Chapter A-11

CIVIL DESIGN

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This chapter presents the results of the civil design evaluation performed as part of the future conditions analysis for the Argentine Unit, East Bottoms Unit (Missouri and Blue Rivers Confluence Area), Fairfax-Jersey Creek (BPU Floodwall), the North Kansas City-Lower Unit (Harlem Area), and the North Kansas City-Lower Unit (National Starch Area) of the Kansas Citys, Missouri and Kansas, Flood Protection Project. The remaining area of interest in this Interim Feasibility Report appendix, the Fairfax-Jersey Creek (Jersey Creek Sheet Pile Wall, did not warrant a separate civil design section. The area of civil design encompasses real estate issues, utility relocations, bridges, and other infrastructure items affected by proposed work.

A-11.1 SITE SELECTION AND PROJECT DEVELOPMENT (ARGENTINE UNIT)

A-11.1.1 Introduction

The U.S. Army Corps of Engineers (USACE), Kansas City District designed and constructed the Kansas Citys protection system. This portion of the study considers raises on the Argentine Unit for the 0.2% (500-year), 0.2% (500-year)-plus-3-feet, and the 0.2% (500-year)-plus-5-feet water surface profile elevations, hereafter called N500+0, N500+3, and N500+5 levees.

The Argentine Unit is located in Wyandotte County, Kansas, on the right bank of the Kansas River from River Miles 10.1 to 4.28. The unit begins at the Santa Fe Railroad embankment upstream from the Turner Bridge, Station 0+00, and extends downstream to Station 288+30, immediately upstream of the 12th Street Bridge. The unit includes levees, floodwalls, 2 stoplog gaps, one sandbag gap, 5 pumping plants, 17 drainage structures, riprap and levee toe protection, and aggregate surfaced levee crown and ramps.

A-11.1.2 Levee Footprint

The unit includes sections of levee and floodwall. All alternatives include widening the levee footprint landward of the river for stability and underseepage berms as indicated by the geotechnical analysis. Floodwalls will be replaced as determined in the structural analysis.

The levee parallels the Burlington Northern railroad yard from Station 253+00 to Station 289+00. Levee raises and the resulting extension of the footprint encroach upon the railroad. A cost analysis was developed comparing the relocation of the railroad with the installation of relief wells in combination with retaining walls. This showed that the combination of relief wells and retaining walls was the most cost effective alternative.

In addition, a cost analysis was developed for new berms that would encroach upon existing buildings. The analysis showed relief wells to be more cost effective than relocating some of the buildings.

In summary, it is recommended to construct fully penetrating relief wells discharging to the surface landward of the levee toe where railroad tracks and buildings

do not allow room for berms. See the Geotechnical Analysis – Argentine Raise chapter for additional detail on the different raises.

A-11.1.3 Bridge Clearances

Four major bridges cross the Argentine Unit. The attached table titled "Argentine Unit Bridge Matrix"(Exhibit A-11.1 in the Supplemental Exhibits section) indicates the bridges, low chord elevation, top of levee (TOL) elevations, and work needed for each alternative levee raise. The table indicates that the Kansas Avenue West, I-635, and Turner (I-32) bridges will require ramp modifications to maintain access to the levee. The I-635 bridge will require a bump-out of the levee maintenance road to maintain the minimum clearance required by the Kansas Department of Transportation (KDOT) for bridge inspections.

A-11.2 REAL ESTATE (ARGENTINE UNIT)

See attachment titled "Borrow Area Designation for Proposed Argentine Unit Raise" (Exhibit A-11.2) for location and discussion of borrow area selection for the project.

Description of Lands, Easements, Rights-of-Way, Relocation and Disposal Areas (LERRD), and Borrow Area for project purposes requires acquisition (at a minimum) of permanent and temporary easements on privately and publicly owned land. There is no fee title acquisition expressly for levee right-of-way.

All sponsors have been provided information on P.L. 91-646 and are aware of their obligation to ensure compliance. The three alternatives proposed for the Argentine Unit mentioned above were investigated. The N500+0 levee would not require relocation assistance. The preferred alternative, N500+3, and the N500+5 alternative identify seven (7) structures for possible relocation, totaling 10,000 sq. ft. of space that could require relocation assistance. The estimate cost for the P.L. 91-646 relocation assistance, including moving expenses, is $277,900.00. All structures identified are out buildings or secondary business structures along the toe of the levee. No residential housing will be affected.

A Preliminary Attorney's Opinion of Compensability has been prepared and used for the purpose of completing the study. Final opinions and final relocation determinations will later occur as required by paragraph 12-22 of Engineering Regulation 405-1-12. Any conclusion or categorization contained in this appendix that an item is a utility or facility relocation would result in work to be performed at the cost of the non-federal sponsor as part of LERRD responsibilities and is preliminary only. The Government will make a final determination of the relocations necessary for the construction, operation or maintenances 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.

For further details on all real estate issues, see the Real Estate Appendix included as part of the main Engineering Feasibility Report.

A-11.3 UTILITY RELOCATIONS (ARGENTINE UNIT)

A review of the Kansas City District's criteria for utility lines was performed. Based on discussions, a criteria document specific to this project was developed. See

attached document "Kansas City's Levee Gravity and Utility Pipeline Guidance" (Exhibit A-11.3). This document was used in determining the disposition of existing utility lines crossing the levee.

A-11.3.1 Utility Levee Crossings

The study of utilities crossing the Argentine Unit was conducted to estimate costs for relocation or removal of functioning or abandoned utilities. Using the criteria indicated above, it was determined that pressure pipelines currently passing under the levee would be relocated over the levee. See attached drawing titled "Argentine Unit Utility Crossing Relocations" (Exhibit A-11.12) for locations. Two utility lines that currently pass under the levee will remain in place. UL 12 at Station 248+05 is a 30-inch ductile iron sanitary sewer force main, which is buried 35 feet below the top of levee and continues under the Kansas River. This line will remain in place due to the prohibitive cost related to relocation of this line. The line also has a sluice gate that can be closed in the event of a flood. Another 30-inch sanitary sewer force main is located at Station 274+09 and buried to a depth of 40 feet below the top of levee. This line also has a sluice gate and is cost prohibitive to relocate and will remain in place. The following list discusses the disposition of utilities crossing through the levee:

Argentine Utility Crossings:

UL1 – Station 12+80 - Gas Line, Steel pipe. Located just east of 55th Street. Buried approximately 14' below top of existing levee. **Relocate over levee.**

UL2 – Station 29+25 - 2.5" Gas Line. Located in railyard under stoplog gap. Buried approximately 2' below stoplog gap. **Relocate due to construction of new stoplog gap for the N500+3 and the N500+5. No action for N500+0.**

UL3 – Station 29+35 - 6" Cable Sleeve. Located in railyard under stoplog gap. Buried approximately 3' below stoplog gap. **Relocate due to construction of new stoplog gap for the N500+3 and the N500+5. No action for N500+0.**

UL4 – Station 29+41 - 6" Cable Sleeve. Located in railyard under stoplog gap. Buried approximately 2' below stoplog gap. **Relocate due to construction of new stoplog gap for the N500+3 and the N500+5. No action for N500+0.**

UL5 - Station 36+20 - 4" Gas Line with gate valve. Located approximately 10' below top of existing levee. **Relocate over levee.**

UL6 – Station 58+60 - 16" Steel Water Line. Located approximately 12' below top of levee. Located within impervious approach fill to Turner Bridge. **Relocate over levee.**

UL7 – Station 58+93 - 2(18" Gas Lines). Located approximately 12' below top of levee. Located within impervious approach fill to Turner Bridge. **Relocate over levee.**

UL8 – Station 71+80 - 8" Steel Pipe (Williams Brothers Petroleum Line). Buried approximately 14' below top of existing levee. **Relocate over levee.**

UL9 – Station 214+40 - 18" DIP Sanitary Sewer Line. Buried approximately 2' below sandbag gap (West Kansas avenue bridge approach) and capped on the riverside. **Relocate over levee.**

UL10 – Station 214+70 - 24" Steel Gas Line with gate valve. Buried approximately 4' below sandbag gap (West Kansas Avenue bridge approach). Buried within the road. **Relocate over levee.**

UL11 – Station 215+20 - 10" Steel Water Line. Buried approximately 6' below top of existing levee. **Relocate over levee.**

Note: USGS Well located at approximate Station 215+50, will need to be adjusted for elevation change.

UL12 – Station 248+05 - 30" DIP Sanitary Sewer Line with sluice gate. Buried approximately 35' below top of existing levee. **No Action.**

Note: 16" Water Line runs parallel with the levee and is approximately 15' from the levee top. Water line is grouted and abandoned from Station 253+53 to Station 269+89 **No Action.**

Note: Sanitary Sewer Line (size not known) is grouted and abandoned from Station 263+40 to Station 266+40. **No Action.**

UL13 – Station 274+09 - 30" CIP Sanitary Sewer Line (pressure line) with sluice gate. Buried approximately 40' below top of existing levee. Note: Located near Strong Avenue Pump Plant. **No Action.**

UL14 – Station 288+36 - 6" Steel cable sleeve. Buried approximately 3' below closure gap within railyard. **Relocate due to construction of new stoplog gap for the N500+3 and the N500+5. No action for N500+0.**

UL15 – Station 288+47 - 2.5" Gas Line. Buried approximately 5' below closure gap within railyard. **Relocate due to construction of new stoplog gap for the N500+3 and the N500+5. No action for N500+0.**

UL16 – Station 288+87 - 6" Steel Cable sleeve. Buried approximately 8' below closure gap within railyard. **Relocate due to construction of new stoplog gap for the N500+3 and the N500+5. No action for N500+0.**

See attachment "Argentine Unit Utility Crossing Detail" (Exhibit A-11.13).

A-11.3.2 Power Lines

Six major power lines cross the levee at Station 39+00, Station 70+00, Station 146+50, Station 238+00, Station 254+00 and Station 282+00. The existing clearance between the power lines and top of levee is approximately 40 feet. The N500+5 alternative results in a levee raise in the range of 5 feet to 7 feet at these locations. Coordination with the Board of Public Utilities (BPU) determined that the required clearance between the power lines and the levee is 20.9 feet. This clearance is based on the National Electric Safety Code (NESC). With the maximum raise of 7 feet reducing the minimum clearance to 33 feet, the clearance between the power lines and the levee is adequate. The location of the transmission tower at Station 39+00 is in close proximity to the levee, approximately 20 feet to the center of the tower (which is 20 feet by 20 feet at the base - see attached Exhibit A-11.14). To avoid relocation of the tower, a small retaining wall will be constructed. The other transmission towers are located well landward of the levee and will not be impacted during construction.

Power lines running parallel (landward) with the levee will have to be protected during construction. From Stations 253+00 to 288+00, lines are located within close proximity to the levee and floodwall. These lines serve the Burlington Northern railyard and will be relocated where stability or underseepage berms are constructed. During construction of floodwall modifications and relief wells lines will be protected or relocated as required to allow safe access for construction equipment.

A-11.3.3 Utility Uplift

The study of uplift on existing utilities was conducted to estimate costs for relocation or removal of functioning or abandoned utilities. Regions were identified for utility uplift concern, based on geotechnical and structural criteria. The region is 500 feet landward of the levee centerline and corresponds with the “critical zone” of the levee.

The geotechnical input identified the thickness of the impervious blanket, which overlies foundation sands. For this study, two categories of blanket were defined: a 15-foot thick blanket and a 30-foot thick blanket. For this study, the driving head of water was bracketed to represent the nominal 500-year level of protection and the nominal 500-year plus 3 feet level of protection. The underseepage spreadsheet was used to calculate the interior foundation sand gradient. The geotechnical designers also provided the dissipation of the gradient throughout the blanket.

The structural designer provided typical pipe weight and required factors of safety for input to the underseepage spreadsheet. The equations are presented on the attached spreadsheets. The final product of the uplift spreadsheet analysis provided the limits from the centerline of the levee that a given type, size and depth of pipe must be located in order to meet minimum uplift factor of safety. The attached spreadsheets are titled “Argentine Pipe Uplift” (Exhibits A-11.4 through A-11.8) and are labeled for the various raise and blanket thickness.

The civil designer provided the expected types of piping and depths that may be anticipated for the existing piping. The civil designer provided final assessment of the limits of the areas of concern near the landside toe of the levee. These areas were then used for estimating the utility modifications required for the Argentine levee unit.

Based upon the uplift spreadsheets discussed above, drawings were developed which show the limits of uplift concern for various pipe sizes assuming 40 inches of

cover. The drawings were then used to estimate the total length of pipe that would have to be lowered. The drawings titled "Utility Uplift Zones" (Exhibits A-11.15 through A-11.34) are attached, and reflect the N500+5 raise. Spreadsheets were used to develop quantities for the N500+0 and the N500+3. The results showed that there was little or no difference between the N500+3 and the N500+5 and some differences in the N500+0 raise.

The results are shown in the attached tables labeled, "N500", "N500+3", and "N500+5" (Exhibits A-11.9 through A-11.11). The tables provide a list of utilities, indicating the blanket thickness, the size and type of line, and the length of line to be lowered to alleviate uplift concern. For the purposes of uplift it was assumed that underground electrical lines (UGE) were not affected and the information on natural gas lines and petroleum lines within the 500-foot zone was limited. Natural gas and water service lines to buildings are generally less than 6 inches in diameter and not located near the levee. Based on the uplift spreadsheets and the proximity of these lines to the levee, they are not affected by uplift. The locations of underseepage berms were also considered in regards to uplift on utility lines as underseepage berms add additional weight over utilities, decreasing the effect of uplift.

