHWESTERN JEFFERSON COUNTY KY
LOCAL FLOOD PROTECTION
RIVERPORT & LOWER MILL CREEK PUMPING STATIONS
RIVERPORT SITE
ELECTRICAL SUBSTATION

DATE: PRIL 1976

DRAWING NUMBER
616-12 6/12

RECORD DRAWING- AS BUILT

GENERAL SHEET NOTES

1. SUBSTATION EQUIPMENT TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. TOTAL OF 2500 KVA PAD-MOUNT TRANSFORMERS
2. SECONDARY WIRING

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY:
J. TYDE
SIZE: ANSI D

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXX
THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

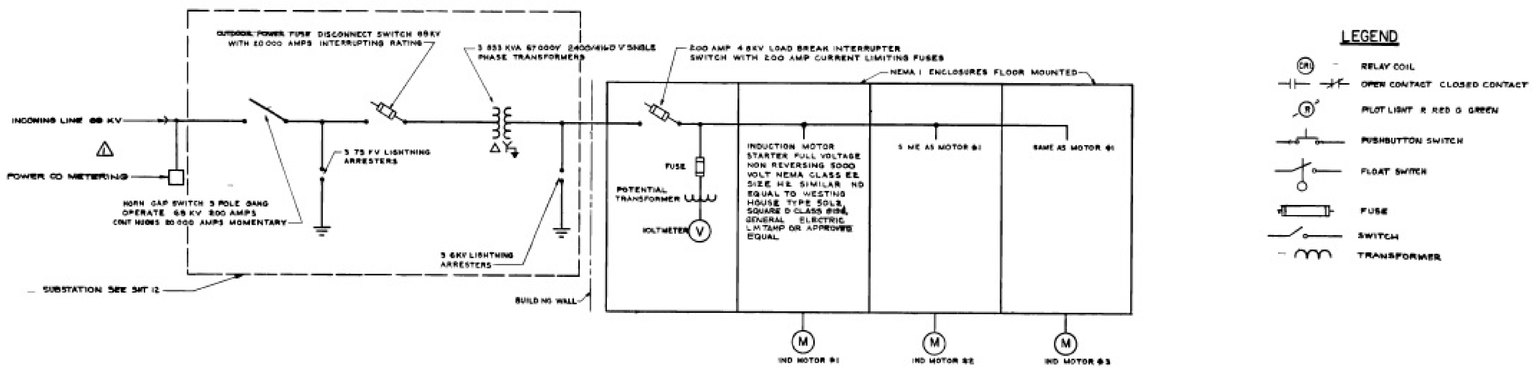
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

RIVERPORT PS SUBSTATION PLAN

SHEET ID
RP-E-102

A1 RIVERPORT PS - SUBSTATION PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL



LEGEND

- RELAY COIL
- OPEN CONTACT CLOSED CONTACT
- PILOT LIGHT R RED G GREEN
- PUSHBUTTON SWITCH
- FLOAT SWITCH
- FUSE
- SWITCH
- TRANSFORMER

GENERAL SHEET NOTES

1. SEE RIVERPORT E-101 FOR EXISTING STATION FLOOR PLAN. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. EXISTING ONE LINE DIAGRAM HAS BEEN PROVIDED AS A REFERENCE. SEE FEASIBILITY REPORT APPENDIX D-ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

A1 RIVERPORT PUMP STATION EXISTING ONE LINE DIAGRAM

SCALE: NOT TO SCALE

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

DESIGNED BY: R. MORRISON	ISSUE DATE: AUGUST 2019
DRAWN BY: R. MORRISON	SOLICITATION NO.: XXXXXX-XX-X-XXXX
CHECKED BY: J. TIMBAS	CONTRACT NO.: XXXXXXXXXXXXXX
SUBMITTED BY: J. TOE	THRU 0023
SIZE: ANSI D	

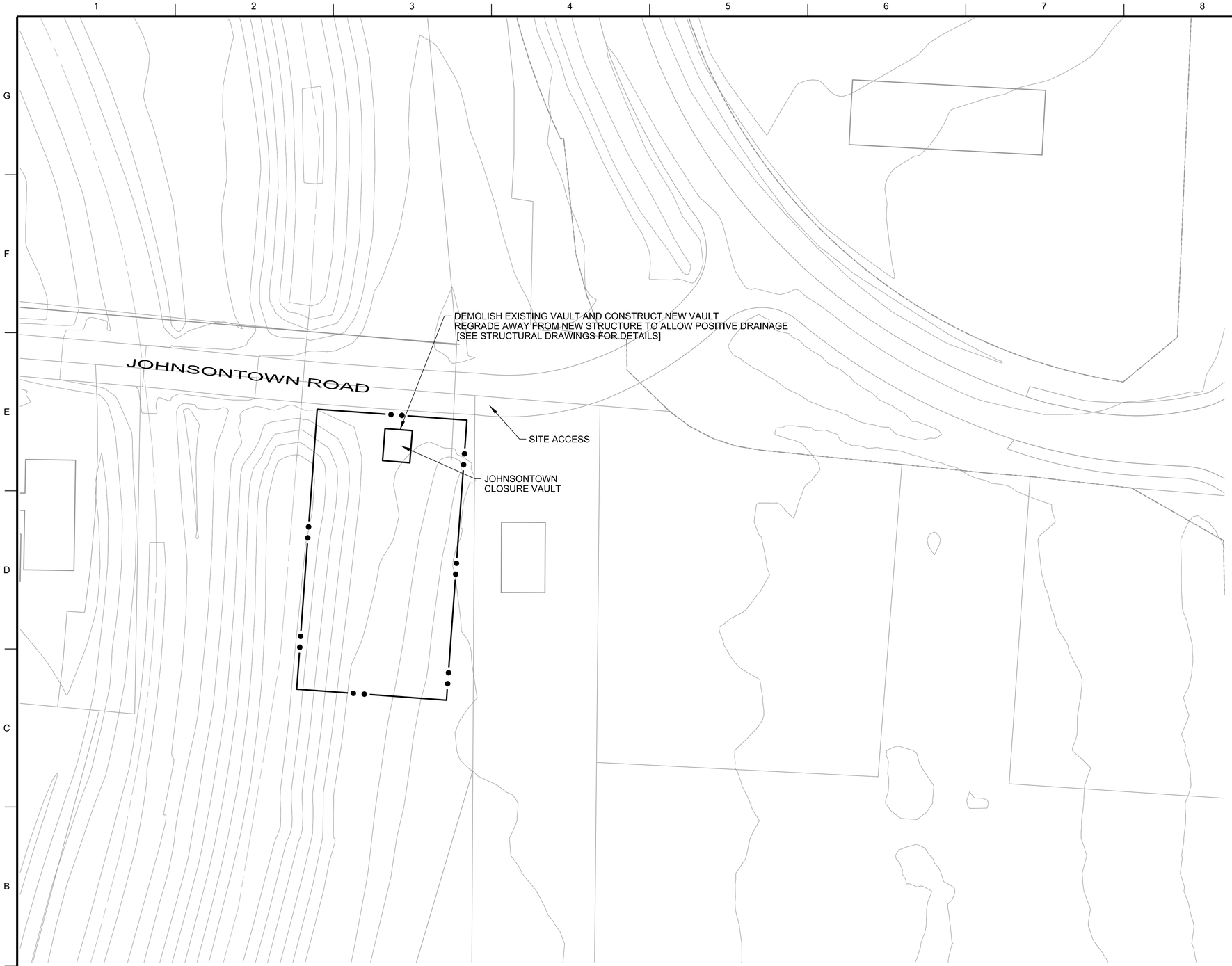
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

RIVERPORT PS EXISTING POWER ONE LINE

SHEET ID

RP-E-601

CONCEPT SUBMITTAL



A1 JOHNSONTOWN CLOSURE VAULT SITE PLAN
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

JOHNSONTOWN CLOSURE VAULT
SITE PLAN

SHEET ID
JT-C-101

CONCEPT SUBMITTAL

...\145626\05\530\CAD_BIM_Sheets\JT-C-101
1:14:23 PM 8/27/2019 LRL_pdf.pltcfg LRL_Screen.dscript

A1 JOHNSONTOWN CLOSURE VAULT RIGHT OF WAY PLAN
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2: 145626

JOHNSONTOWN CLOSURE VAULT
RIGHT OF WAY

SHEET ID
JT-R-101

...\145626\05\530\CAD_BIM_Sheets\JT-R-101
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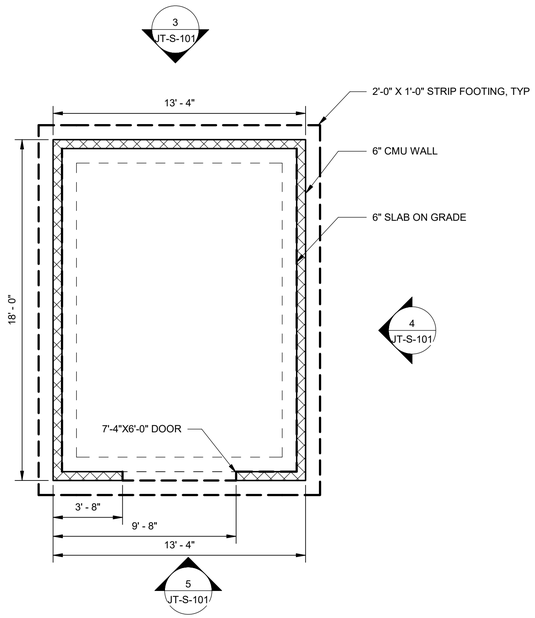
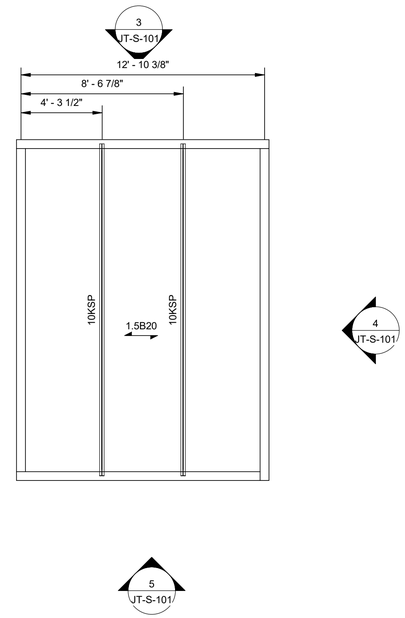
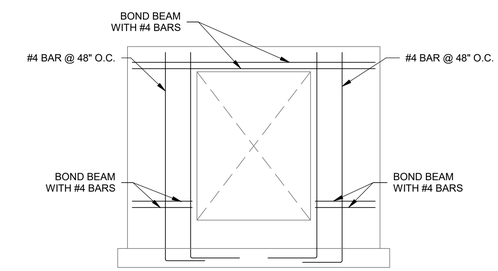
CONCEPT SUBMITTAL



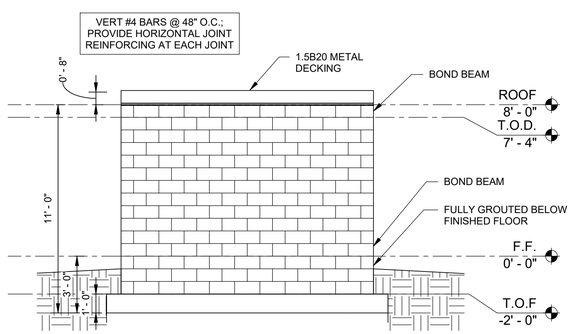
1 FOUNDATION PLAN
1/4" = 1'-0"