A-11.4 EAST BOTTOMS UNIT (MISSOURI AND BLUE RIVERS CONFLUENCE AREA)

The geotechnical analysis considered various alternatives (see Geotechnical Analysis – East Bottoms (Missouri and Blue Rivers Confluence Area) chapter for additional detail) to control an underseepage problem that developed during the 1993 flood event. The recommended alternative is to construct new relief wells between Station 403+00 and Station 420+00.

A review of the existing utilities in the East Bottoms reach from Station 400+00 to Station 430+00 was conducted and used to determine whether uplift is a concern in relation to the utilities and the new relief wells (see Exhibits A-11.43 and A-11.44). Within the reach of levee indicated, and landward of the levee, the following utilities exist: 12-inch RCP sanitary sewer line, 18-inch RCP sewer line, 6-inch RCP sanitary sewer line, and a 12-inch ductile iron fire water line. See the attached drawings (Exhibit A-11.45) for location of utilities. In addition, there are existing power lines (see Exhibit A-11.46) which run along the Bayer property line that will have to be protected (braced) relocated during installation of relief wells.

Based on the depth of utilities, and the reduction in pressure from new relief wells, there is not anticipated to be any uplift problems on utilities.

A-11.5 FAIRFAX-JERSEY CREEK UNIT (BPU FLOODWALL)

The Board of Public Utilities (BPU) floodwall is located in the Fairfax-Jersey Creek Unit beginning at Station 287+97 and ending at Station 302+20. The structural analysis of the floodwall determined that the landside piles are loaded beyond capacity. Based on that determination, three alternative fixes have been developed. The following are the proposed alternatives and their impact on existing utilities.

Alternative #1 – Construct New Floodwall

This alternative involves the construction of a new floodwall directly landward of the existing wall. See Structural Analysis – Fairfax-Jersey Creek (BPU Floodwall) chapter for additional detail. The new wall would require an excavation 50' landward of the existing wall.

- Several large intake pipes for the Kansas City, KS power plant exist within the current foundation of the existing floodwall. Pile spacing for the active intake pipes between would have to be adjusted and bridged to protect pipes.
- Original intake structure located at approximate Station 298+00 has been abandoned. Two 30" steel intake pipes have been grouted and abandoned in place. Pipes are buried approximately 27' below the existing top of floodwall and 15' below existing ground surface. Section of pipes can be removed for installation of piles.
- The abandoned pump building will be abandoned in place. Currently a determination is being made as to the historical significance of this building.
- There are 5 existing drainage structures/pipes under the floodwall: 30" CIP at Station 292+69, 4'x6' reinforced concrete box at Station 291+86, a 4'x6' RCB at Station 291+49, and a 24" CIP at Station 289+70. Location of the piles would have to accommodate the existing drainage structures. In addition existing drainage structures will have to be extended for construction of new wall.
- The existing pump house landward of the floodwall is located 45' from the wall (approximate levee Station 294+00). Shoring may be necessary to protect the facility.
- Within the excavation are numerous at grade structures with valves used to open and close drainage structures. These structures will have to be relocated landward of the new floodwall.
- Approximately a 200'section of existing 54" aboveground emergency water line will have to be relocated approximately 10' landward. This includes the concrete pedestals.
- Existing direct buried control cable would need to be relocated landward for the entire length of the wall.
- Miscellaneous re-grading will be necessary to facilitate good drainage.

Alternative #2 – Adding Row of Piles

This alternative consists of adding a row of piles landward of the existing floodwall with and possible wall strengthening (buttresses, counterforts, etc.).

- Several large intake pipes for the Kansas City, KS power plant exist within the current foundation of the existing floodwall. Pile spacing for the active intake pipes between would have to be adjusted and bridged to protect pipes.
- Original intake structure located at approximate Station 298+00 has been abandoned. Two 30" steel intake pipes have been grouted and abandoned in place. Pipes are buried approximately 27' below the existing top of floodwall and 15' below existing ground surface. Section of pipes can be removed for construction of new piles.

- There are 5 existing drainage structures/pipes under the floodwall: 30" CIP at Station 292+69, 4'x6' reinforced concrete box at Station291+86, a 4'x6' RCB at Station 291+49, and a 24" CIP at Station 289+70. Location of the piles would have to accommodate the location of existing drainage structures.
- The existing aboveground 54" emergency water line located 40' from the floodwall at Station 290+60 will not be impacted by the excavation. The potential exists for the line to obstruct access for construction equipment.
- Pipes are buried approximately 27' below the existing top of floodwall and 15' below existing ground surface. Section of pipes can be removed for installation of piles.
- There are 5 existing drainage structures/pipes under the floodwall: 30" CIP at Station 292+69, 4'x6' reinforced concrete box at Station 291+86, a 4'x6' RCB at Station 291+49, a 24" CIP at Station 289. Excavation for new piles would extend approximately 20' landward of the floodwall.
- Miscellaneous re-grading will be necessary to facilitate good drainage.

Alternative #3 – Combination of Alternative #1 and #2

This alternative consists of construction of a new floodwall landward of the existing wall and for an approximate 500' reach, adding a row of piles landward of the existing floodwall. See the Structural Analysis – Fairfax-Jersey Creek (BPU Floodwall) chapter for more detail.

- Several large intake pipes for the Kansas City, KS power plant exist within the current foundation of the existing floodwall. Pile spacing for the active intake pipes between would have to be adjusted and bridged to protect pipes.
- Original intake structure located at approximate Station 298+00 has been abandoned. Two 30" steel intake pipes have been previously grouted and can be removed to accommodate new piles and reduce the number of penetrations through the floodwall.
- There are 5 existing drainage structures/pipes under the floodwall: 30" CIP at Station 292+69, 4'x6' reinforced concrete box at Station 291+86, a 4'x6' RCB at Station 291+49, a 24" CIP at Station 289. Structures would be extended in areas where new wall is constructed. Valve structures would be relocated for construction of new wall.
- The existing aboveground 54" emergency water line located 35' from the floodwall at Station 290+60 will not be impacted by the excavation. The potential exists for the line to obstruct access for construction equipment.
- Excavation for new piles would extend approximately 20' landward of the floodwall. There will be impact to existing at grade structures, which will require relocation.
- Miscellaneous re-grading will be necessary to facilitate good drainage.

See the attached BPU floodwall drawings and photos (Exhibits A-11.37 through A-11.42) for more information. See the related Structural Analysis chapter for a discussion of the selected alternative.

A-11.6 NORTH KANSAS CITY - LOWER UNIT (HARLEM AREA)

A-11.6.1 Introduction

The North Kansas City – Lower Unit is located in Clay County, Missouri on the left bank of the Missouri river between River Miles 363 and 371. The section of levee known as the "Harlem Area" extends roughly from the Broadway Bridge to the Heart of America Bridge and corresponds with approximate levee Stations 205+00 to 250+00. The primary area of concern, and the focus of the underseepage analysis (see Geotechnical Analysis - North Kansas City - Lower (Harlem Area) chapter), is levee Stations 210+00 to 240+00.

A-11.6.2 Levee Footprint

The levee footprint from Stations 210+00 to 240+00 (the Harlem area) is approximately 150 feet wide. The levee in this area is 15-20 feet high with 10-foot crest width. Riverside slopes are 1V on 3H riprap protected, and landside slopes are 1V on 4H grass covered. This levee unit is not recommended for raising as a result of the hydraulic analysis of the Missouri and Kansas River flows. A buried collector system is recommended for underseepage control (see Geotechnical Analysis - North Kansas City - Lower (Harlem Area) chapter). Installation of this collector system will not alter the existing levee footprint.

A-11.6.3 Proposed Levee Modifications (Buried Collector System)

The buried collector system consists of approximately 3000 lineal feet (Stations 210+00 to 240+00) of 18-inch diameter perforated pipe installed 7-10 feet deep at zero grade with nine equally spaced 6-foot diameter manholes (approximately 375 feet on center). The manholes will act as relief wells, allowing subsurface flow to spill onto the ground or, at the discretion of the local sponsor, be pumped back over the levee to the river. The system is designed so that commonly available rental pumps may be used for evacuation of flows without undue risk of cavitation.

Refer to the Geotechnical Analysis - North Kansas City - Lower (Harlem Area) chapter for alternatives considered and design basis for the buried collector system. Refer to figure "Harlem Area Collector System" (Exhibit A-11.35) at the end of this section for preliminary layout drawings of the system. Refer to hand-written computations (Exhibit A-11.36) at the end of this section for additional civil design details.

A-11.6.4 Utility Relocations & Coordination

No utility modifications or relocations are required for the Harlem area, however several areas will require precautions to avoid disturbing existing utilities during construction of the buried collector system.

Force main. An existing 8-inch diameter cast iron sewage force main extends along the land-side of the levee from approximate Station 234+00 (discharge from the Harlem Pump Station) to Station 212+00 where it crosses the levee at approximately a 90 degree angle. The force main parallels the levee approximately 10 feet inside the existing chain link fence (approximately 113 feet landward of the levee centerline) and is buried with approximately 4 feet of cover, including the section that passes up and over the

levee. An air release valve and manhole are on the force main at the levee crest. The force main was installed in approximately 1970 and is expected to be in sound condition based on discussions with City staff. The force main will be near the edge of and parallel to the excavation for the buried collector system (see Exhibit A-11.35) and may require tying back to prevent lateral movement if pockets of unstable soils are encountered. The force main may also require bracing near Station 212+00 where the collector system will cross beneath it at approximately a 90-degree angle. In summary, care must be taken not to disturb the force main during construction; however, significant problems or expenses are not expected.

Power line. A power line extends along the land-side of the levee parallel to the levee and force main and approximately 3 feet landward of the force main (approximately 116 feet landward of the levee centerline). Several power poles were braced for previous spot repairs on the adjacent force main. All remaining power poles (approximately 10) are expected to be braced as a precautionary measure during construction of the collector system.

Chain link fence. A chain link fence extends along the land-side of the levee parallel to the levee, force main and power line and approximately 10 feet landward of the force main (approximately 123 feet landward of the levee centerline). The fence will not be disturbed during construction, except possibly for temporary construction access.

Water and gravity sewer lines within the protected area. An existing network of water distribution and gravity sewage collection lines of varying materials and depths owned and maintained by Kansas City, Missouri Water Services extends throughout the protected area landward of the levee. Under current conditions (i.e. no buried collector system), uplift is a consideration under high river stages. The collector system, per the Geotechnical Analysis - North Kansas City - Lower (Harlem Area) chapter, will alleviate uplift forces in the area such that utility relocations/modifications in the area are not required.

A-11.7 NORTH KANSAS CITY - LOWER UNIT (NATIONAL STARCH AREA)

A-11.7.1 Introduction

The North Kansas City – Lower Unit is located in Clay County, Missouri on the left bank of the Missouri river between River Miles 363 and 371. The area of concern lies between the Heart of America and Paseo Bridges in the vicinity of National Starch and Chemical. In order to increase levee reliability, a relief well and pump station system are to be used to intercept underseepage and pump it riverward of the levee (see Geotechnical Analysis - North Kansas City - Lower (Harlem Area) chapter). The following assumptions used for sizing the relief well header system and pump station were obtained from geotechnical team members.

- The area of concern is from Station 258+00 to Station 272+50
- Relief wells are to be installed to intercept underseepage
- 20 wells are to be installed each with a flow of 1.25 cfs
- Relief wells will discharge 1.5 ft below existing grade
- Relief wells are to be located at the toe of the stability berm on approximately 75 ft centers

A-11.7.2 Levee Footprint

The levee footprint from Stations 258+00 to 272+50 (the National Starch area) is approximately 150 feet wide. The levee in this area is 15-20 feet high with 10-foot crest width. Riverside slopes are 1V on 3H riprap protected, and landside slopes are 1V on 4H grass covered. This levee unit is not recommended for raising as a result of the hydraulic analysis of the Missouri and Kansas River flows. Installation of the relief well system will not alter the existing levee footprint.

A-11.7.3 Proposed Modifications (Relief Well System Header and Pump Station)

Since the relief well system is to discharge below existing grade, a pump system is required to evacuate intercepted underseepage flows. Evacuated flows would be pumped over the levee and discharged riverward. The use of totally enclosed fan cooled (TEFC) motors and electrical panel designed for outdoor use will eliminate the need for a superstructure. A gantry crane would be provided for pump and motor maintenance. Given the pump station is located in a heavily industrialized area and is near a KCP&L substation, back up power was not considered necessary as outages are not expected to last for long durations. Discharge piping would be placed on top of the levee and fill would be placed over piping to provide adequate cover. Outlet headwalls and riprap blanket will be provided at discharge pipe outfalls to prevent erosion. The levee crest elevation in this reach is approximately 757.25 ft and the natural grade line is approximately 740 ft. It was assumed that 200 ft of discharge line would be required for each pump. The following is a discussion of investigations for the design of a header and pump station systems. The low water pumping condition for calculating an initial static head was assumed to be 722 ft.