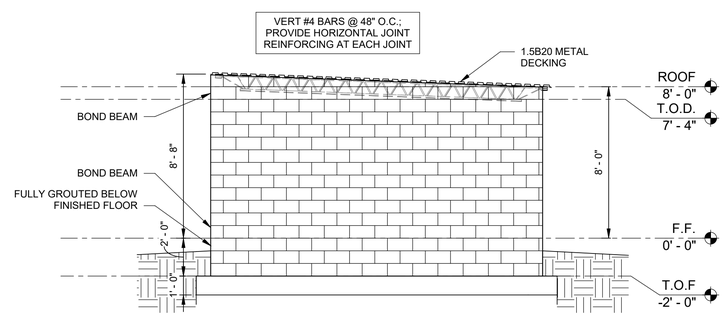
2 ROOF FRAMING PLAN
1/4" = 1'-0"



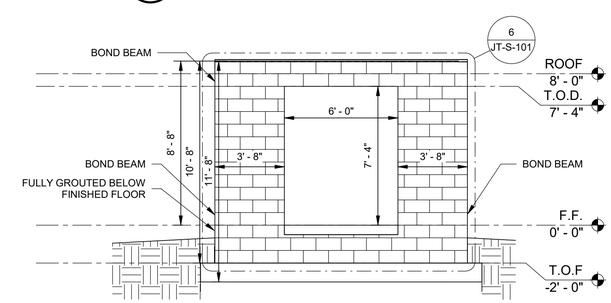
6 FRONT WALL REINFORCING
6 JT-S-101 — 1/4" = 1'-0"



3 REAR ELEVATION
3 JT-S-101 — 1/4" = 1'-0"



4 SIDE ELEVATION
4 JT-S-101 — 1/4" = 1'-0"



5 FRONT ELEVATION
5 JT-S-101 — 1/4" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: B. EVANS
DRAWN BY: C. KERBY
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

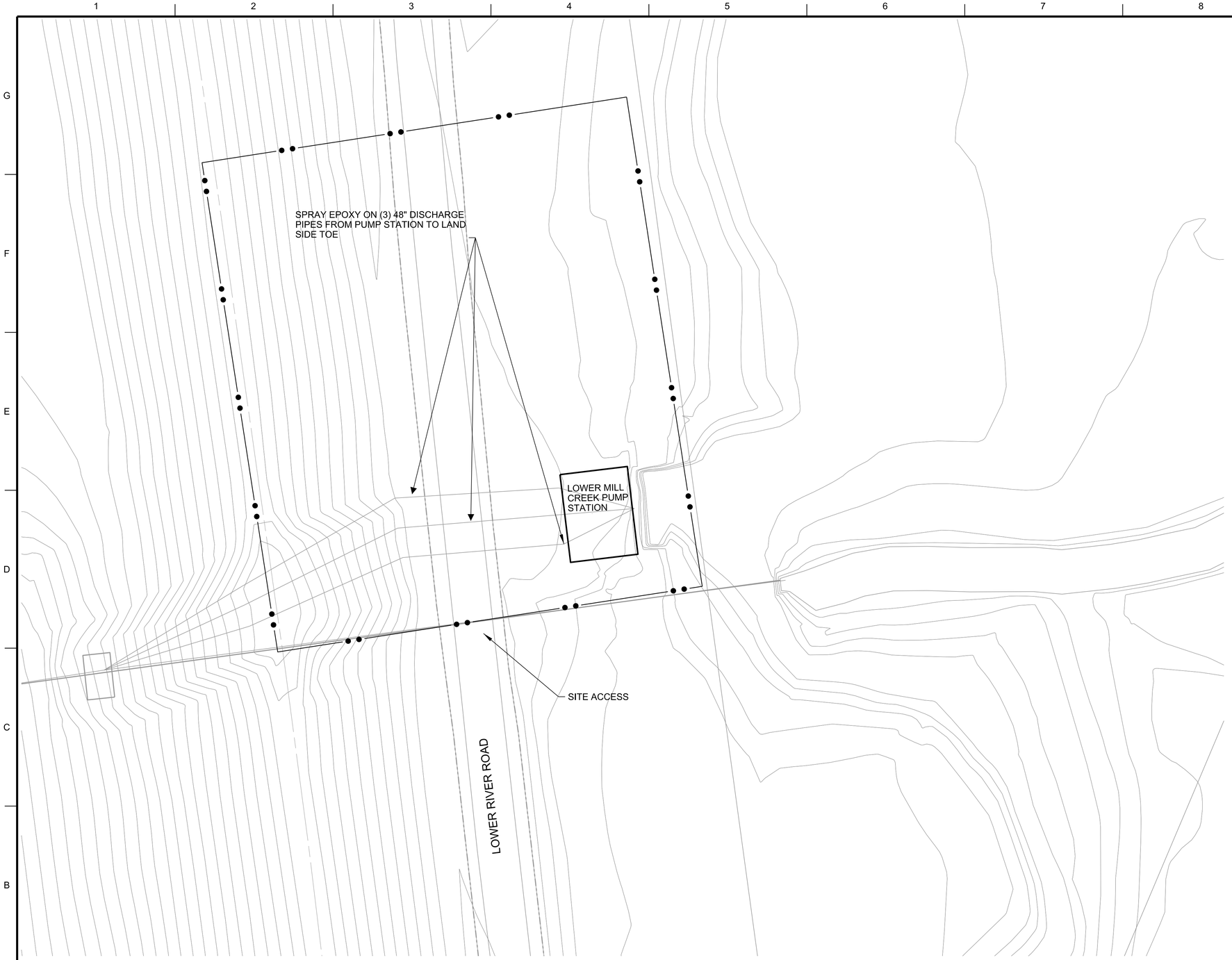
US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR MARTIN LUTHER KING JR PLACE

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

JOHNSONTOWN RD CLOSURE VAULT PLANS

SHEET ID
JT-S-101

CONCEPT SUBMITTAL



A1 RIGHT OF WAY PLAN 20 OF 22
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET. DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOYE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

LOWER MILL CREEK PS
SITE PLAN

SHEET ID
LC-C-101

...\145626\05\530\CAD_BIM_Sheets\LMC-C-101
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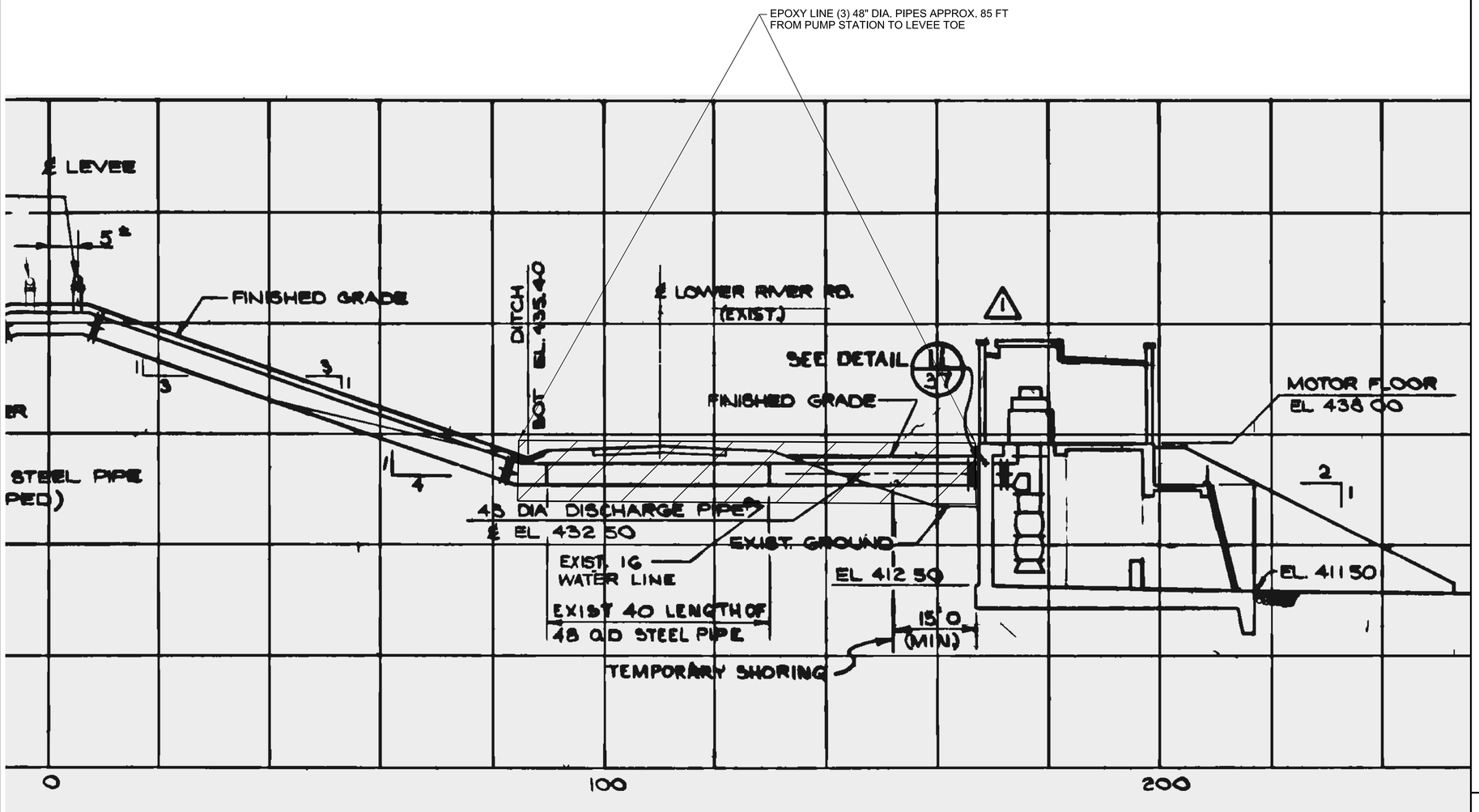
CONCEPT SUBMITTAL



A1 DETAIL SHEET- LOWER MILL CREEK PUMP STATION
1"=30'

N

0 30' 60'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. LIZE
SIZE: ANSI D
FSC:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