Alternative #1 - Single Pump System with Redundancy: Two Pumps Total

Pump. For calculating the required system head, discharge pipe sizes of 24", 30", 36" and 42" diameters were investigated. Based on system head required, the 30" discharge pipe was preferred - this system required 40 ft of head for 11,221gpm. A pump was then selected based on system curve. The pump selected for consideration was a Fairbanks Morse 24" Model 8312, 705RPM with 24" diameter column and elbow. The pump is a two stage pump with two A-363-T propellers. This pump is rated at 11,400 gpm (25.4 cfs) at 40 ft of head. Minor and column losses were calculated assuming ~30 ft setting depth and 4-60° miter bends to cross the levee. In order to pump at the specified rate, a 140 hp electric motor will be required. Typically electric motors of this size are recommended to start no more than two times per hour. In order to provide redundancy, a second backup pump/motor assembly is incorporated in design. Each pump would have its own discharge pipe and would be set up to run alternately.

Sump. The sump was designed for pump outflows of 25 cfs, and minimum of 30 minutes between start times. Sump volume was calculated assuming inflow equal to half pump outflow, as this condition results in minimum time between starts (see References at the end of this chapter). The following formula was used to compute required volume.

V=tQ/4

Where:

V = volume (ft^3)
t = time between starts (min)
Q = pump discharge capacity, or difference in flow rate between lead and lag pumps (ft^3/min)

From this equation, usable sump volume required was calculated at 11,250ft^3. Usable sump volume does not include sump volume required to maintain adequate pump submergence. Refer to Exhibit 11.47 for detailed calculations.

For the sump layout, the Hydraulic Institute Engineering Data Book was consulted (see References). Dimensions obtained for suction bell height above floor, distance from back wall to pump centerline, and minimum water level were sized based on pump outflow of 25 cfs. Plan and profile drawings for two alternate sump layouts are attached as Exhibit A-11.48 in the Supplemental Exhibits section.

Alternative #2 - Dual Pump System with Redundancy: Four Pumps Total

Pump. The pump system evaluated for this alternative is comprised of two pumps that would each carry half of the intercepted flow. For calculating the required system head, discharge pipe sizes of 18", 24", 30" and 36" diameters were investigated. Based on system head required, the 24" pipe was preferred - this system required 39 ft of head for 5,610 gpm. Each pump will have a dedicated discharge pipe. A pump was then selected based on the system curve. The pump selected for consideration was a Fairbanks Morse 16" Model 8312 880RPM with 16" diameter column and elbow. The pump is a two stage pump with two A-371-T propellers. This pump is rated at 6,000 gpm (13.4 cfs) at 40 ft of head. Minor and column losses were calculated assuming ~30 ft setting depth and 4-60° miter bends to cross the levee. The two pumps would be set up in a lead/lag configuration and rotated to ensure equal wear. In order to provide redundancy, an identical backup pump/motor assembly will be incorporated for each primary pump/motor assembly. As with primary pumps, these will be activated alternately to ensure equal wear. In order to pump at the specified rate, a 70 hp electric motor will be required to drive each pump. Typically, electric motors of this size are recommended to start no more than four times per hour.

Sump. The sump was designed for maximum pump outflows of 25 cfs, and a minimum of 15 minutes between start times. Two scenarios were evaluated when sump volume was considered. The first was if inflow equaled half of the lead pump rated outflow. The second was if inflow was equal to the pumping rate of the lead pump plus half the pumping rate of the lag pump. In this situation, the lead and lag pump have the same pumping rate therefore the calculated volume was equal for both conditions. The following formula was used to compute required volume.

V=tQ/4

Where,

V = volume (ft^3)
t = time between starts (min)
Q = pump discharge capacity, or difference in flow rate between lead and lag pumps (ft^3/min)

As indicated above, Q is equal to pump discharge capacity or the difference in flow rates between lead and lag pumps. Both situations were calculated and it was determined that the controlling situation is when both pumps are operating. For this situation, usable sump volume required was calculated at 2,813 ft^3. Usable sump volume does not include sump volume required to maintain adequate pump submergence. Refer to Exhibit 11.47 for detailed calculations.

For the sump layout, the Hydraulic Institute Engineering Data Book was consulted. Dimensions obtained for suction bell height above floor, distance from back wall to pump centerline, and minimum water level were sized based on pump outflow of 12.5 cfs. Plan and profile drawings for two alternate pump station layouts are attached as Exhibit A-11.49 in the Supplemental Exhibits section.

Header. The header pipe will carry flow from the wells to the pump sump. It will need to be capable of handling 25 cfs. The pipe selected for this was 30" diameter reinforced concrete pipe (RCP). For this material, a Manning's N value of 0.012 was assumed. In order to meet flow requirements, the pipe will have to be installed at a 0.3% slope.

Cost. A cost estimate for this pump station was developed by cost estimating team members. This estimate includes temporary facilities necessary for construction, relief wells, the header system, the pump station and discharge facilities.

Conclusions

While Alternative #1 is technically feasible, Alternative #2 is the recommended alternative. The four smaller pumps in Alternative #2 are roughly the same cost as the two larger pumps in Alternative #1, but allow for less sump volume. This reduction in sump volume will reduce the excavation footprint and depth, and correspondingly, the overall cost of the pump station. A preliminary plan and profile view of pump station, discharge piping and temporary excavation is shown in Exhibit 11.50 for the selected sump layout. During plans and specifications, further refinements would need to be made in selecting a pump based on efficiency, the sump layout, and features based on the selected pump. Discharge pipe routing and outlet protection will also have to be considered.

A-11.7.4 Utility Relocations & Coordination

After Alternative #2 was selected, approximate excavation limits for the pump station were determined. Utility mapping obtained from National Starch and proposed excavation limits were used to locate the pump station. The pump station location and National Starch utilities are shown in Exhibit 11.51. Existing waterlines, electrical duct

banks, and an overhead steam line are in the vicinity of the pump station. During construction, sheet piling is to be provided to shore existing waterline and electrical duct bank within the limits of excavation. The location of the overhead steam line is not anticipated to impede pump station operation and maintenance. The proposed pump station is located approximately at NKC levee station 260+00. At the proposed location, excavation of the NKC levee would not be required for pump station construction. Since the levee fill would not be removed during construction, a temporary ring levee would not be required.

A-11.8 REFERENCES

1. Task Force on Design of Wastewater and Stormwater Pumping Stations 1993. "Design of Wastewater and Stormwater Pumping Stations" Water Environment Federation, Alexandria, Virgina.

2. American Water Works Association "Steel Pipe – A Guide for Design and Installation", AWWA M11 4, 2004.

3. Hydraulic Institute "Hydraulic Institute Engineering Data Book" Hydraulic Institute, Cleveland, Ohio.

A-11.9 SUPPLEMENTAL EXHIBITS

EXHIBIT A-11.1
Argentine Unit Bridge Matrix

DRAFT - ARGENTINE UNIT BRIDGE MATRIX

Argentine Levee Unit - Right Bank, Kansas River Mile 4.5 - 9.8
Identify if bridges on the Kansas River, that lie in the footprint of the Argentine Levee, will be impacted by the following levee raise elevations.
All elevations in ft. msl (NGVD 1929).

Kansas River Mile (HEC-RAS)	Bridge Name	Bridge Low Chord Elevation at TOL	Existing TOL Elevation (+/- 0.5')	Nom 500yr TOL Elevation	Nom 500yr +3 TOL Elevation	Nom 500yr +5 TOL Elevation	Nom 500yr +5 Clearance between TOL & Bridge (ft)	Notes
4.96	18th Street Expressway	>785	771.0	773.4	776.4	778.4	18.6	Clearance OK.
		~797 ??						
5.821	Kansas Ave. West	778	774.0	775.0	778.0	780.0	N/A	New Bridge since O&M -
								Levee ties into bridge embankment
								Existing Ramps will require minor
								earthwork modifications.
7.36	I-635 (NB and SB)	>785	775.0	776.0	779.0	781.0	11.0	Will require landside bumpout of levee
		~792 ??						maintenance road to maintain
								min. vehicle clearance (12 ft.)
9.5	Turner (I-32)	781.6*	777.0	778.5	781.5	783.5	N/A	*existing bridge
								Assume raised levee would tie into
								existing embankment
								Minor ramp work around abutment

EXHIBIT A-11.2
Borrow Area Designation for Proposed Argentine Unit Raise

Prospective borrow areas were identified by the Sponsor and screened through joint Corps and Sponsor efforts. Total required fill quantities are 90,301, 257,881, and 508,281 compacted cubic yards (ccy) for N500, N500+3, and N500+5 raises, respectively. In each case, the proposed levee raise accounts for about half of the fill requirement and stability or underseepage berms account for the other half. Subsurface investigation of the borrow area provided the required geotechnical information for the materials to be used in the levee.

Originally, the Argentine & Armourdale foreshore areas were considered due to their close proximity to the Argentine unit. As HTRW investigations were undertaken for areas of interest, however, various regions of contamination were discovered which eliminated most of these areas from consideration. Total remaining available fill in these areas, ASSUMING NO FURTHER HTRW DISCOVERIES, is approximately 143,000 CY (see FIGURE 1 - "FORESHORE"). The figure reflects avoidance of known HTRW concerns, a minimum 300' standoff distance from existing levees or floodwalls, and maximum depth of excavation of ordinary high water (OHW) minus 4 feet. It is recommended that this area be retained for further consideration during project engineering & design, though there is a possibility that further HTRW investigations will make even the remaining material unusable. Even if no further HTRW issues are discovered, any borrow from this area would need chemical analysis sampling at a rate of 1 sample (about $1000) per 5000 cy of borrow due to the known contamination and associated legal entanglements in the area.

Since the remaining foreshore quantity alone (assuming future HTRW clearance) is marginal for the N500 raise and insufficient for the other two prospective modifications to the Argentine unit, efforts were taken to identify alternative borrow areas as close to the project as possible. FIGURE 2 - "VICINITY MAP" shows various sites considered and investigated. Many of the sites near the project area were either very small or had other undesirable characteristics such as extremely high land values or prior industrial use. Several areas, as discussed on the following pages, were further investigated.

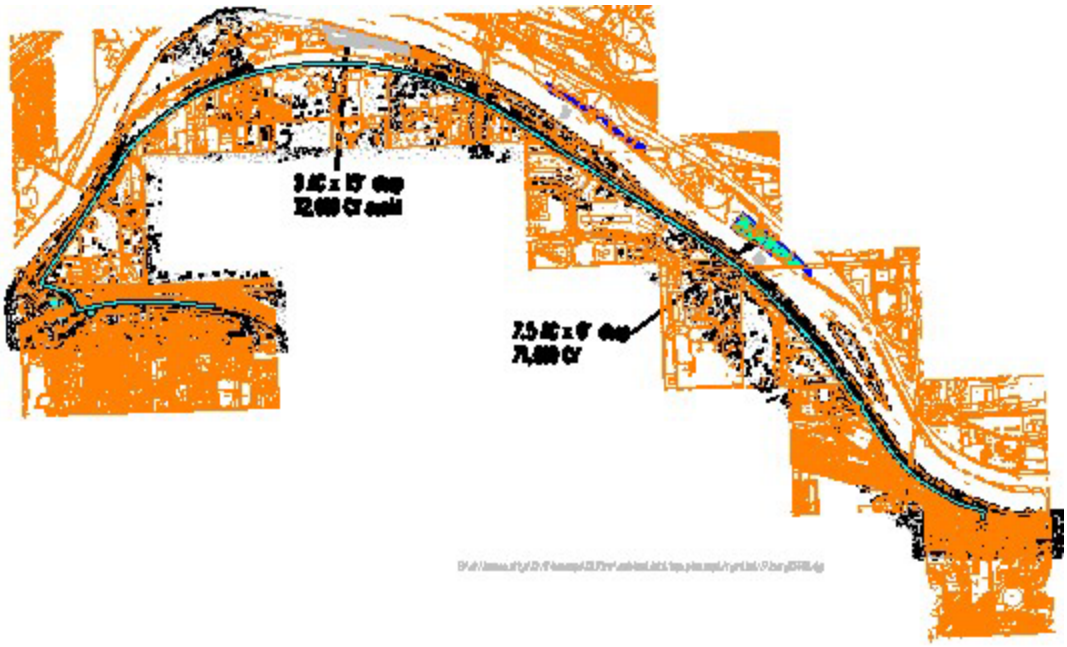


FIGURE 1 – FORESHORE

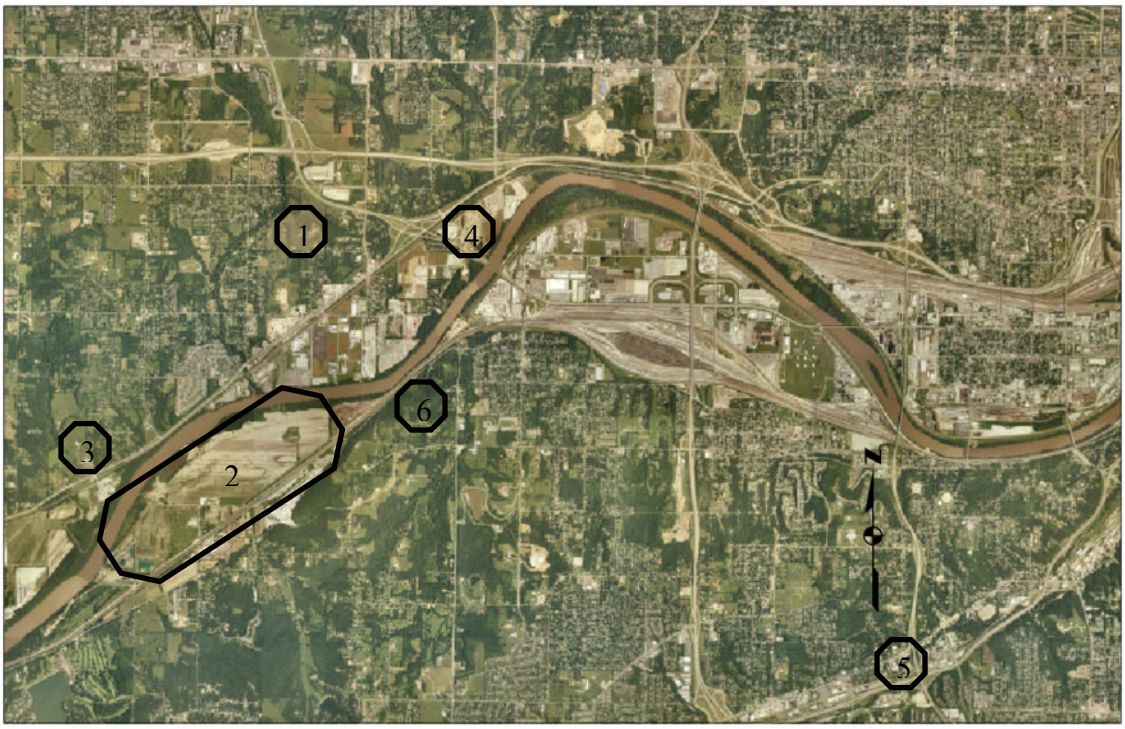


FIGURE - 2 VICINITY MAP

Area 1 is an open field south of the Turner Diagonal. The area is approximately 40 acres and appears to have been previously used as a borrow area. Since access to and from the area requires travel through residential neighborhoods on narrow routes, the area was not considered for further study.

Area 2 is in the Kansas River floodplain. The area is approximately 500 acres, 380 of which are owned by Water District One of Johnson County (WaterOne). This area appeared to be a good candidate for further consideration, and is discussed in detail below.

Area 3 is owned by Amino Brothers Construction and has previously been used as source of borrows. Approximately 200,000 cy of material is available, per conversation with the owner. This site may be a viable backup source for impervious materials, if required.

Area 4 is approximately 50 acres and used for a variety of commercial / industrial purposes. Since current appraised land values are in excess of $2000 per acre, this area was not considered for further study.

Area 5 is owned by Sandifer Leasing and has previously been used as source of borrows. Field investigations show little to no remaining fill, therefore the site was not considered for further study.

Area 6 is a large wooded hillside, which appears to be undisturbed. The area below is covered by a network of tunnels, originally used for limestone mining and currently for cold storage. Due to the likelihood of disturbing the tunnels below during earth moving operations, this area was not considered for further study.

See TABLE 1 "BORROW AREA COMPARISON" for a summary comparison of prospective sites.

AREA	OWNER	HAUL DIST	PROS	CONS	ACTION
1	Unknown	2 miles	Close to site	Residential access, small	Remove from consideration
2	WaterOne	4 miles	Little or no cost	Haul distance	Investigate as primary source
3	Amino Bros.	5 miles	Bank source – expected to be impervious	Haul distance, cost of fill	Keep for possible contingency
4	5701 LLC	2 miles	Close to site	High cost of comm/ind property, developed	Remove from consideration
5	Sandifer	5 miles	None	Haul distance, look like no fill left	Remove from consideration
6	Unkonwn	3 miles	Bank	Haul distance,	Remove

AREA	OWNER	HAUL DIST	PROS	CONS	ACTION
			source-expected impervious	likelihood of damaging tunnels below	from consideration
Foreshore	KVDD easement	0 (Argentine) 4 miles (Armourdale)	Very close to site	Potential HTRW, legal entanglements, high chemical sampling cost	Keep for possible contingency

TABLE 1 - BORROW AREA COMPARISON

Area 2, shown below in additional detail in FIGURE 3, contains approximately 500 acres and is bounded by the Kansas River and Holliday Drive. Water One owns 380 acres in this area and uses the site for disposal of quicklime used in the water treatment process. Individual cells, each 5-10 acres and 20 feet deep, are excavated and, over the course of 3-5 years, filled with dewatered lime (40-60% solids). The cells are then capped with soil, and the excess soil stockpiled elsewhere onsite. During an October 2004 meeting with Water One staff, the requirements for the Argentine levee raise project were discussed in detail. Water One staff indicated a desire to dispose of excess materials and was interested in pursuing an agreement for use of the excess materials. Soil boring logs for previous WaterOne well and disposal cell construction indicate significant deposits of silt and silty clay, both of which would qualify as impervious fill, in the area.

FIGURE 3 – BORROW AREA 2 - WATER ONE

Exploratory soil borings and chemical analysis sampling was conducted in January 2005. . Chemical analysis entailed 3 grab samples for volatile organic

compounds (VOCs) and three composite samples for metals, pesticides herbicides, and semivolatile organic compounds (SVOCs). Chemical analysis sampling points differed from soil boring locations, but were taken at various locations throughout the WaterOne property to assure representative results. All parameters tested were below action levels.

Subsurface Investigation.

Exploratory Borings.

The subsurface investigation of the borrow area consisted of 8 exploratory borings, 10-feet deep, drilled with 3 ¾ ID Hollow Stem Auger with 3-inch inner barrel sampler. The borings location with WaterOne property delineated is shown in FIGURE 4 and the strip logs are included at the end of the paragraph. All holes were backfilled with the3 bags of cuttings prior to leave the site. No water was encountered during drilling or after 24 hours. Forty (40) jar samples and 8 sack samples (1 composite sack sample for each boring) were collected from all borings. The boring logs show an impervious soil layer consisting of silts and clays extending up to 6 feet below the surface followed by sandy aquifer. The central part of the borrow area has a thin layer of sand at the surface, varying between 1 and 4.5 feet in thickness, followed by 3 to 4 feet of silts and clay, on the top of the sandy aquifer. The sandy material can be used as backfill in the random portion of the levee embankment.

Laboratory Testing.

Selected samples of material obtained during the field exploration were tested to determine engineering and physical properties of the soils. Laboratory testing was performed by Geotechnology, Inc. The laboratory testing included Atterberg Limits, natural moisture contents, and Standard Proctor tests. The samples were grouped in 5 categories of similar characteristics and Atterberg Limits were performed on a representative sample of each category. The moisture content varies between 4 and 35%. Overburden clay and silt material was classified in accordance with ASTM D 2487 as lean clay (CL) or silt (ML). Three of the groups were determined to be non plastic, the other 2 groups were classified one as a lean clay (CL) and the other as silt (ML). The silt was determined to be non-plastic material. The Liquid Limit (LL) of the CL material varies between 39 and 47 and the Plasticity Index (PI) between 19 and 28. The results of the natural moisture content tests and performed on twenty five (25) disturbed samples and of the Atterberg Limits tests performed on 2 selected representative samples of clay material are shown in an enclosure at the end of the paragraph.

Three Standard Proctor Tests were performed on composite samples collected from the borrow areas conform ASTM D-698. The materials were classified as low plasticity clay with the LL between 52 and 55 and PI between 35 and 37 respectively. The maximum dry density varied between 107.5 and 102 pcf with the optimum moisture content varying between 18.5% and 20.5%.

Required borrow quantities.

If 600,000 cy of borrow required (to account for unusable materials and unknown in-place densities) and a 10 foot deep excavation with 1 on 3 side slopes are considered, the required borrow area is then approximately 40 acres.

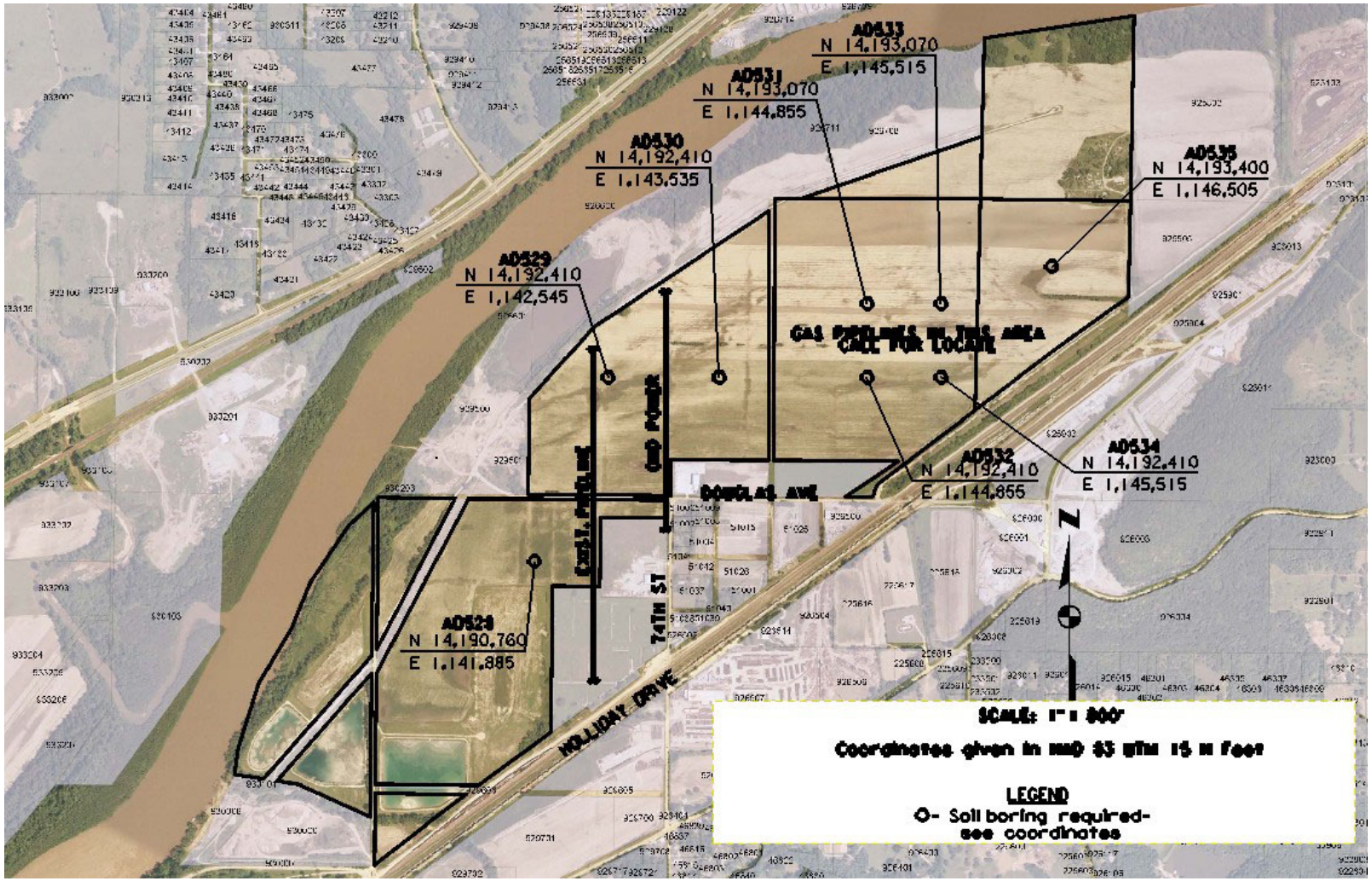
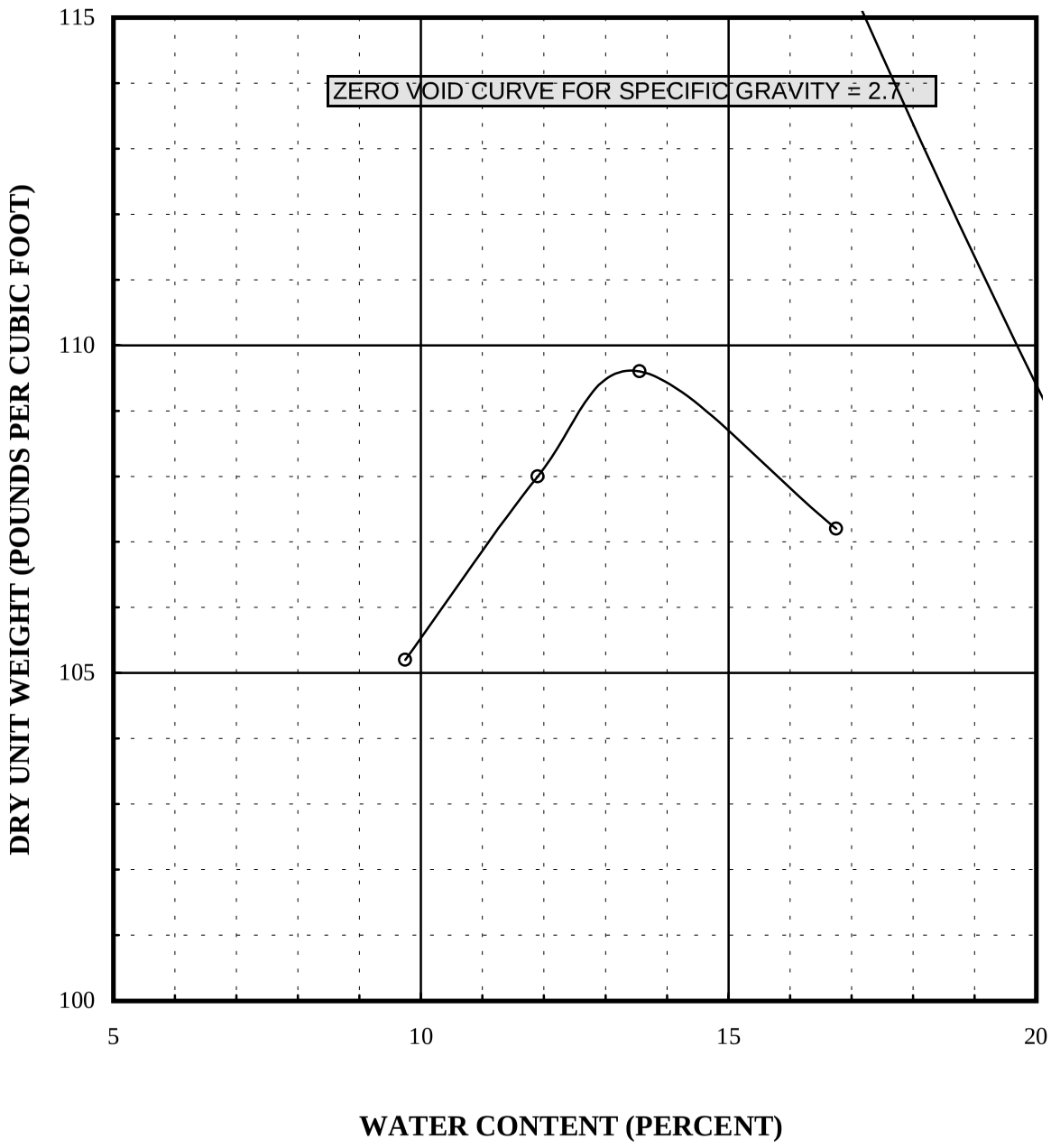