LOWER MILL CREEK DETAIL

SHEET ID
LC-C-201

CONCEPT SUBMITTAL

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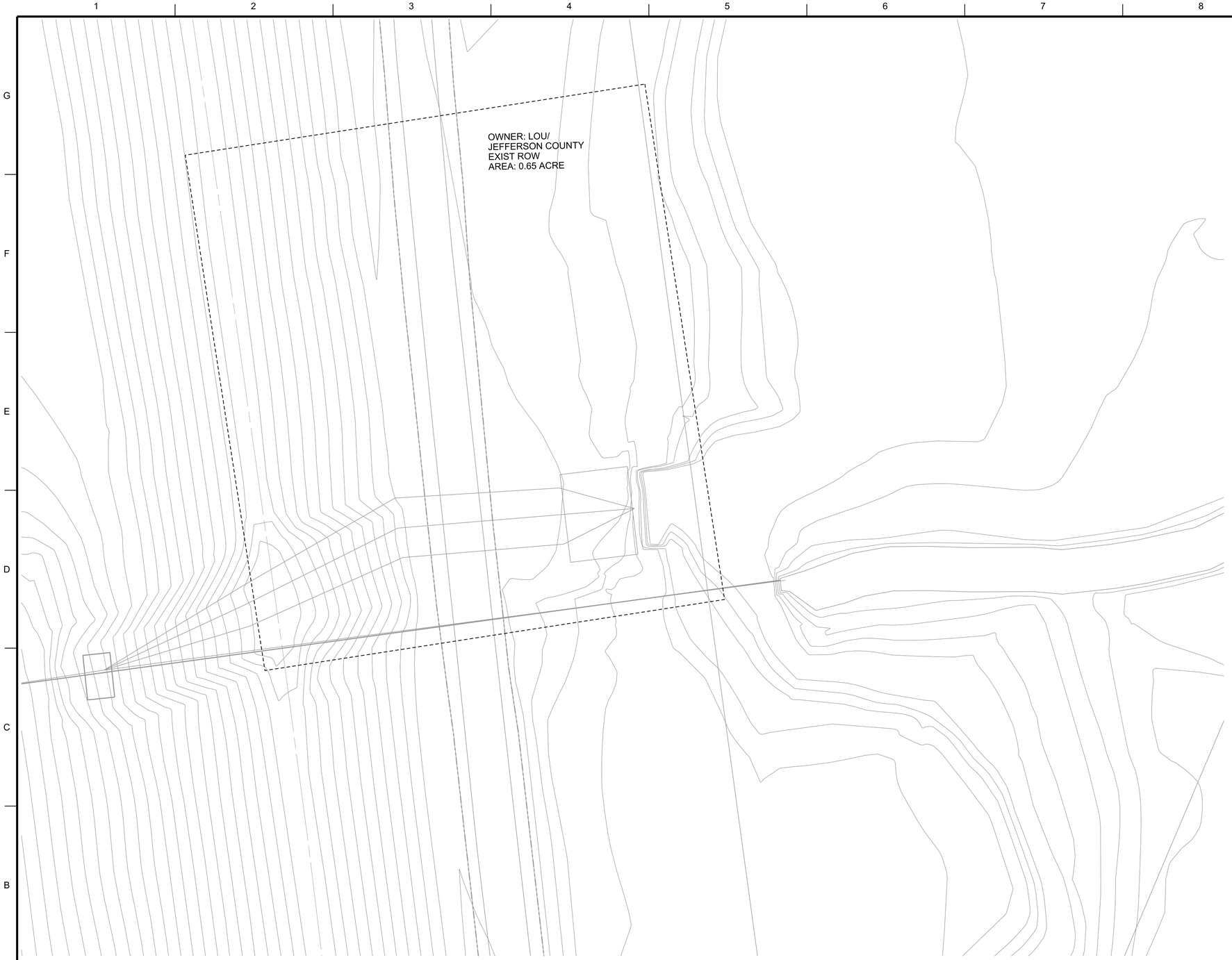


A1 LOWER MILL CREEK PS RIGHT OF WAY PLAN
1"=50'

0 50' 100'

N

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TYDE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

LOWER MILL CREEK PS
RIGHT OF WAY

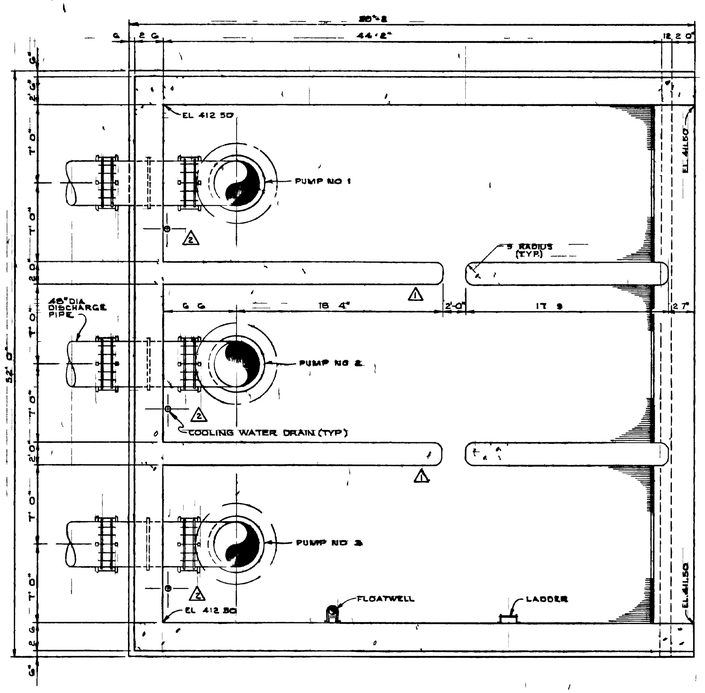
SHEET ID
LC-R-101

...\145626\05\530\CAD_BIM_Sheets\LMC-R-101
1:15:08 PM 8/27/2019 LRL_pdf.pltcfg LRL_Screen.dscript

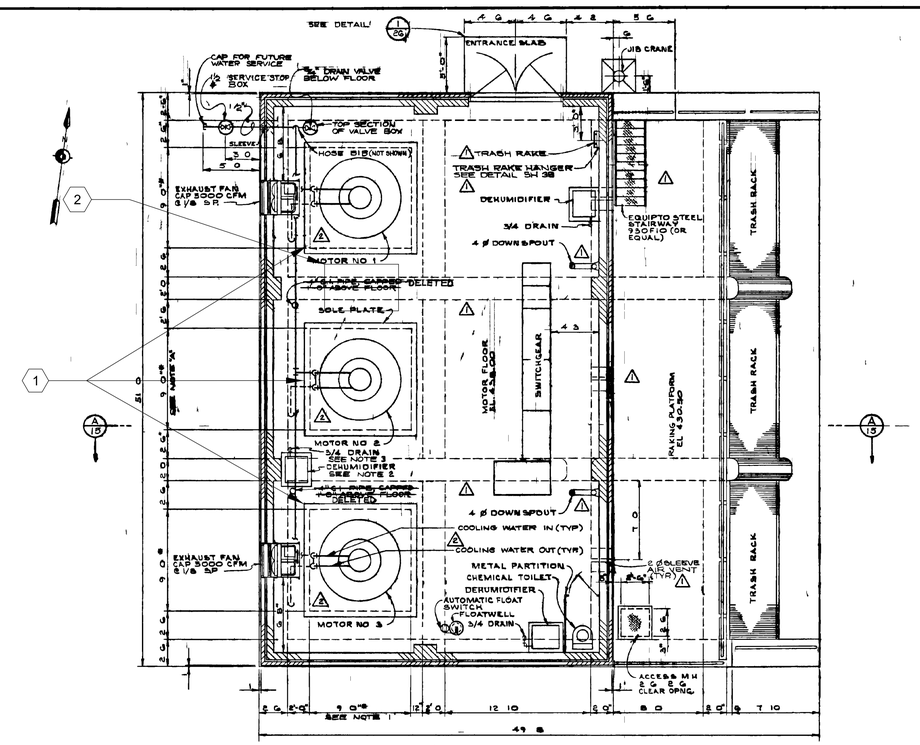
CONCEPT SUBMITTAL

CORPS OF ENGINEERS

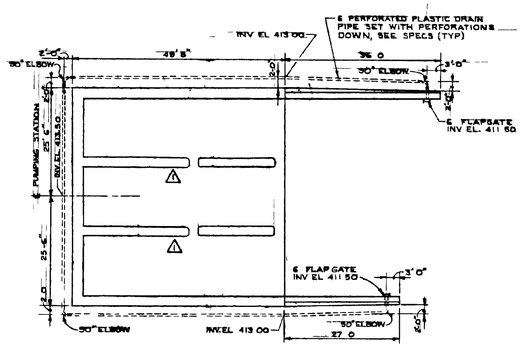
U S ARMY



SUMP PLAN

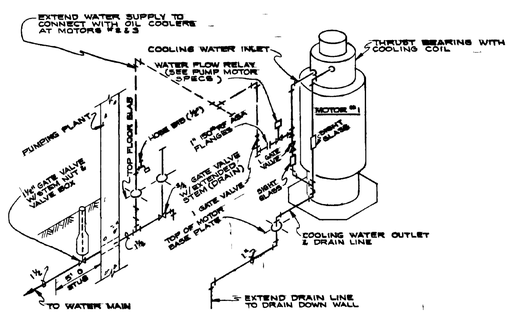


MOTOR FLOOR PLAN



PLAN OF GRANULAR BACKFILL DRAINAGE SYSTEM

SCALE 3/32" = 1'-0"



COOLING WATER SCHEMATIC

SCALE NONE

NOTE:
COOLING WATER PIPING WATER PIPING SCHEMATIC SHOWN FOR PUMP MOTOR #1. CONNECTIONS ARE SIMILAR FOR PUMP MOTORS #2 & #3. SEE MOTOR MANUFACTURER'S DWGS FOR PIPING SUPPLIED WITH UNITS WHERE COOLING WATER PIPES PASS THRU FLOOR SLAB OR MOTOR BASE PLATE THE ANNULUS SPACE SHALL BE CAULKED PER SPECS

NOTES:
1. DIMENSIONS OF OPENINGS THROUGH FLOOR SLAB INDICATED BY AN ASTERISK (*) ARE APPROXIMATE. ACTUAL DIMENSIONS TO BE DETERMINED BY PUMP MANUFACTURER.
2. REFRIGERATION TYPE DEHUMIDIFIER WITH AUTOMATIC DE ICING. MINIMUM CAPACITY OF 5 GALLON OF WATER/DAY AT 60% RELATIVE HUMIDITY AT 80 F DRY BULB. PROVIDE HEATING CABLE ON DRAIN LINE. CAPACITY EACH UNIT TYPICAL FOR 2 LOCATIONS (MOUNT 2.0 ABOVE FLOOR)
3. DRAIN THROUGH FLOOR 3/4 DIA PIPE & DIA SLEEVE SEALED.
4. PILASTERS SHALL BE LOCATED AS SHOWN ON ROOF FRAMING PLAN SHEET 2B

REVISION	DATE	DESCRIPTION	BY	APPD
2	18 JAN 80	ADDED COOLING WATER LINES (CONT MOD.)	WRC	
1	4 MAY 79	WALLS AND MISC REV (AMDT NO.1)	EWD	

U S ARMY ENGINEER DISTRICT LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

DESIGNED: JAL
DRAWN: DLC
TRACED:
CHECKED:
SUBMITTED:

OHIO RIVER BASIN
SOUTHWESTERN JEFFERSON COUNTY KY
LOCAL FLOOD PROTECTION
RIVERPORT & LOWER MILL CREEK PUMPING STATIONS
LOWER MILL CREEK
SUMP & MOTOR FLOOR PLANS

DATE APRIL 1979

SCALE: AS SHOWN.
DRAWING NUMBER
6B-12 6/14

RECORD DRAWING AS BUILT

PUMP DATA				
PUMP #	TYPE	DESIGN FLOW (GPM)	TDH (FT OF WATER)	NOTES
1	COLUMN PUMP	73,500	47.1	REFURBISH PUMP
2	COLUMN PUMP	73,500	47.1	REFURBISH PUMP
3	COLUMN PUMP	73,500	47.1	REFURBISH PUMP