FIGURE 4 - SOIL BORING

	BORING NO.	Sample Depth (feet)	Sample No.	LABORATORY TESTS							Classification or Group Classification ASTM D2487
				Group Class.	Moisture Content %	Atterberg Limits			Standard Proctor		
						Liquid Limit	Plastic Limit	Plasticity Index	Max. Dry Density	Optima Water Content	
					ASTM D2216	ASTM D4318			ASTM 698 Method A		
SACK SAMPLES	AD-528	0.8-4.0	Sack-1	--	--	29	21	8	104.7	18.2	CL-dark brown sandy low plasticity CLAY
	AD-529	3.0-6.0	Sack-1	--	--	27	17	10	113.9	14.6	SC-dark brown clayey SAND
	AD-535	1.0-4.5	Sack-1	--	--	47	19	28	102.5	19.0	CL-dark brown sandy low plasticity CLAY
DISTURBED SAMPLES	AD-528	0.0-0.5	J-1	5	29.2	Not enough sample					**Group Classification Number:**
		0.5-0.8	J-2	5							1. CL - dark brown sandy low plasticity CLAY
		0.8-4.0	J-3	1							2. ML - light brown low plasticity SILT
		4.0-4.6	J-4	1	25.0	39	20	19			3. SP - tan fine-grained SAND
		4.6-8.4	J-5	3							4. SM - dark brown silty SAND
		8.4-9.0	J-6	2							5. FILL - dark brown gravelly low plasticity CLAY with sand
	AD-529	0.0-1.0	J-1	4	27.5						6. CL - dark brown low plasticity CLAY
		1.0-3.0	J-2	3							
		3.0-4.0	J-3	4	21.2						
		4.5-6.0	J-4	1	24.9						
		6.0-10.0	J-5	3							
	AD-530	0.0-1.0	J-1	4							
		1.0-1.5	J-2	3	4.0						
		1.5-2.5	J-3	2	20.1	Non-plastic					
		2.5-4.3	J-4	2	11.3						
		4.3-8.0	J-5	2	25.2						
		8.0-9.3	J-6	4		Non-plastic					

BORING NO.	Sample Depth (feet)	Sample No.	LABORATORY TESTS							Classification or Group Classification ASTM D2487
			Group Class.	Moisture Content %	Atterberg Limits			Standard Proctor		
					Liquid Limit	Plastic Limit	Plasticity Index	Max. Dry Density	Optima Water Content	
				ASTM D2216	ASTM D4318			ASTM 698 Method A		
AD-531	0.0-1.0	J-1	4	14.4						
	1.0-3.5	J-2	1	22.2						
	3.5-4.0	J-3	2							
	4.0-6.5	J-4	2	25.1						
	6.5-9.0	J-5	3		Non-plastic					
AD-532	0.0-4.3	J-1	1	26.3						
	4.3-6.3	J-2	1	30.7						
	6.3-8.3	J-3	2							
AD-533	0.0-2.3	J-1	1	18.9						
	2.3-4.3	J-2	2	9.9						
	4.3-6.0	J-3	2	14.9						
	6.0-8.0	J-4	1	26.2						
	8.0-9.3	J-5	2							
ADU-534	0.0-4.0	J-1	1	25.7						
	4.0-6.0	J-2	2	30.7						
	6.0-6.5	J-3	6	35.4						
	6.5-7.0	J-4	1	28.3						
	7.0-9.0	J-5	2	15.5						
AD-535	0.0-4.5	J-1	6	20.3	47	19	28			
	4.5-7.5	J-2	1	29.5						
	7.5-8.5	J-3	2							
	8.5-9.5	J-4	3							
	9.5-10.0	J-5	2							



PROJECT NAME

Argentine Levee Unit – Borrow Area

SPECIFICATIONS

Standard Proctor	
ASTM D 698	Method A
Percent of Compaction	N/A
Moisture Range ±%	N/A

PROCTOR TEST RESULTS

Max. Dry Density	Optimum Water Content
104.7 pcf	18.2%

ATTERBERG LIMITS (ASTM D-4318)

Liquid Limit	Plastic Limit	Plasticity Index
29	21	8

DESCRIPTION

Dark brown, sandy low plasticity CLAY

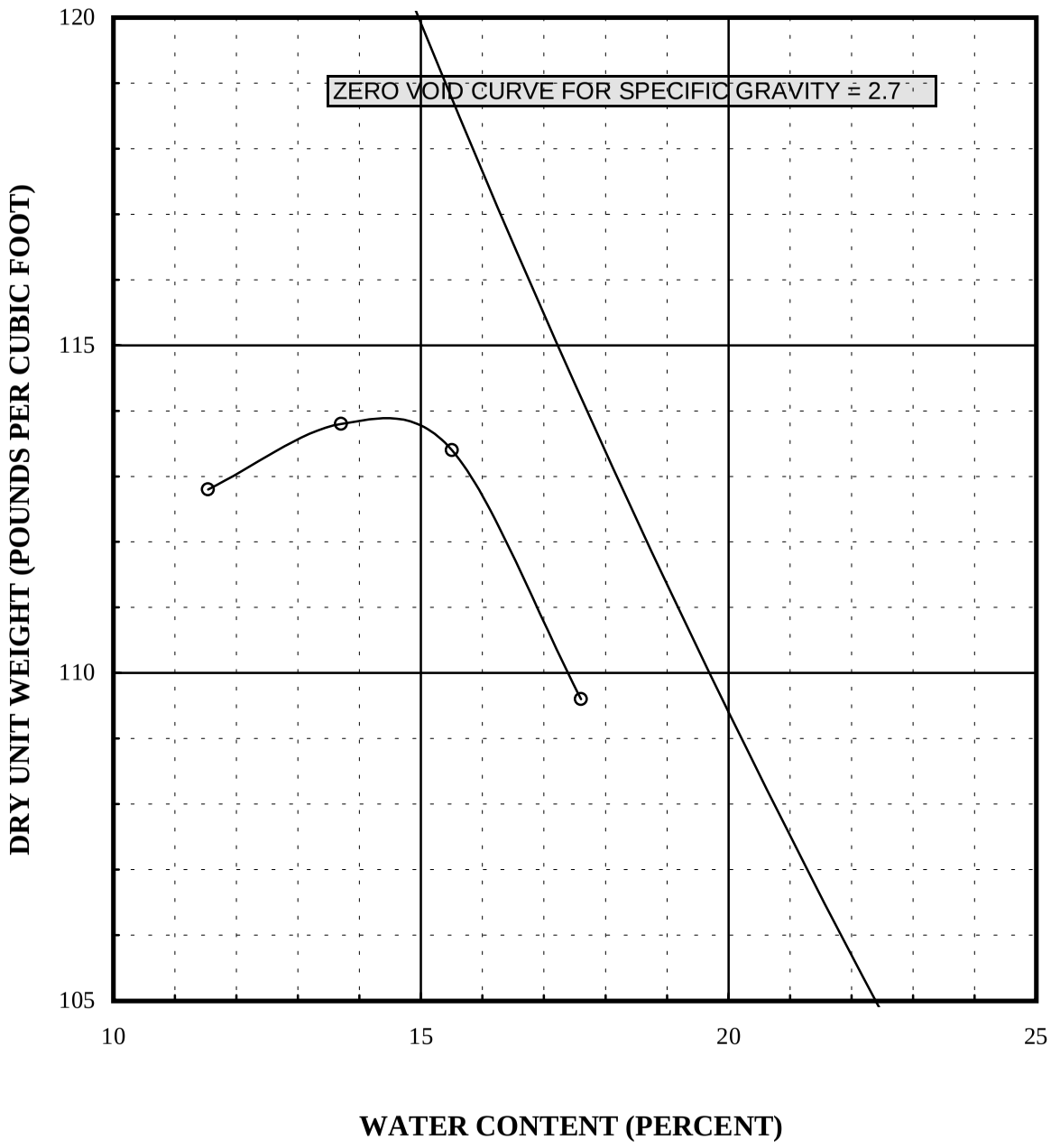
SAMPLE LOCATION

AD 528, 0.8-4.0 feet below grade

GEOTECHNOLOGY, INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
St. Louis, Collinsville, Kansas City

COMPACTION TEST

Job No.	0680806.52KM	**Test Date**	3/4/2005
Sampled By	USCOE	**Tested By**	SD
Sample Date	1/18/2005	**Calc. By**	YAW
Proctor No.	1075	**Ch'd By**	ARK



PROJECT NAME

Argentine Levee Unit – Borrow Area

SPECIFICATIONS

Standard Proctor	
ASTM D 698	Method A
Percent of Compaction	N/A
Moisture Range ±%	N/A

PROCTOR TEST RESULTS

Max. Dry Density	Optimum Water Content
113.9 pcf	14.6%

ATTERBERG LIMITS (ASTM D-4318)

Liquid Limit	Plastic Limit	Plasticity Index
27	17	10

DESCRIPTION

Dark brown clayey SAND

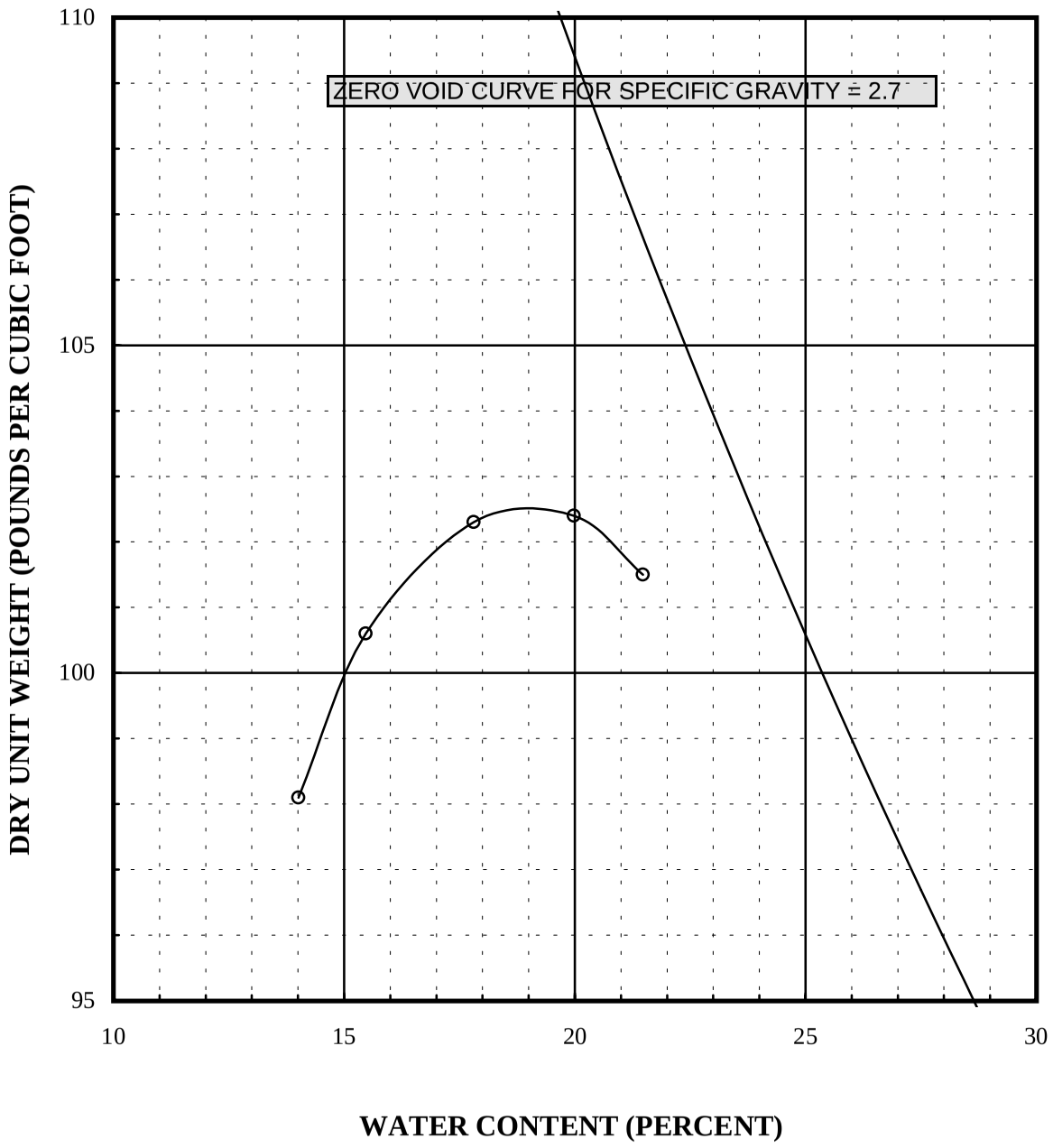
SAMPLE LOCATION

AD 529, 3.0-6.0 feet below grade

GEOTECHNOLOGY, INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
St. Louis, Collinsville, Kansas City