SHEET KEYNOTES

1. REFURBISH ALL PUMPS TO MANUFACTURER'S SPECIFICATIONS. DISCONNECT COLUMNS AT FLEXIBLE COUPLINGS. ABRASIVE BLAST COLUMNS TO WHITE METAL AND COAT WITH C200A. INSTALL NEW FLEXIBLE COUPLINGS.
2. INSTALL NEW GREASE LUBRICATION SYSTEM WITH CENTRALIZED PUMP AND FILL STATION TO FEED ALL PUMPS. SEE LINCOLN INDUSTRIAL SYSTEM AT SHAWNEE.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: K. BURNS
DRAWN BY: K. BURNS
CHECKED BY:
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

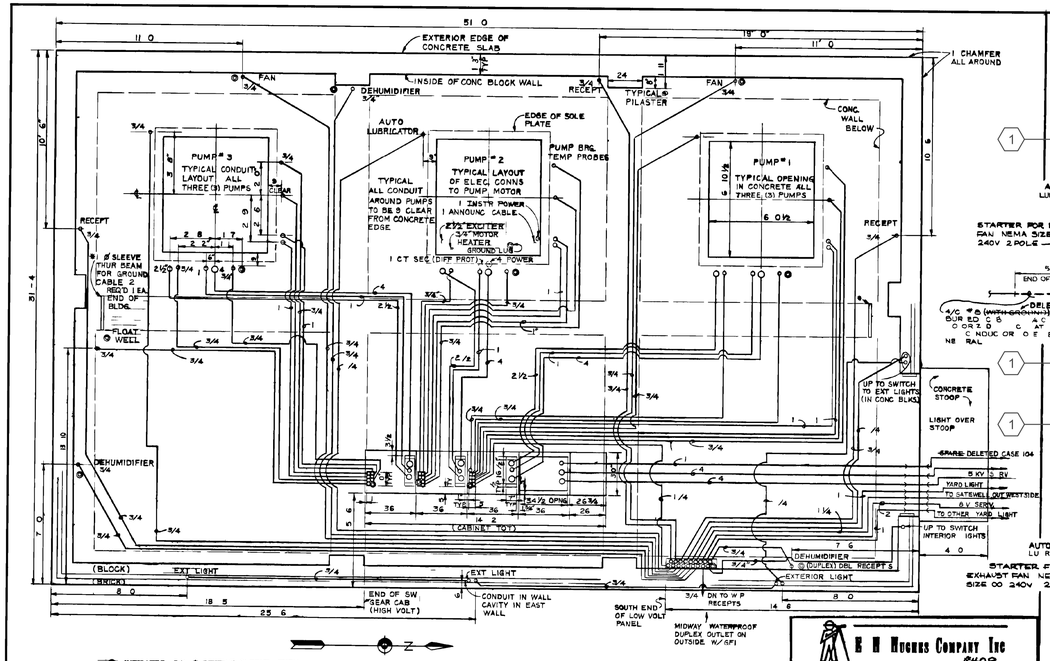
LOWER MILL CREEK PS
MECHANICAL PLANS

SHEET ID
LMC-M-101

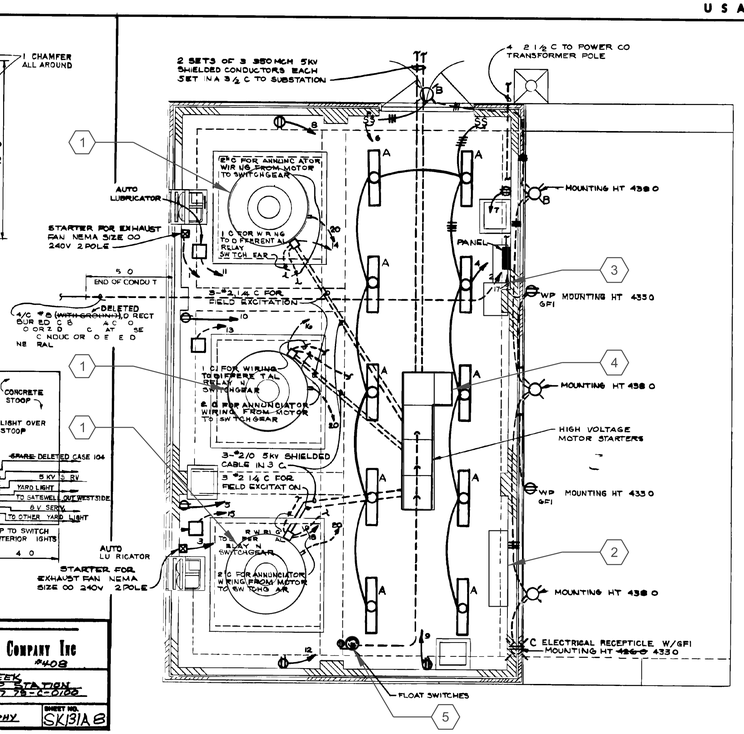
CONCEPT SUBMITTAL

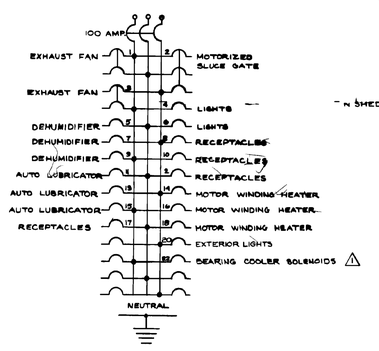
CORPS OF ENGINEERS

U S ARMY

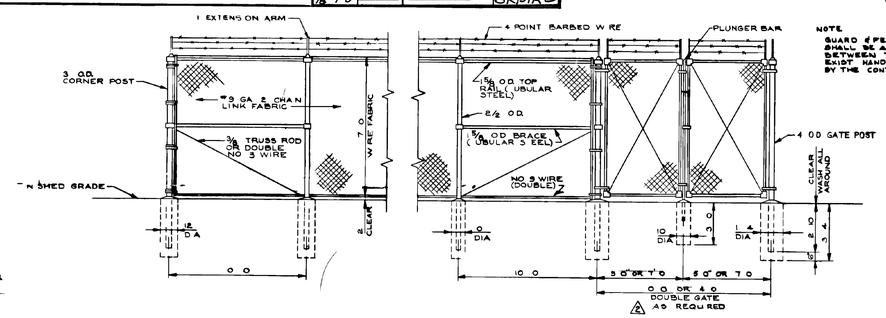


CONDUIT LAYOUT PLAN
SCALE 3/8 1-0



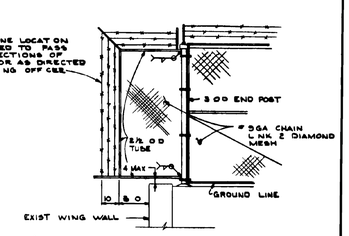


PANEL
100 AMP, 120/208V, 3ϕ, 4W
ALL CIRCUIT BREAKERS SHALL BE 20 AMP UNLESS OTHERWISE INDICATED



SUBSTATION & SECURITY FENCE DETAIL
AT PUMPING STATION

NOTE
GUARD & FENCE LINE LOCATION SHALL BE ADJUSTED TO PASS BETWEEN THE SECTIONS OF EXIST HANDRAIL OR AS DIRECTED BY THE CONTRACTING OFFICER



ELEVATION - FENCE GUARD
NOT TO SCALE

NOTE
FOR LEGEND AND LIGHTING FIXTURE SCHEDULE SEE SH 10

REVISION	DATE	DESCRIPTION	BY	APP'D
2	28 JUN 80	ADDED ELEV & REV DOUB E GATE (CONT MOD)	DMK	
1	18 JAN 80	CONDUIT FOR SWITCH & CIRCUIT ADDED (CONT MOD)	SFB	

U S. ARMY ENGINEER DISTRICT LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE KENTUCKY

OHIO RIVER
SOUTHWESTERN JEFFERSON COUNTY KY
LOCAL FLOOD PROTECTION
RIVERPORT & LOWER MILL CREEK PUMPING STATIONS
LOWER MILL CREEK
ELECTRICAL FLOOR PLAN

DATE APRIL 1979
DRAWING NUMBER 616-12 6/23

RECORD DRAWING AS BUILT

E H HUGHES COMPANY INC #408
LOWER MILL CREEK PUMP STATION
CONTRACT DACW27-78-C-0160
SCALE 3/8 1 0 | DATE 11 JUNE 1980 | DRAWN BY M MURPHY | SHEET NO. SK 13 A 8

GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. 1250 HP PUMP MOTOR LOCATION
2. PUMP CONTROLS WILL BE UPDATED AND INTEGRATED INTO MSD SCADA SYSTEM. A PLC PANEL SHALL BE INSTALLED FOR CONTROL.
3. A 112.5 KVA TRANSFORMER WILL BE INSTALLED FOR BUILDING SUPPORT SYSTEMS. PUMP CONTROLS, LIGHTING, 208/120 VAC POWER, HVAC, ETC.
4. MOTOR CONTROL CENTER WILL BE REPLACED WITH A MODERN DAY EQUIVALENT.
5. REPLACEMENT CONTROLS INSTRUMENTATION (SUBMERSIBLE LEVEL TRANSDUCER/ FLOAT SWITCH MAST)

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON	ISSUE DATE: AUGUST 2019
DRAWN BY: R. MORRISON	SOLICITATION NO.: XXXXXX-XX-X-XXXX
CHECKED BY: J. TIMBAS	CONTRACT NO.: XXXXXXXXXXXXX
SUBMITTED BY: S. TOE	THRU 0023
SIZE: ANSI D	

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

LOWER MILL CREEK PS ELECTRICAL PLAN

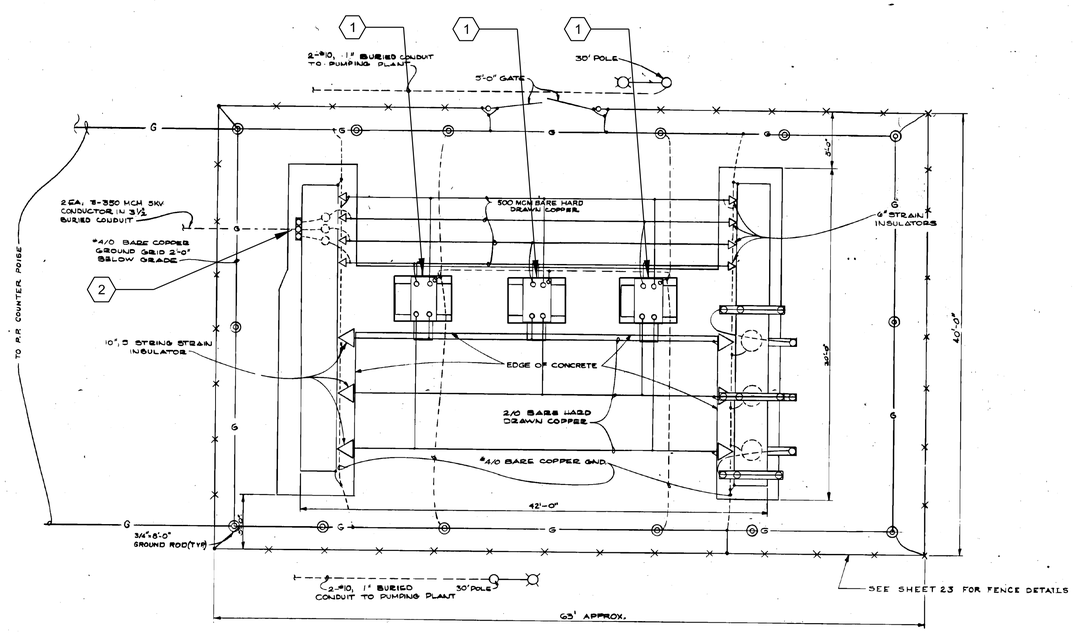
SHEET ID
LMC-E-101

A1 LOWER MILL CREEK PS ELECTRICAL PLAN
SCALE: NOT TO SCALE

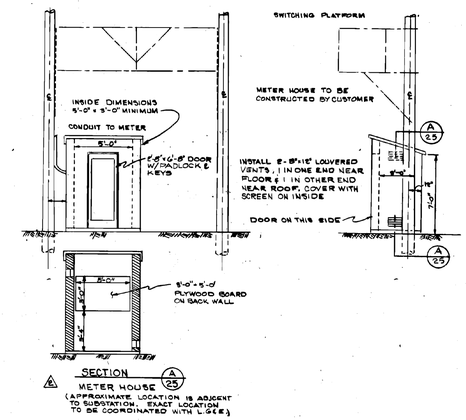
CONCEPT SUBMITTAL

CORPS OF ENGINEERS

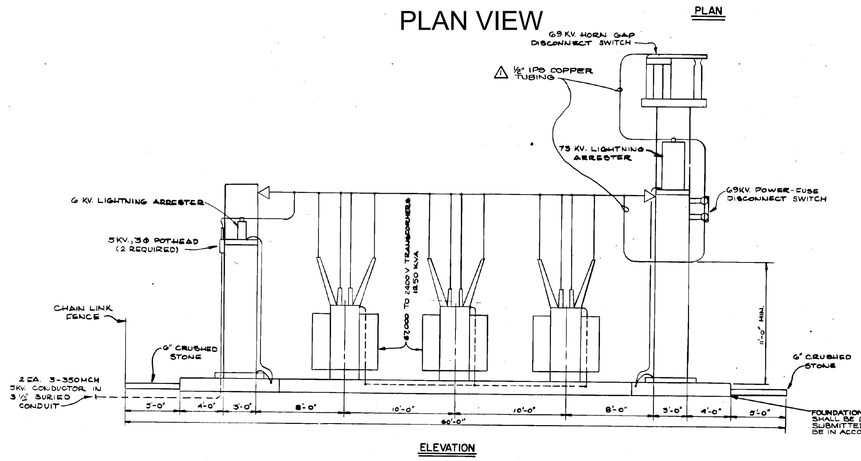
U. S. ARMY



PLAN VIEW

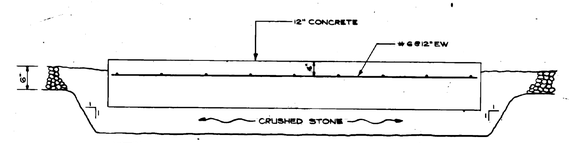


SECTION A/25
METER HOUSE
(APPROXIMATE LOCATION IS ADJACENT TO SUBSTATION. EXACT LOCATION TO BE COORDINATED WITH L.G.&E.)



ELEVATION

ELEVATION VIEW



NOTE:
CONCRETE SHALL EXTEND A MINIMUM OF 12" BEYOND BASE OF TRANSFORMER

FOUNDATION DETAIL UNDER TRANSFORMER

NO SCALE

REVISION	DATE	DESCRIPTION	BY	APP'D
2	18 JAN 80	METER HOUSE ADDED (CONT. MOD)	SYB	
1	4 MAY 79	NOTE CHANGED (AMDT. NO. 1)	DAS	

U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

DESIGNED: S.B.
DRAWN: DRMC
TRACED: —
CHECKED:
SUBMITTED:
SCALE: 1/16"=1'-0"

OHIO RIVER
SOUTHWESTERN JEFFERSON COUNTY, KY.
LOCAL FLOOD PROTECTION
RIVERPORT & LOWER MILL CREEK PUMPING STATIONS
LOWER MILL CREEK
ELECTRICAL SUBSTATION

DATE: APRIL 1979
DRAWING NUMBER
616-12.6/25

RECORD DRAWING-"AS BUILT"

GENERAL SHEET NOTES

1. SUBSTATION EQUIPMENT TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. TOTAL OF 3750 KVA TRANSFORMERS
2. SECONDARY WIRING

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. LEE
SCALE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
APPROVED BY: THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

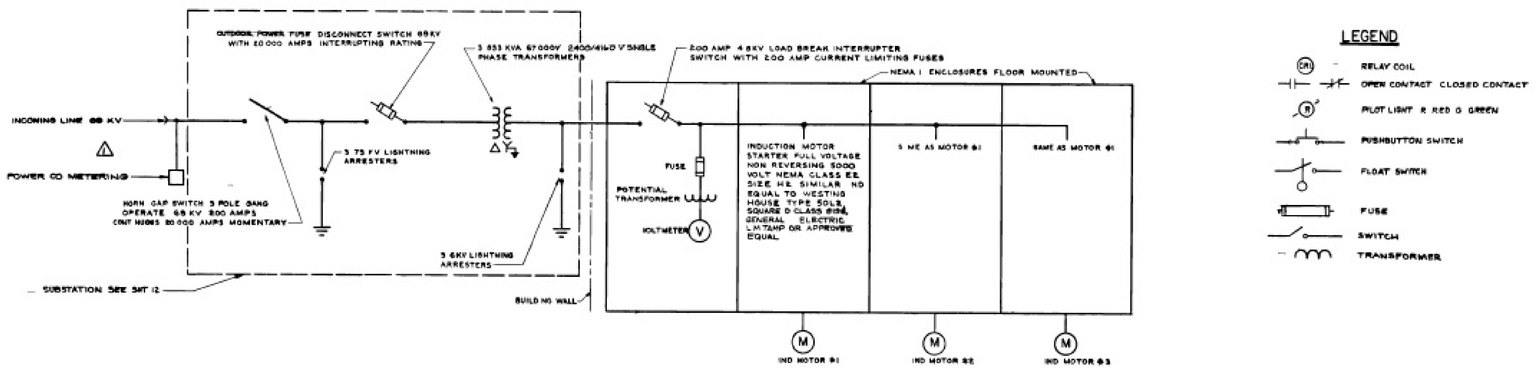
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

LOWER MILL CREEK PS SUBSTATION PLAN

SHEET ID
LMC-E-102

A1 LOWER MILL CREEK PS - SUBSTATION PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL



LEGEND

- RELAY COIL
- OPEN CONTACT CLOSED CONTACT
- PILOT LIGHT R RED G GREEN
- PUSHBUTTON SWITCH
- FLOAT SWITCH
- FUSE
- SWITCH
- TRANSFORMER

GENERAL SHEET NOTES

1. SEE LOWER MILL CREEK E-101 FOR EXISTING STATION FLOOR PLAN. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. EXISTING ONE LINE DIAGRAM HAS BEEN PROVIDED AS A REFERENCE. SEE FEASIBILITY REPORT APPENDIX D-ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

A1 LOWER MILL CREEK PUMP STATION EXISTING ONE LINE DIAGRAM

SCALE: NOT TO SCALE

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TOTE
SIZE: ANSI D

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

LOWER MILL CREEK PS EXISTING POWER ONE LINE

SHEET ID
LMC-E-601

CONCEPT SUBMITTAL

A1 POND CREEK PS SITE PLAN 1 OF 2
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

POND CREEK PS SITE PLAN
1 OF 2

SHEET ID
PC-C-101

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CONCEPT SUBMITTAL

A1 POND CREEK PS SITE PLAN 2 OF 2
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

CONTRACTOR WORK LIMIT

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

POND CREEK PS SITE PLAN
2 OF 2

SHEET ID
PC-C-102

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CONCEPT SUBMITTAL

A1 POND CREEK PS RIGHT OF WAY PLAN 1 OF 2
1"=50'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

- TEMPORARY WORK EASEMENT
- PROPOSED PERMANENT EASEMENT
- EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

POND CREEK PUMP STATION
RIGHT OF WAY 1 OF 2

SHEET ID
PC-R-101

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CONCEPT SUBMITTAL

A1 POND CREEK PS RIGHT OF WAY PLAN 2 OF 2
1"=50'

N

0 50' 100'

GENERAL SHEET NOTES

1. ALL DIMENSIONS ARE IN U.S. SURVEY FEET.
   DIMENSIONS ARE TO THE EDGE OF PAVEMENT.

SHEET KEYNOTES

LEGEND

— — — — — — — —	TEMPORARY WORK EASEMENT
— · — · — · — · —	PROPOSED PERMANENT EASEMENT
- - - - - - - - - - - - - - - -	EXISTING RIGHT OF WAY

US Army Corps of Engineers®

MARK	DESCRIPTION	APPR.	DATE

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PL.
LOUISVILLE, KY 40202

DESIGNED BY: J. WALTERS
DRAWN BY: B. SAYLOR
CHECKED BY: J. SINKHORN
SUBMITTED BY: J. TOE
SIZE:
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