COMPACTION TEST

Job No.	0681901.32KT	**Test Date**	3/7/2005
Sampled By	USCOE	**Tested By**	SD
Sample Date	1/18/2005	**Calc. By**	YAW
Proctor No.	1077	**Ch'd By**	ARK



PROJECT NAME

Argentine Levee Unit – Borrow Area

SPECIFICATIONS

Standard Proctor	
ASTM D 698	Method A
Percent of Compaction	N/A
Moisture Range ±%	N/A

PROCTOR TEST RESULTS

Max. Dry Density	Optimum Water Content
102.5 pcf	19.0%

ATTERBERG LIMITS (ASTM D-4318)

Liquid Limit	Plastic Limit	Plasticity Index
47	19	28

DESCRIPTION

Dark brown sandy low plasticity CLAY

SAMPLE LOCATION

AD 535, , 1.0-4.5 feet below grade

GEOTECHNOLOGY, INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
St. Louis, Collinsville, Kansas City

COMPACTION TEST

Job No.	0681901.32KT	**Test Date**	3/4/2005
Sampled By	USCOE	**Tested By**	SD
Sample Date	1/18/2005	**Calc. By**	YAW
Proctor No.	1076	**Ch'd By**	ARK

LOG OF BORING AD-528

US Army Corps of Engineers ®
Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-528
LOCATION: Kansas and Missouri
COORDINATES: N 14190735.79, E 1141877.29 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/18/05 - 1/18/05

FIELD DATA

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

DEPTH (ft)	DESCRIPTION OF STRATUM	LEGEND
0	CLAY HARD DRY BROWN frozen	0.5 0.8
2	GRAVELLY COBBLES MODERATELY HARD GREY decomposed rock	
4	LEAN CLAY MEDIUM DAMP - MOIST DARK BROWN	4.6
6	FINE SAND LOOSE - MEDIUM COMPACT DRY LIGHT BROWN	
8		8.4
10	SILT LOOSE DRY GREY	10.0
	Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug	

Fill (made ground)
USCS Low Plasticity Clay
USCS Poorly-graded Sand
USCS Silt

LABORATORY DATA

USCS SYMBOL	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification	OTHER LAB DATA
			29.2	VG5	
				VG5	
CL	29	8		VG1	
CL	39	19	25	VG1	
				VG3	
				VG2	

OTHER LAB DATA: S: Minus 200 Sieve (%); U: Unconfined Compressive Strength (tsf); C: Confining Pressure (psi); F: Failure Strain (%); T: Total Sulfates; P: Soil pH

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG1 - CL(LL=39,PI=19); VG2 - ML; VG3 - SP; VG5 - FILL

LOG_A_2005 KANSAS-CITY-LEVEES.GPJ 4/1/05

LOG OF BORING AD-529

US Army Corps of Engineers ®
Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-529
LOCATION: Kansas and Missouri
COORDINATES: N 14192413.68, E 1142543.89 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/18/05 - 1/18/05

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

FIELD DATA: DEPTH (ft)	SOIL SYMBOL	BREAKS: bb or mb	SAMPLE/DRILL METHOD	BLOWS	T: TORVANE KG/CM SQ	RC: % RQD: % Additional Field Data	DESCRIPTION OF STRATUM	LEGEND	LABORATORY DATA: USCS SYMBOL	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC INDEX (PI)	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification	OTHER LAB DATA
0							FINE SAND FROZEN DARK BROWN					27.5	VG4	
							1.0							
							FINE SAND LOOSE DRY BROWN						VG3	
2							3.0							
							CLAYEY SAND MEDIUM COMPACT DAMP-MOIST DARK BROWN		SC	27	10	21.2	VG4	
4							4.5							
							CLAY SOFT DAMP DARK BROWN very silty					24.9	VG1	
							6.0							
6							FINE SAND LOOSE-MEDIUM DRY-DAMP LIGHT BROWN silty						VG3	
8								USCS Silty Sand USCS Poorly-graded Sand USCS Clayey Sand USCS Low Plasticity Clay						
							10.0							
10							Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug							

OTHER LAB DATA:
S: Minus 200 Sieve (%)
U: Unconfined Compressive Strength (tsf)
C: Confining Pressure (psi)
F: Failure Strain (%)
T: Total Sulfates
P: Soil pH

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG1 - CL(LL=39,PI=19); VG3 - SP; VG4 - SM

LOG_A_2005 KANSAS-CITY-LEVEES.GPJ 4/1/05

LOG OF BORING AD-530

US Army Corps of Engineers ®
Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-530
LOCATION: Kansas and Missouri
COORDINATES: N 14192416.14, E 1143534.5 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/12/05 - 1/18/05

FIELD DATA

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

DEPTH (ft)	SOIL SYMBOL	BREAKS: bb or mb	SAMPLE/DRILL METHOD	BLOWS	T: TORVANE KG/CM SQ	RC: % RQD: % Additional Field Data	DESCRIPTION OF STRATUM	LEGEND
0							SILTY SAND FROZEN DARK BROWN fine grained	1.0
							FINE SAND LOOSE DRY-DAMP BROWN poorly graded	1.5 2.5
2							SILT MEDIUM COMPACT DAMP DARK BROWN	4.3
4							SILT MEDIUM COMPACT LIGHT BROWN	
							SILT MEDIUM COMPACT DAMP GRAYISH BROWN sandy wet zone	8.0
6								USCS Silty Sand USCS Poorly-graded Sand USCS Silt
8							SILTY SAND MEDIUM COMPACT DAMP LIGHT BROWN laminated fine grained	10.0
10							Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug	

LABORATORY DATA

USCS SYMBOL	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC INDEX PI	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification	OTHER LAB DATA
				VG4	
			4	VG3	
			20	VG2	
			11	VG2	
			25	VG2	
				VG4	

OTHER LAB DATA
S: Minus 200 Sieve (%)
U: Unconfined Compressive Strength (tsf)
C: Confining Pressure (psi)
F: Failure Strain (%)
T: Total Sulfates
P: Soil pH

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG2 - ML; VG3 - SP; VG4 - SM

LOG_A_2005 KANSAS-CITY-LEVEES.GPJ 4/1/05

LOG OF BORING AD-531

US Army Corps of Engineers ®
Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-531
LOCATION: Kansas and Missouri
COORDINATES: N 14193052.59, E 1144847.77 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/18/05 - 1/18/05

FIELD DATA

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

LABORATORY DATA

OTHER LAB DATA: S: Minus 200 Sieve (%); U: Unconfined Compressive Strength (tsf); C: Confining Pressure (psi); F: Failure Strain (%); T: Total Sulfates; P: Soil pH

DEPTH (ft)	DESCRIPTION OF STRATUM	LEGEND	USCS SYMBOL	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification
0	SILTY SAND FROZEN LIGHT BROWN very fine grained					14	VG4
1.0	LEAN CLAY SOFT-VERY SOFT DAMP DARK BROWN very silty ~ 30-40 % silt					22	VG1
2							
3.5	SILT LOOSE DRY BROWN with fine sand						VG2
4.0						25	VG2
4							
6	SILT MEDIUM COMPACT DAMP BROWN slightly sandy ~ 10-15 % very fine sand						
6.5	FINE SAND MEDIUM COMPACT - LOOSE DAMP-DRY LIGHT BROWN						VG3
8							
10.0							
10	Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug						

USCS Silty Sand
USCS Low Plasticity Clay
USCS Silt
USCS Poorly-graded Sand

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG1 - CL(LL=39,PI=19); VG2 - ML; VG3 - SP; VG4 - SM

LOG_A_2005 KANSAS-CITY-LEVEES.GPJ 4/1/05

LOG OF BORING AD-532

US Army Corps of Engineers ®
Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-532
LOCATION: Kansas and Missouri
COORDINATES: N 14192422.33, E 1144971.11 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/18/05 - 1/18/05

FIELD DATA

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

LABORATORY DATA

OTHER LAB DATA: S: Minus 200 Sieve (%); U: Unconfined Compressive Strength (tsf); C: Confining Pressure (psi); F: Failure Strain (%); T: Total Sulfates; P: Soil pH

DEPTH (ft)	DESCRIPTION OF STRATUM	LEGEND	USCS SYMBOL	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification
0	LEAN CLAY MEDIUM MOIST DARK BROWN frozen to 1.0 ft					26	VG1
4.3							
	LEAN CLAY MEDIUM MOIST-WET DARK BROWN silty					31	VG1
6.3							
	SILT MEDIUM COMPACT DRY-DAMP LIGHT BROWN sandy	USCS Low Plasticity Clay USCS Silt					VG2
10.0							
	Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug						

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG1 - CL(LL=39,PI=19); VG2 - ML

LOG_A_2005 KANSAS-CITY-LEVEES.GPJ 4/1/05

LOG OF BORING AD-533

US Army Corps of Engineers ®
Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-533
LOCATION: Kansas and Missouri
COORDINATES: N 14193066.09, E 1145518.24 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/18/05 - 1/18/05

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

FIELD DATA: DEPTH (ft)	SOIL SYMBOL	BREAKS: bb or mb	SAMPLE/DRILL METHOD	BLOWS	T: TORVANE KG/CM SQ	RC: % RQD: % Additional Field Data	DESCRIPTION OF STRATUM	LEGEND	LABORATORY DATA: USCS SYMBOL	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC INDEX (PI)	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification	OTHER LAB DATA
0							LEAN CLAY MEDIUM DAMP DARK BROWN silty					19	VG1	
2							2.3							
							SILT MEDIUM COMPACT DRY-DAMP LIGHT BROWN with fine-grained sand					10	VG2	
4							4.3							
							SILT MEDIUM COMPACT DRY-DAMP BROWN with very fine-grained sand					15	VG2	
6							6.0							
							LEAN CLAY MEDIUM MOIST DARK BROWN with silt	USCS Low Plasticity Clay				26	VG1	
8							8.0							
							SILT MEDIUM COMPACT DRY-DAMP LIGHT BROWN with very fine-grained sand	USCS Silt					VG2	
10							10.0							
							Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug							

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG1 - CL(LL=39,PI=19); VG2 - ML

OTHER LAB DATA: S: Minus 200 Sieve (%); U: Unconfined Compressive Strength (tsf); C: Confining Pressure (psi); F: Failure Strain (%); T: Total Sulfates; P: Soil pH

LOG_A_2005 KANSAS-CITY-LEVEES.GPJ 4/1/05

LOG OF BORING AD-534

US Army Corps of Engineers ®
Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-534
LOCATION: Kansas and Missouri
COORDINATES: N 14192405.24, E 1145517.16 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/19/05 - 1/19/05

FIELD DATA

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

LABORATORY DATA

DEPTH (ft)	SOIL SYMBOL	BREAKS: bb or mb	SAMPLE/DRILL METHOD	BLOWS	T: TORVANE KG/CM SQ	RC: % RQD: % Additional Field Data	DESCRIPTION OF STRATUM	LEGEND	USCS SYMBOL	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC INDEX PI	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification	OTHER LAB DATA
0							LEAN CLAY MEDIUM DAMP DARK BROWN silty					26	VG1	
4							4.0 SILT MEDIUM COMPACT WET DARK BROWN clayey					31	VG2	
6							6.0 LEAN CLAY					35	VG6	
							6.5 SOFT MOIST-WET DARK BROWN silty					28	VG1	
							7.0 LEAN CLAY MEDIUM MOIST-WET DARK BROWN silty	USCS Low Plasticity Clay USCS Silt				16	VG2	
8							SILT MEDIUM COMPACT DRY-DAMP LIGHT BROWN with very fine-grained sand							
10							10.0 Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug							

OTHER LAB DATA
S: Minus 200 Sieve (%)
U: Unconfined Compressive Strength (tsf)
C: Confining Pressure (psi)
F: Failure Strain (%)
T: Total Sulfates
P: Soil pH

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG1 - CL(LL=39,PI=19); VG2 - ML; VG6 - CL(LL=47,PI=28)