POND CREEK PUMP STATION
RIGHT OF WAY 2 OF 2

SHEET ID
PC-R-102

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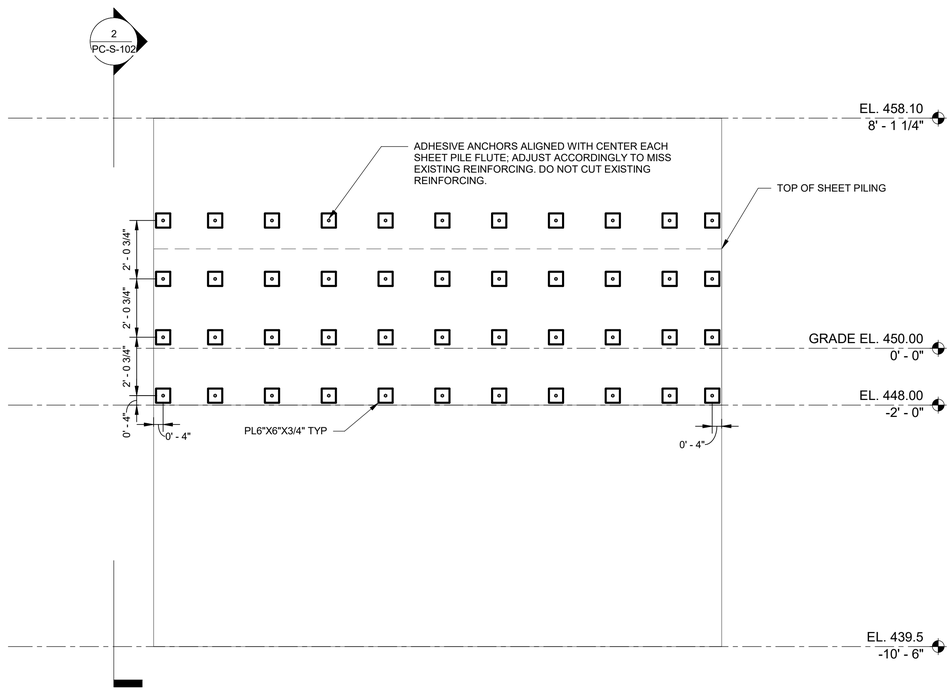
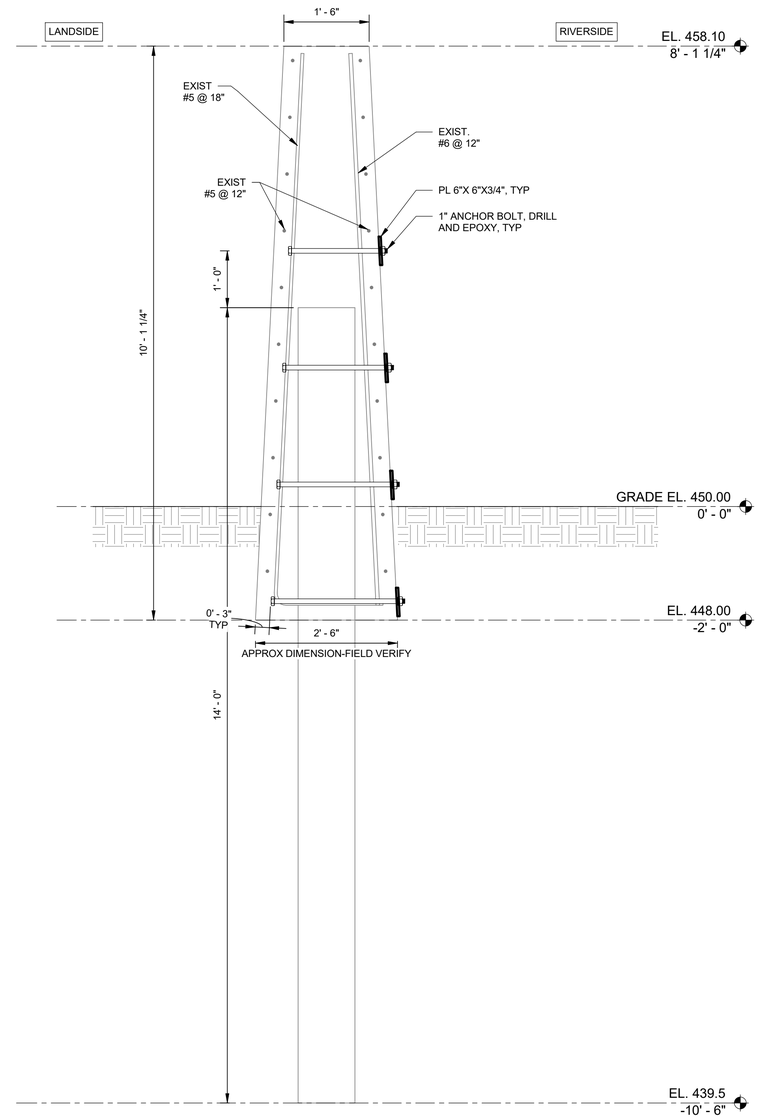
CONCEPT SUBMITTAL



1 POND CREEK I-WALL REPAIR
3/8" = 1'-0"

NOTE: GPR BOTH SIDES OF WALL TO LOCATE REINFORCING. DRILL RIVERSIDE FACE OF WALL THROUGH SHEET PILE, 3" CLEARANCE TO LANDSIDE I-WALL FACE . PLACE AND EPOXY ANCHORS IN WALL PER MANF RECOMMENDATION. PLATE AND ANCHORAGE SHALL BE HOT DIP GALVANIZED.

DO NOT CUT EXISTING REINFORCING



2 PC-S-102 POND CREEK I-WALL REPAIR
3/4" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

US ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR MARTIN LUTHER KING JR PLACE

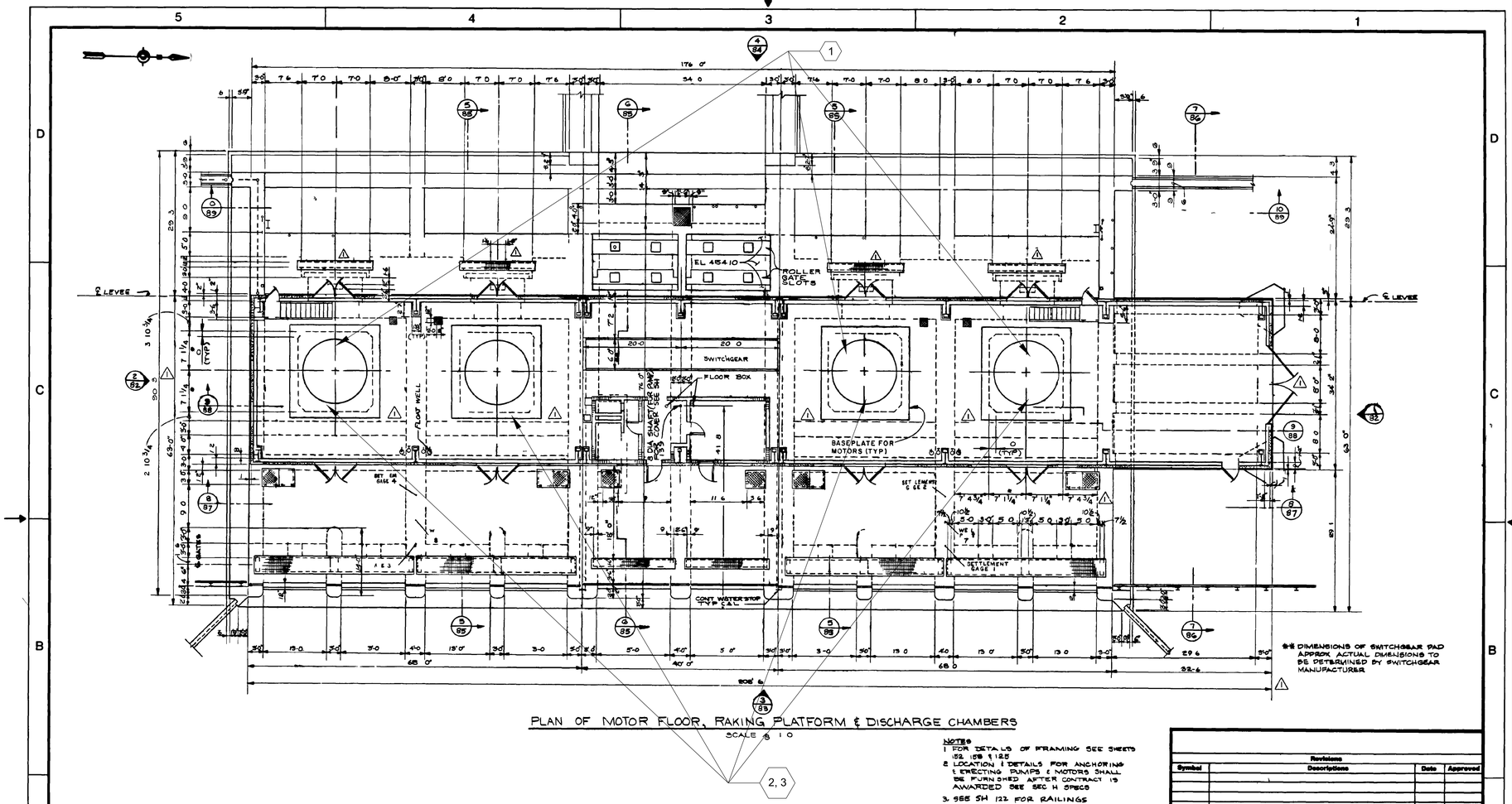
DESIGNED BY: B. EVANS
DRAWN BY: B. EVANS
CHECKED BY: C. YOUNG
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.:
CONTRACT_NO.:
DRAWING CODE:

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY

POND CREEK I-WALL REPAIR

SHEET ID
PC-S-102

CONCEPT SUBMITTAL



PLAN OF MOTOR FLOOR, RAKING PLATFORM & DISCHARGE CHAMBERS

SCALE 1/8 = 1'0

NOTES
1. FOR DETAILS OF FRAMING SEE SHEETS 152, 158 & 125
2. LOCATION & DETAILS FOR ANCHORING & ERECTING PUMPS & MOTORS SHALL BE FURNISHED AFTER CONTRACT IS AWARDED SEE SEC H SPECS
3. SEE SH 122 FOR RAILINGS

Revisions			
Symbol	Descriptions	Date	Approved
1	DOOR & MOTOR FLOOR REVISED (CONT MOD CASE AB)	5MAY86	

US ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE KENTUCKY

SOUTHWESTERN JEFFERSON COUNTY KY
POND CREEK PUMPING STATION

Designed by: BALDWIN
Drawn by: SPIVEY/NEUMANN
Checked by: A WARE
Reviewed by:
Approved by:

MOTOR FLOOR PLAN

Scale: 1/8 = 1'0
Date: JULY 1985
Drawing Code: 618-12 19
Sheet reference number: S 7
Sheet 81 of

"BELIEVED AS BUILT"

079

PUMP DATA				
PUMP #	TYPE	DESIGN FLOW (GPM)	TDH (FT OF WATER)	NOTES
1	COLUMN	460,000	36.0	RECONDITION PUMP
2	COLUMN	460,000	36.0	
3	COLUMN	460,000	36.0	RECONDITION PUMP
4	COLUMN	460,000	36.0	RECONDITION PUMP

SHEET KEYNOTES

1. REBUILD PUMPS 1, 3 AND 4 TO FACTORY SPECIFICATIONS. ABRASIVE BLAST COLUMNS TO WHITE METAL AND COAT WITH C200A.
2. INSTALL VIBRATION SENSORS ON PUMP COLUMNS.
3. INSTALL FORMED SUCTION INTAKE ON ALL PUMPS, SEE PC-M-102 AND PC-M-103

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX

DESIGNED BY: K. BURNS
DRAWN BY: K. BURNS
CHECKED BY: K. BURNS

SUBMITTED BY: J. TOTE
SIZE: ANSI D

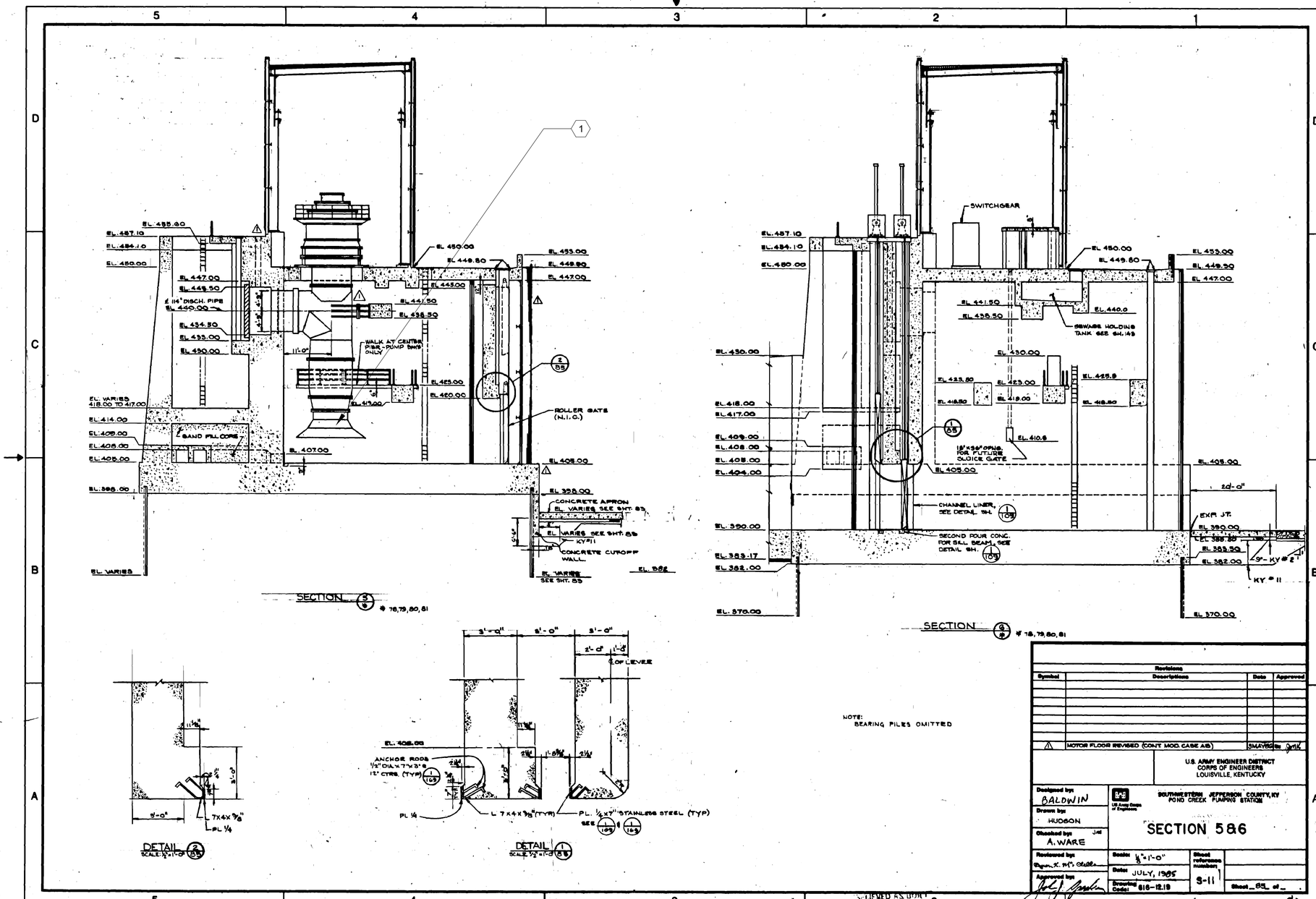
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

POND CREEK PS
MECHANICAL PLANS

SHEET ID
PC-M-101

CONCEPT SUBMITTAL



SHEET KEYNOTES

1. REMOVE INTAKE BELL ON EACH PUMP AND INSTALL FORMED SUCTION INTAKE. GROUT INTAKE IN PLACE. SEE PC-M-103 FOR CONSTRUCTION DETAILS.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: K. BURNS
DRAWN BY: T. HIBBS
CHECKED BY: XXX
SUBMITTED BY: XXX
ISSUE DATE: JAN/05/2/07/2019
SOLICITATION NO.: XXXXXXXXXXXXXXXXXX
CONTRACT NO.: XXXXXXXXXXXXXXXXXX
DATE: THRU 0023
SIZE: ANSI/B/D

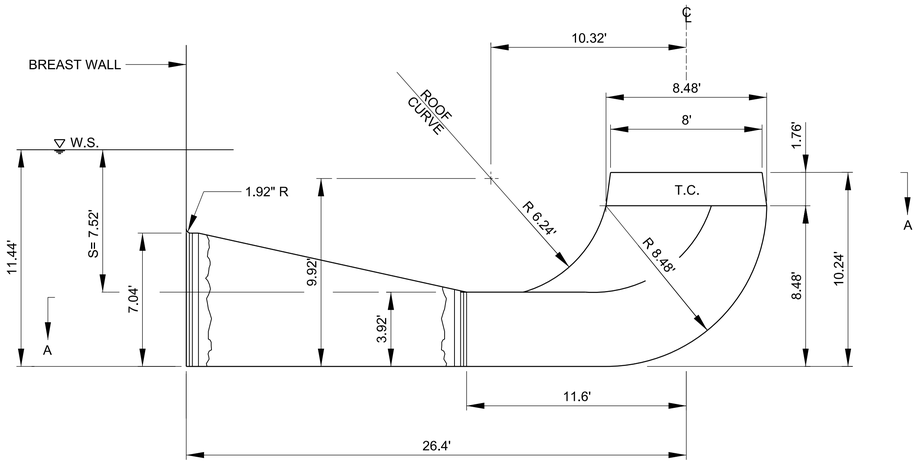
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
LOUISVILLE, KENTUCKY

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145026

POND CREEK PS
MECHANICAL SECTION

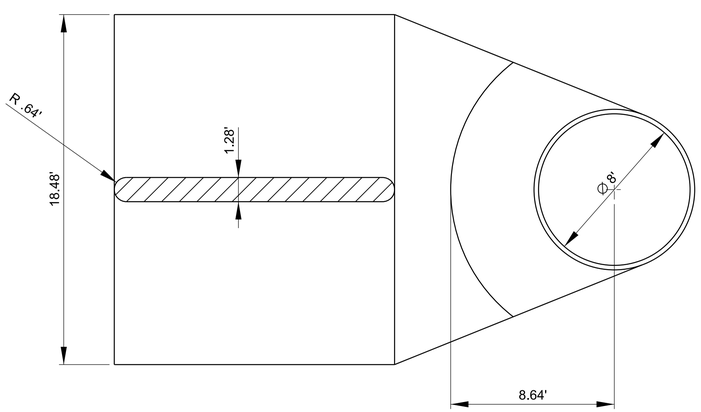
SHEET ID
PC-M-102

CONCEPT SUBMITTAL

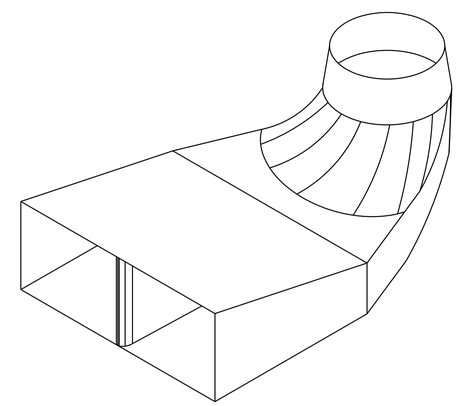


T.C. = TRUNCATED CONE
S = MINIMUM SUBMERGENCE

ELEVATION
SCALE: 1/4" = 1'-0"



SECTION A-A
SCALE: 1/4" = 1'-0"



ISOMETRIC VIEW

NOTES:

1. FABRICATE FROM 3/4" STEEL PLATE.
2. COAT INSIDE AND OUT WITH C200A PAINT SYSTEM.
3. MAKE 4.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: K. BURNS
DRAWN BY: T. HIBBS
CHECKED BY:
SUBMITTED BY: J. TOTZKE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXX

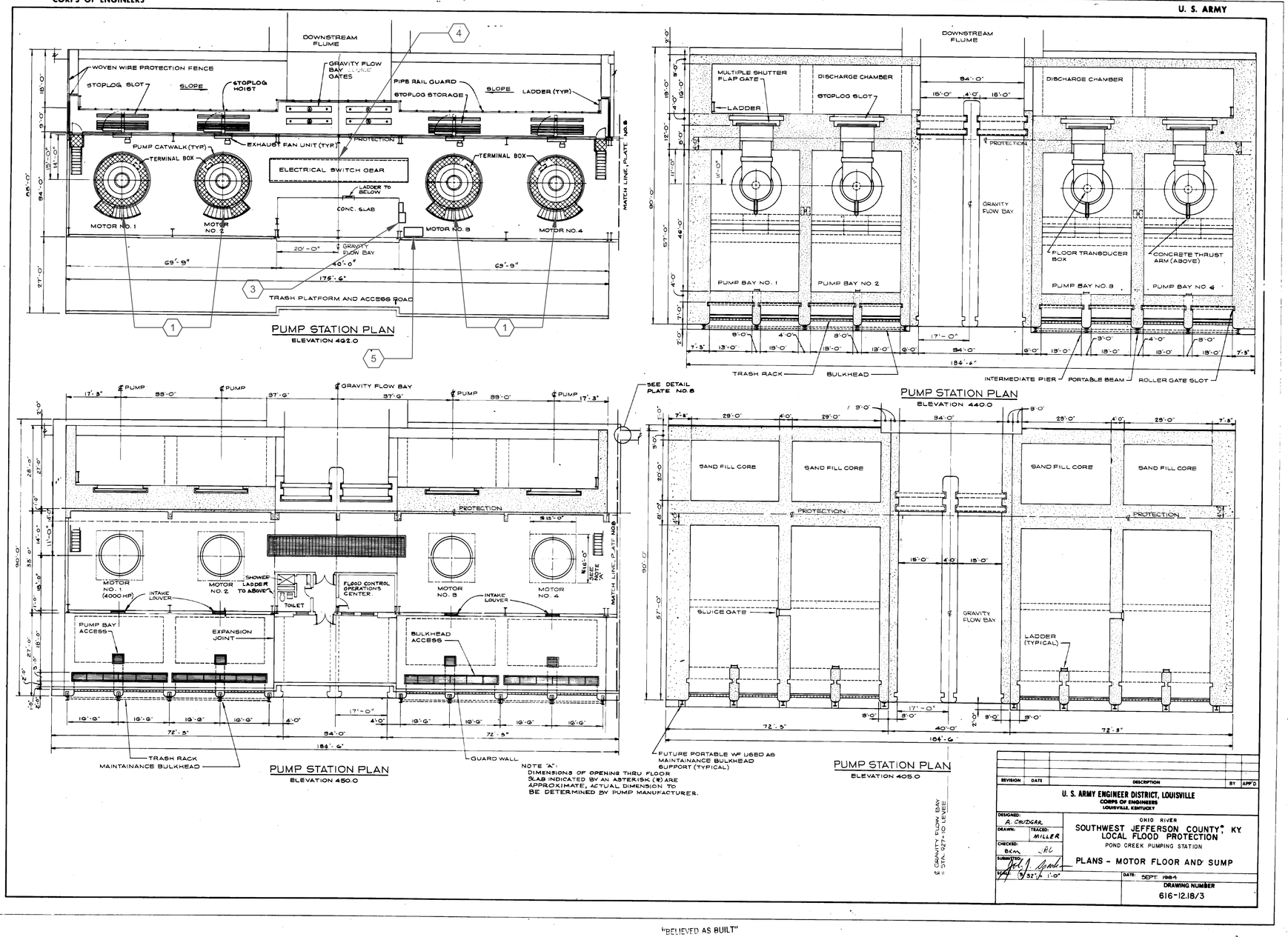
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

POND CREEK PS
FORMED SUCTION INTAKE

SHEET ID
PC-M-103

CONCEPT SUBMITTAL



186

"BELIEVED AS BUILT"

GENERAL SHEET NOTES

1. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. REFURBISH 4700 HP PUMP MOTORS
2. PUMP CONTROLS WILL BE UPDATED AND INTEGRATED INTO MSD SCADA SYSTEM.
3. A 112.5 KVA TRANSFORMER WILL BE INSTALLED FOR BUILDING SUPPORT SYSTEMS. PUMP CONTROLS, LIGHTING, 208/120 VAC POWER, HVAC, ETC.
4. MOTOR CONTROL CENTER WILL BE REPLACED WITH A MODERN DAY EQUIVALENT.
5. NEW PLC BASED STATION CONTROL PANEL LOCATION

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY:
CODE:
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXXX
THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