LOG_A_2005 KANSAS-CITY-LEVEES.GPJ 4/1/05

LOG OF BORING AD-535

US Army Corps of Engineers ®
Department of the Army
Kansas City District
Corps of Engineers
700 Federal Building
Kansas City, MO 64106

INSTALLATION: Kansas City, Seven Levees
PROJECT: Argentine Levee Unit-Borrow Area
BORING NUMBER: AD-535
LOCATION: Kansas and Missouri
COORDINATES: N 14193402.93, E 1146504.01 ; NAD 83 UTM 15N feet
ELEVATION: 0.0 (ft)
DATE(S) DRILLED: 1/18/05 - 1/18/05

FIELD DATA

DRILLING METHOD(S): Diedrich D-90, 3 3/4" ID hollow stem auger, 3" ID inner barrel sampler

Driller: Mike Cooney Geologist:Jennifer Denzer

GROUNDWATER INFORMATION:
No water encountered during drilling or after. Dry 1/19/05

▽ Water Level during drilling ▼ Water level after drilling

LABORATORY DATA

OTHER LAB DATA

S: Minus 200 Sieve (%)
U: Unconfined Compressive Strength (tsf)
C: Confining Pressure (psi)
F: Failure Strain (%)
T: Total Sulfates
P: Soil pH

DEPTH (ft)	SOIL SYMBOL	BREAKS: bb or mb	SAMPLE/DRILL METHOD	BLOWS	T: TORVANE KG/CM SQ	RC: % RQD: % Additional Field Data	DESCRIPTION OF STRATUM	USCS SYMBOL	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	MOISTURE CONTENT (%)	VG=Visual Grouping FC=Field Classification
0							LEAN CLAY SOFT DAMP DARK BROWN silty ~ 10-15% silt	CL	47	28	20	VG6
4.5								CL	47	28		
7.5							LEAN CLAY MEDIUM WET DARK BROWN silty				30	VG1
8							SILT MEDIUM COMPACT DAMP					VG2
8.5							LIGHT BROWN with very fine-grained sand					VG3
9.5							FINE SAND LOOSE DRY					VG2
10.0							LIGHT BROWN poorly graded SILT MEDIUM COMPACT DAMP-MOIST BROWN sandy					
							Bottom of hole - No Refusal Backfilled to surface with cuttings and 3 bags Holeplug					

LEGEND

- USCS Low Plasticity Clay
- USCS Silt
- USCS Poorly-graded Sand

R: BLOW COUNT REFUSAL = >50 blows/1/2 foot for SPT, > 100 blows for drive barrel
T - TORVANE EQUALLY SPACED ALONG SAMPLE
RC - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS: Coordinates Trimble Hand GPS
VG1 - CL(LL=39,PI=19); VG2 - ML; VG3 - SP; VG6 - CL(LL=47,PI=28)

LOG_A_2005 KANSAS-CITY-LEVEES.GPJ 4/1/05

EXHIBIT A-11.3
Kansas City's Levee Utility Criteria

KANSAS CITY'S LEVEE GRAVITY AND UTILITY PIPELINE GUIDANCE

The purpose of this document is to provide specific guidance as to the disposition of existing utilities and drainage structures within the sections of levee to be raised. This guidance will be used for the feasibility level of effort in order to develop reasonable costs associated with the modification of drainage structures and the relocation of utilities.

GRAVITY PIPELINES

Existing pipelines crossing the levee that do not meet current COE criteria shall be replaced with pipelines that are compliant. Existing pipelines that meet current COE criteria shall remain with the following exceptions:

Any Corrugated Metal Pipe (CMP) with a diameter greater than 36" shall be replaced with a minimum diameter 48" Reinforced Concrete Pipe (RCP).

Any pipe inadequate to handle the drainage shall be replaced with a minimum diameter 48" RCP.

Any pipe known to have joints that are not watertight shall be replaced with a minimum diameter 48" RCP.

Pipe strengths, unless otherwise known, will be assumed to be that required by Corps criteria at the time of their installation. Pipe condition shall be determined by field assessment.

GATEWELLS AND POSITIVE CLOSURES

In areas where levee raises are performed, positive closure will be provided for all drainage and utility lines crossing the levee. In some cases this will involve replacing existing landside gatewells with riverside closure structures. EM 385-1-1 - *Safety and Health Requirements Manual* (and OSHA) give safety requirements for ascending heights greater than 20 feet, which most existing gatewell structures may not meet. New or modified existing gatewells will be designed to meet current safety requirements. In some instances this may require replacing existing gatewell structures.

PRESSURE PIPELINES CROSSING THROUGH OR UNDER LEVEES

It is preferable for all pressure pipes to cross over the levee rather than penetrate the embankment or foundation materials. This includes pipes carrying gas or liquid. Where raises are made to the levee, pressure lines shall be relocated over the crest of the new levee raise.

Before consideration is given to allowing a pressure pipe to remain through or beneath the levee, the pipe owner shall provide an engineering study to support their request. The owner, regardless of the type of pipe, shall show adequate capability as to the condition of the existing pipe. An agreement shall be formed between the owner and the levee district to the effect that should repairs to a pipe in the levee become necessary, the pipe will be abandoned, grouted, and relocated over the levee.

ABANDONED PIPELINES

Pipelines, which are currently abandoned and grouted in accordance with COE criteria under or through the levee, will not be disturbed. Pipes that have been abandoned and do not meet criteria shall be removed or grouted accordingly. Pipelines that are currently active but are to be abandoned as part of this project will be removed or grouted full in accordance with criteria.

SUMMARY OF RECOMMENDATIONS

For sections of levee to be raised, current Corps requirements will be extended to all components of that levee section, including any pipes and closure structures therein.

EXHIBIT A-11.4
500 year Flood Event

Designed by: Bolte Nov-03
Checked by : Loehr Nov-03

6-Inch Steel Pipe		8-Inch Steel Pipe		12-Inch Steel Pipe		16-Inch Steel Pipe		24-Inch Steel Pipe		48-Inch Steel Pipe	
Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee
2	350	2	450	2	950	2	---	6	1100	15	875
3.33	300	4	350	4	475	4	750	10	550	30	450
4	275	10	250	10	300	10	400	15	425	45	350
10	250	15	225	15	250	15	300	30	300		
15	225	30	225	30	225	30	275	45	275		

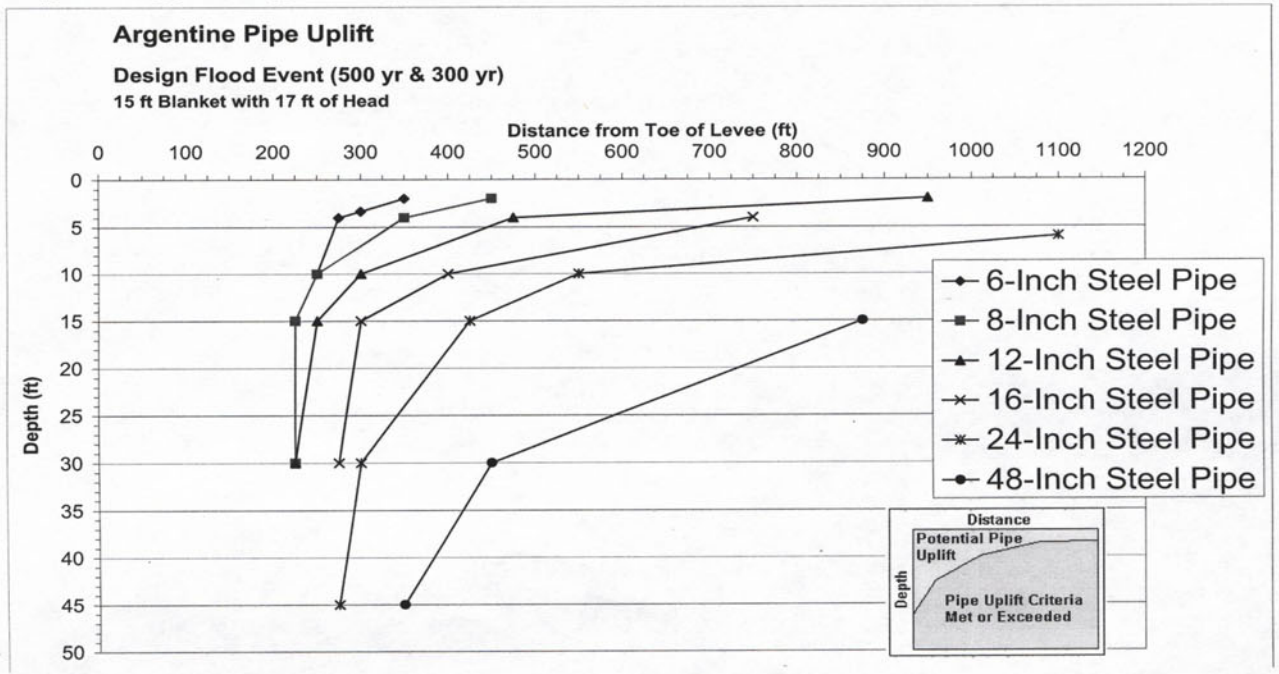


EXHIBIT A-11.5
500 year Flood Event

6-Inch Steel Pipe		8-Inch Steel Pipe		12-Inch Steel Pipe		16-Inch Steel Pipe		24-Inch Steel Pipe		48-Inch Steel Pipe	
Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee
0	0	1	1000	2	950	4	500	6	750	15	550
2	0	2	50	3.333	175	6	100	10	100	20	200
4	0	3	0	4	50	8	0	13	0	29	0
10	0			5	0	15	0	30	0	45	0
15	0			15	0	30	0	45	0		

Designed by:	Bolte	11 2004
Checked by :	Loehr	11 2004

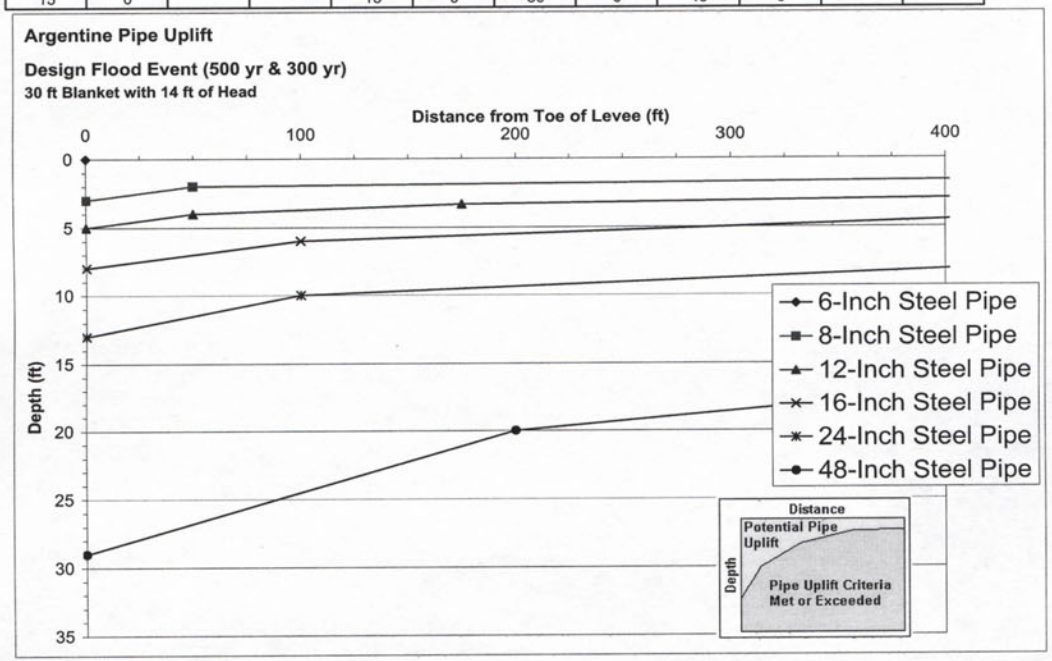


EXHIBIT A-11.6
500 year Flood Event + 3 ft

6-Inch Steel Pipe		8-Inch Steel Pipe		12-Inch Steel Pipe		16-Inch Steel Pipe		24-Inch Steel Pipe		48-Inch Steel Pipe	
Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee
2	400	2	525	2	1000	4	775	6	1100	15	875
4	350	4	375	4	550	10	425	10	575	30	500
10	325	10	325	10	375	15	375	15	450	45	400
15	300	15	325	15	350	30	325	30	375		
30	300	30	300	30	325			45	350		