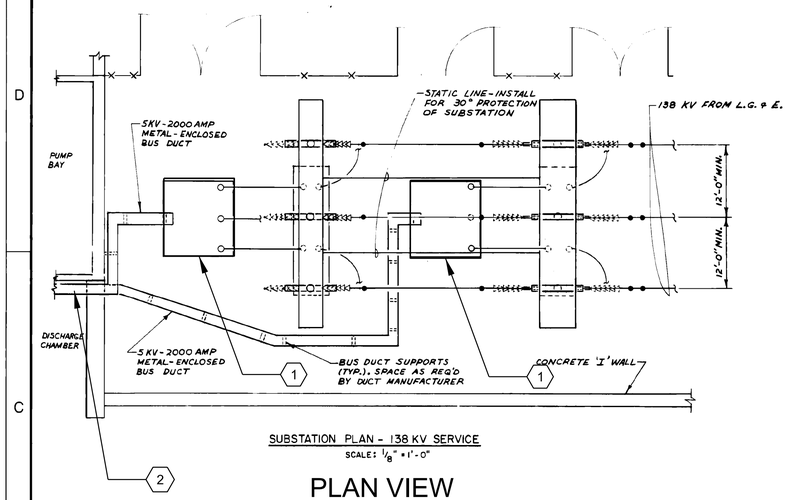
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

POND CREEK PS ELECTRICAL PLAN

SHEET ID
PC-E-101

A1 POND CREEK PS ELECTRICAL PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL

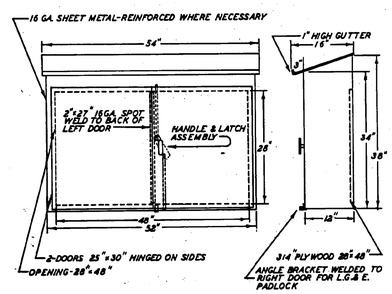


SUBSTATION PLAN - 138 KV SERVICE

SCALE: 1/8" = 1'-0"

PLAN VIEW

ELECTRICAL CLEARANCES (MINIMUM)					
VOLTAGE (KV)	BIL (KV)	TO GROUND FOR RIGID PARTS	BETWEEN PHASES FOR RIGID PARTS METAL TO METAL	BETWEEN OVERHEAD CONDUCTORS AND GRADE FOR PERSONNEL SAFETY INSIDE SUBSTATION	BETWEEN WIRES AND ROADWAYS
138	550	4'-2"	5'-2"	13'-0"	25'-0"
0.60	-	-	-	-	18'-0"

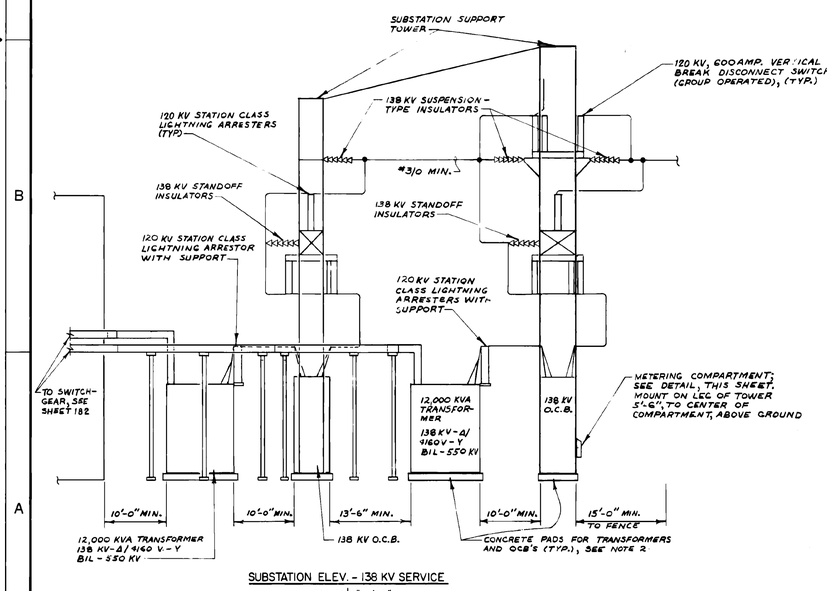


METERING COMPARTMENT DETAIL

SCALE: NONE

NOTE:

1. ALL CONDUCTOR NOT LABELED, OTHER THAN L.G.+E. CONDUCTOR, WILL BE STANDARD PIPE SIZE COPPER TUBING, 3/4 (1.05" O.D.) (MIN.), FOR PRIMARY CONDUCTOR. STRUCTURAL DESIGN TO DICTATE EXACT SIZE.
2. CONCRETE PAD SIZES FOR TRANSFORMERS AND OCB'S WILL BE AS REQUIRED BY THE RESPECTIVE MANUFACTURERS, AND WILL BE A MINIMUM OF: 6" BEYOND EDGE OF BASES; 6" ABOVE AND 30" BELOW GRADE. EARTH LOADING SHALL NOT EXCEED 2,500 LBS. PER SQ. FT.



SUBSTATION ELEV. - 138 KV SERVICE

SCALE: 1/8" = 1'-0"

ELEVATION VIEW

Revisions			
Symbol	Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

SOUTHWESTERN JEFFERSON COUNTY, KY
POND CREEK PUMPING STATION

US Army Corps of Engineers

SUBSTATION PLAN AND ELEVATION

Designed by: D.SMITH
Drawn by: T.STEMLER
Checked by: 4/19/85
Reviewed by:
Approved by:
Scale: AS SHOWN
Date:
Drawing Code: 616-12.19
Sheet reference number: E-3
Sheet 182 of 188

55

"BELIEVED AS BUILT"

GENERAL SHEET NOTES

1. SUBSTATION EQUIPMENT TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. SEE FEASIBILITY REPORT APPENDIX D - ELECTRICAL WRITE UP AND ASSOCIATED ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

SHEET KEYNOTES

1. TWO 12000 KVA TRANSFORMERS
2. SECONDARY WIRING

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXX
THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

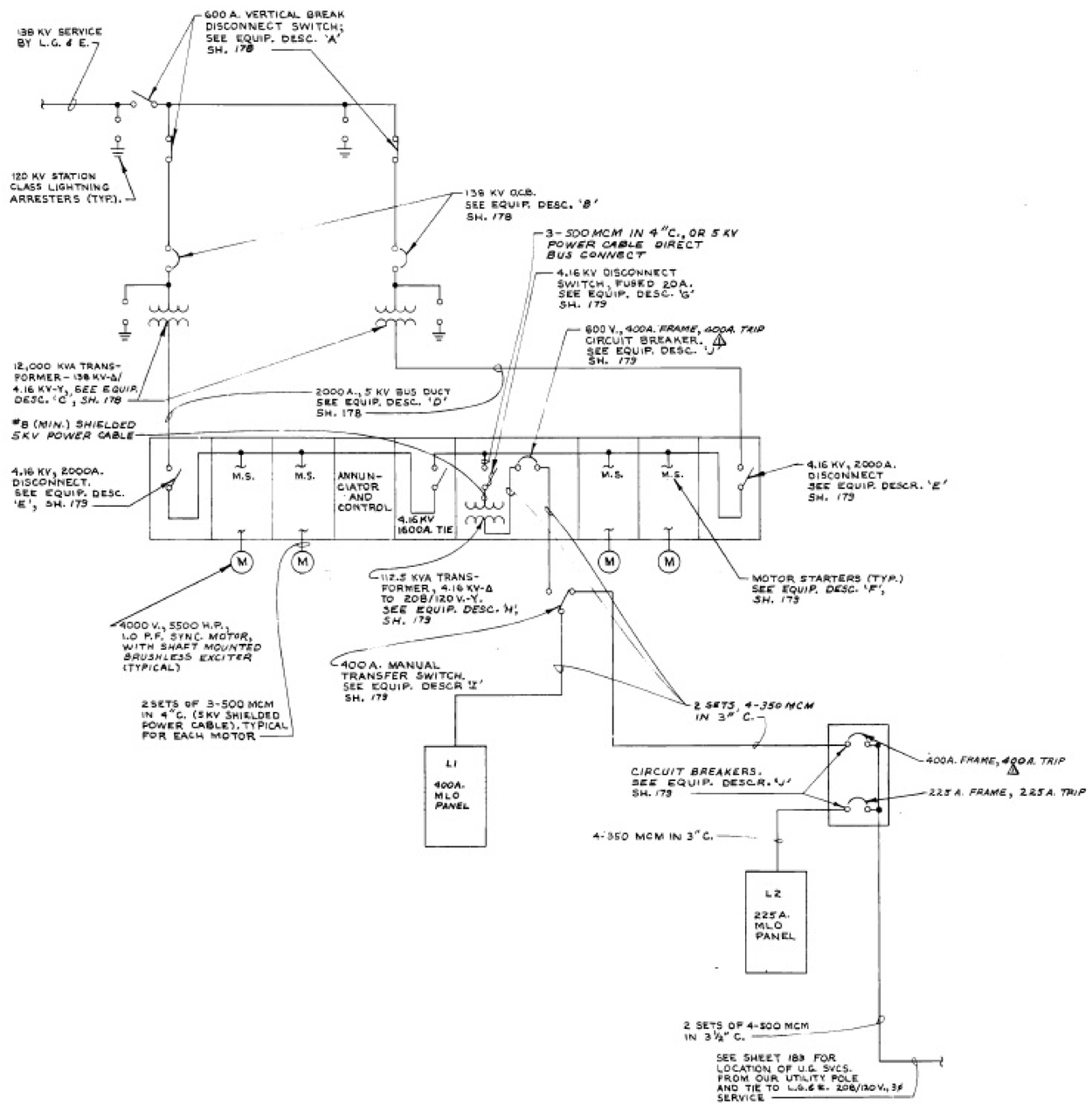
OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2: 145626

POND CREEK PS SUBSTATION PLAN

SHEET ID
PC-E-102

A1 POND CREEK PS - SUBSTATION PLAN
SCALE: NOT TO SCALE

CONCEPT SUBMITTAL



A1 POND CREEK PUMP STATION EXISTING ONE LINE DIAGRAM

SCALE: NOT TO SCALE

GENERAL SHEET NOTES

1. SEE POND CREEK E-101 FOR EXISTING STATION FLOOR PLAN. EQUIPMENT DENOTED ON PLAN ARE SLATED TO BE REPLACED OR PROVIDED UNDER PROJECT FEASIBILITY.
2. EXISTING ONE LINE DIAGRAM HAS BEEN PROVIDED AS A REFERENCE. SEE FEASIBILITY REPORT APPENDIX D-ELECTRICAL WRITE UP, ATTACHMENT 1 - ELECTRICAL EQUIPMENT MATRIX FOR ADDITIONAL INFORMATION/COSTS.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. MORRISON
DRAWN BY: R. MORRISON
CHECKED BY: J. TIMBAS
SUBMITTED BY: J. TOE
SIZE: ANSI D
ISSUE DATE: AUGUST 2019
SOLICITATION NO.: XXXXXX-XX-X-XXXX
CONTRACT NO.: XXXXXXXXXXXXX
THRU 0023

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 DR. MARTIN LUTHER KING JR. PLACE
LOUISVILLE, KY 40202

OHIO RIVER
LOUISVILLE LEVEE SYSTEM
FEASIBILITY STUDY
P2 145626

POND CREEK PUMP STATION
EXISTING ONE LINE DIAGRAM

SHEET ID
PC-E-601

CONCEPT SUBMITTAL