Designed by: Bolte 11 2004
Checked by : Loehr 11 2004

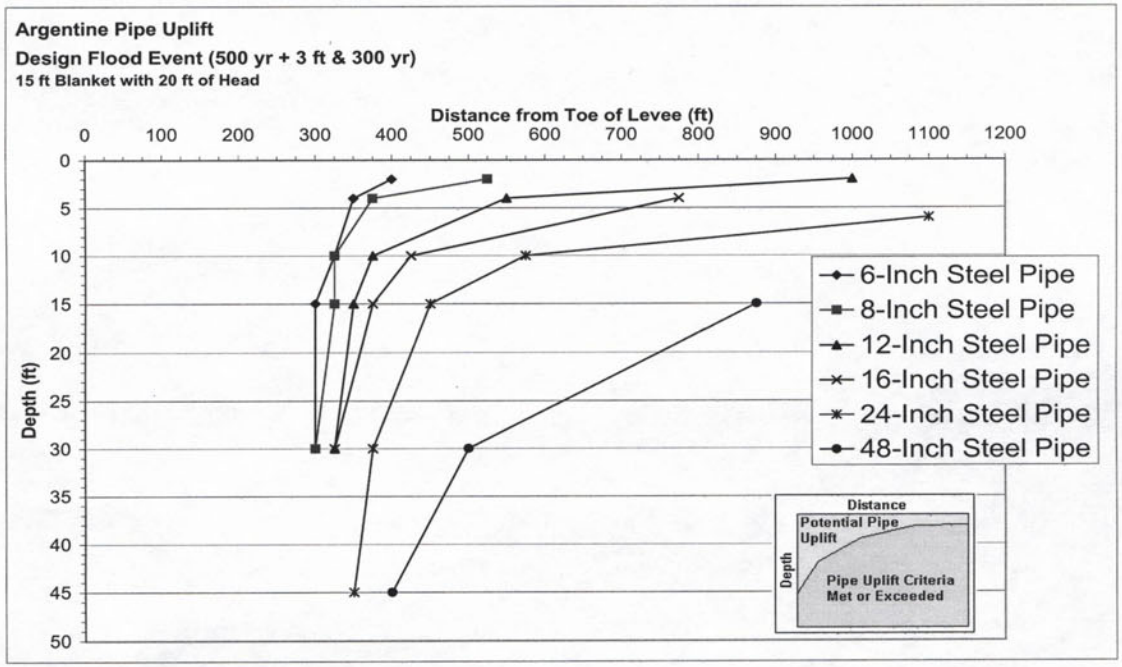


EXHIBIT A-11.7
500 year Flood Event +3 ft

Designed by:	Bolte	11 2004
Checked by :	Loehr	11 2004

6-Inch Steel Pipe		8-Inch Steel Pipe		12-Inch Steel Pipe		16-Inch Steel Pipe		24-Inch Steel Pipe		48-Inch Steel Pipe	
Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee
0	0	1	1000	2	950	4	500	6	800	15	600
2	0	2	125	4	100	6	150	10	175	20	225
4	0	4	0	6	0	10	0	15	25	30	50
10	0			15	0	15	0	17	0	38	0
15	0			30	0	30	0	45	0		

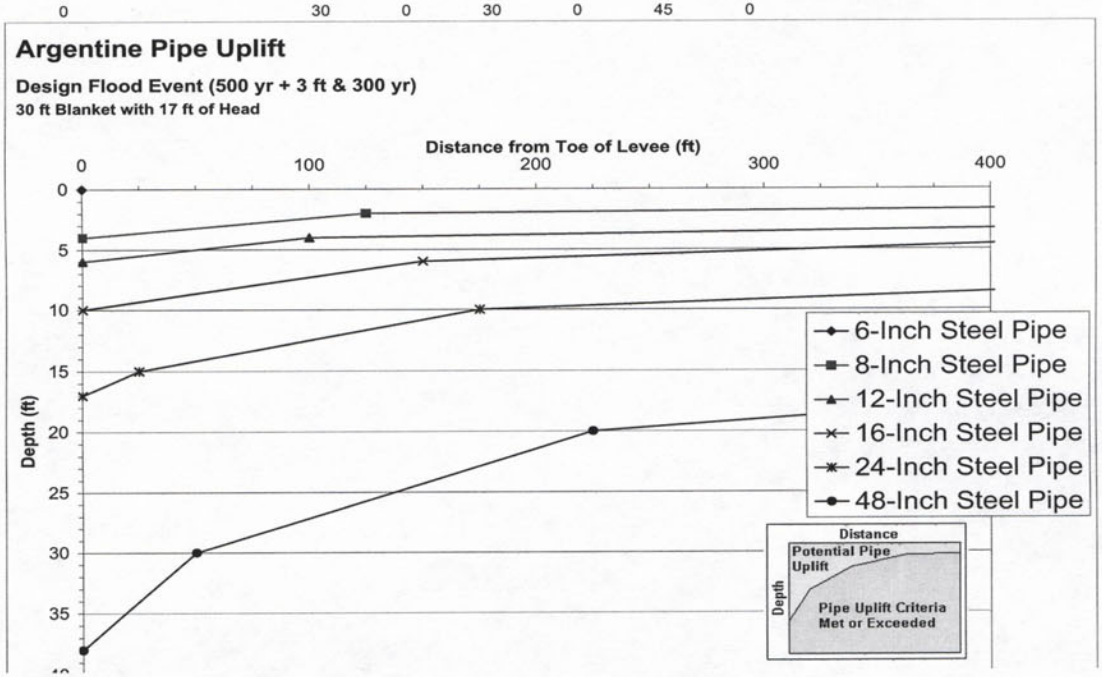


EXHIBIT A-11.8
500 year Flood Event +5 ft

Designed by:	Bolte	11 2004
Checked by :	Loehr	11 2004

6-Inch Steel Pipe		8-Inch Steel Pipe		12-Inch Steel Pipe		16-Inch Steel Pipe		24-Inch Steel Pipe		48-Inch Steel Pipe	
Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee	Pipe Depth	Minimum Distance from Toe of Levee
0.5	600	1	1050	2	1000	4	500	6	700	15	600
1	225	2	200	4	175	6	225	10	250	20	300
2	25	5	0	6	75	10	75	15	100	30	125
3	0			9	0	15	0	25	0	55	0
				30	0	30		45	0		

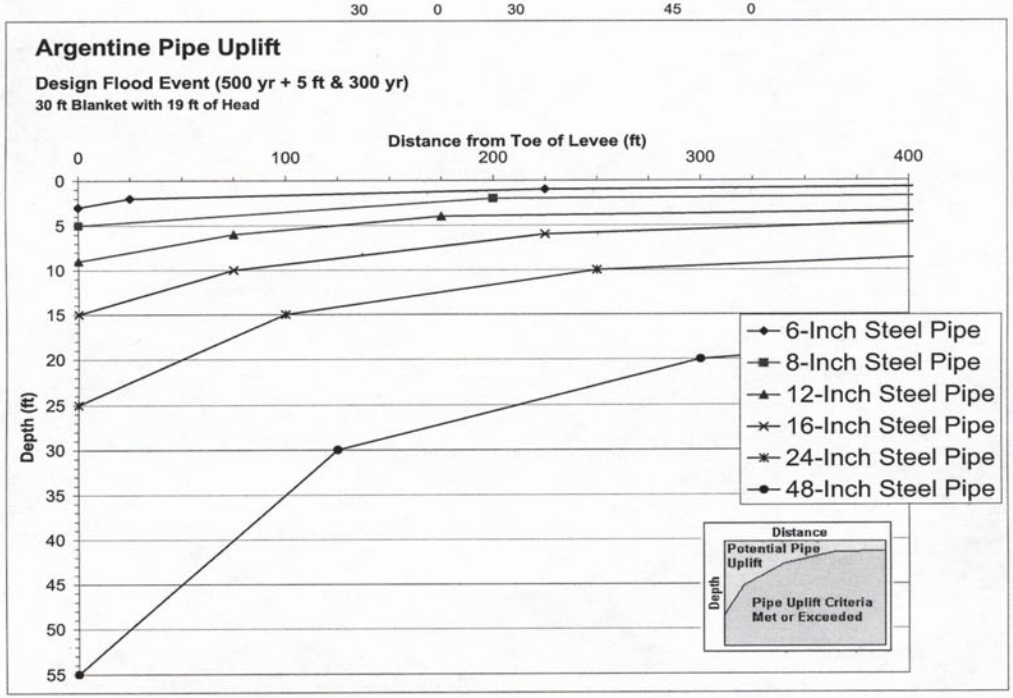


EXHIBIT A-11.9
Argentine Uplift N500+0

KC Levee - Argentine Unit - N500+0
Utilities that are subject to Uplift concerns
These utilities are located on the landside of the Argentine Levee Unit

Assumptions:
For the purposes of uplift existing utility lines are buried to frost depth
All Lines shall be lowered 2 feet to alleviate the concern with uplift
Manholes shall be removed and replaced with new structures
No information available on natural gas lines or petroleum lines
UGE Lines are assumed not affected by uplift
Underseepage berms considered in development of uplift on utilities

Station	Blanket Thickness	12" SS lines	Manholes	6" Water Lines	12" Water Lines	16" Water Lines
0+00 to 15+00	28'	0	2	0	0	0
15+00 to 25+00	28'	0	4	0	0	0
25+00 to 45+00	35'	0	5	0	0	0
45+00 to 60+00	20'	0	0	225	0	0
60+00 to 70+00	23'	390	1	380	0	0
70+00 to 85+00	16'	350	1	170	0	0
85+00 to 95+00	28'	0	0	0	0	0
95+00 to 110+00	30'	0	0	0	0	0
110+00 to 125+00	20'	0	0	380	800	0
125+00 to 138+00	20'	0	0	430	0	0
138+00 to 153+00	25'	0	0	0	0	0
153+00 to 168+00	25'	0	1	0	0	0
168+00 to 180+00	10'	240	1	0	0	0
180+00 to 195+00	23'	0	0	0	0	0
195+00 to 208+00	25'	0	0	0	0	0
208+00 to 220+00	25'	0	4	0	0	0
220+00 to 235+00	30'	0	4	0	0	0
235+00 to 248+00	28'	0	1	0	0	0
248+00 to 260+00	28'	0	0	0	0	130
260+00 to 275+00	28'	0	0	0	0	300
275+00 to 288+00	40'	0	4	0	0	0
Total Length in Feet		**980**	**28**	**1585**	**800**	**430**

EXHIBIT A-11.10
Argentine Uplift N500+3

KC Levee - Argentine Unit - N500+3
Utilities that are subject to Uplift concerns
These utilities are located on the landside of the Argentine Levee Unit

Assumptions:
For the purposes of uplift existing utility lines are buried to frost depth
All Lines shall be lowered 2 feet to alleviate the concern with uplift
Manholes shall be removed and replaced with new structures
No information available on natural gas lines or petroleum lines
UGE Lines are assumed not affected by uplift
Underseepage berms considered in development of uplift on utilities

Station	Blanket Thickness	12" SS lines	Manholes	6" Water Lines	12" Water Lines	16" Water Lines
0+00 to 15+00	28'	0	2	0	0	0
15+00 to 25+00	28'	0	4	0	0	0
25+00 to 45+00	35'	0	5	0	0	0
45+00 to 60+00	20'	0	0	525	0	0
60+00 to 70+00	23'	470	1	480	0	0
70+00 to 85+00	16'	475	1	170	0	0
85+00 to 95+00	28'	0	0	0	0	0
95+00 to 110+00	30'	0	0	0	0	0
110+00 to 125+00	20'	0	0	450	800	0
125+00 to 138+00	20'	0	0	540	0	0
138+00 to 153+00	25'	0	0	0	0	0
153+00 to 168+00	25'	0	1	0	0	0
168+00 to 180+00	10'	240	1	0	0	0
180+00 to 195+00	23'	0	0	0	0	0
195+00 to 208+00	25'	0	0	0	0	0
208+00 to 220+00	25'	0	4	0	0	0
220+00 to 235+00	30'	0	4	0	0	0
235+00 to 248+00	28'	0	1	0	0	0
248+00 to 260+00	28'	0	0	0	0	130
260+00 to 275+00	28'	0	0	0	0	300
275+00 to 288+00	40'	0	4	0	0	0
Total Length in Feet		**1185**	**28**	**2165**	**800**	**430**

EXHIBIT A-11.11
Argentine Uplift N500+5

KC Levee - Argentine Unit - N500+5
Utilities that are subject to Uplift concerns
These utilities are located on the landside of the Argentine Levee Unit

Assumptions:
For the purposes of uplift existing utility lines are buried to frost depth
All Lines shall be lowered 2 feet to alleviate the concern with uplift
Manholes shall be removed and replaced with new structures
No information available on natural gas lines or petroleum lines
UGE Lines are assumed not affected by uplift
Underseepage berms considered in development of uplift on utilities

Station	Blanket Thickness	12" SS lines	Manholes	6" Water Lines	12" Water Lines	16" Water Lines
0+00 to 15+00	28'	0	2	0	0	0
15+00 to 25+00	28'	0	4	0	0	0
25+00 to 45+00	35'	0	5	0	0	0
45+00 to 60+00	20'	0	0	525	0	0
60+00 to 70+00	23'	470	1	480	0	0
70+00 to 85+00	16'	475	1	170	0	0
85+00 to 95+00	28'	0	0	0	0	0
95+00 to 110+00	30'	0	0	0	0	0
110+00 to 125+00	20'	0	0	450	800	0
125+00 to 138+00	20'	0	0	540	0	0
138+00 to 153+00	25'	0	0	0	0	0
153+00 to 168+00	25'	0	1	0	0	0
168+00 to 180+00	10'	240	1	0	0	0
180+00 to 195+00	23'	0	0	0	0	0
195+00 to 208+00	25'	0	0	0	0	0
208+00 to 220+00	25'	0	4	0	0	0
220+00 to 235+00	30'	0	4	0	0	0
235+00 to 248+00	28'	0	1	0	0	0
248+00 to 260+00	28'	0	0	0	0	130
260+00 to 275+00	28'	0	0	0	0	300
275+00 to 288+00	40'	0	4	0	0	0
Total Length in Feet		**1185**	**28**	**2165**	**800**	**430**

EXHIBIT A-11.12
Argentine Unit Utility Crossing Relocations

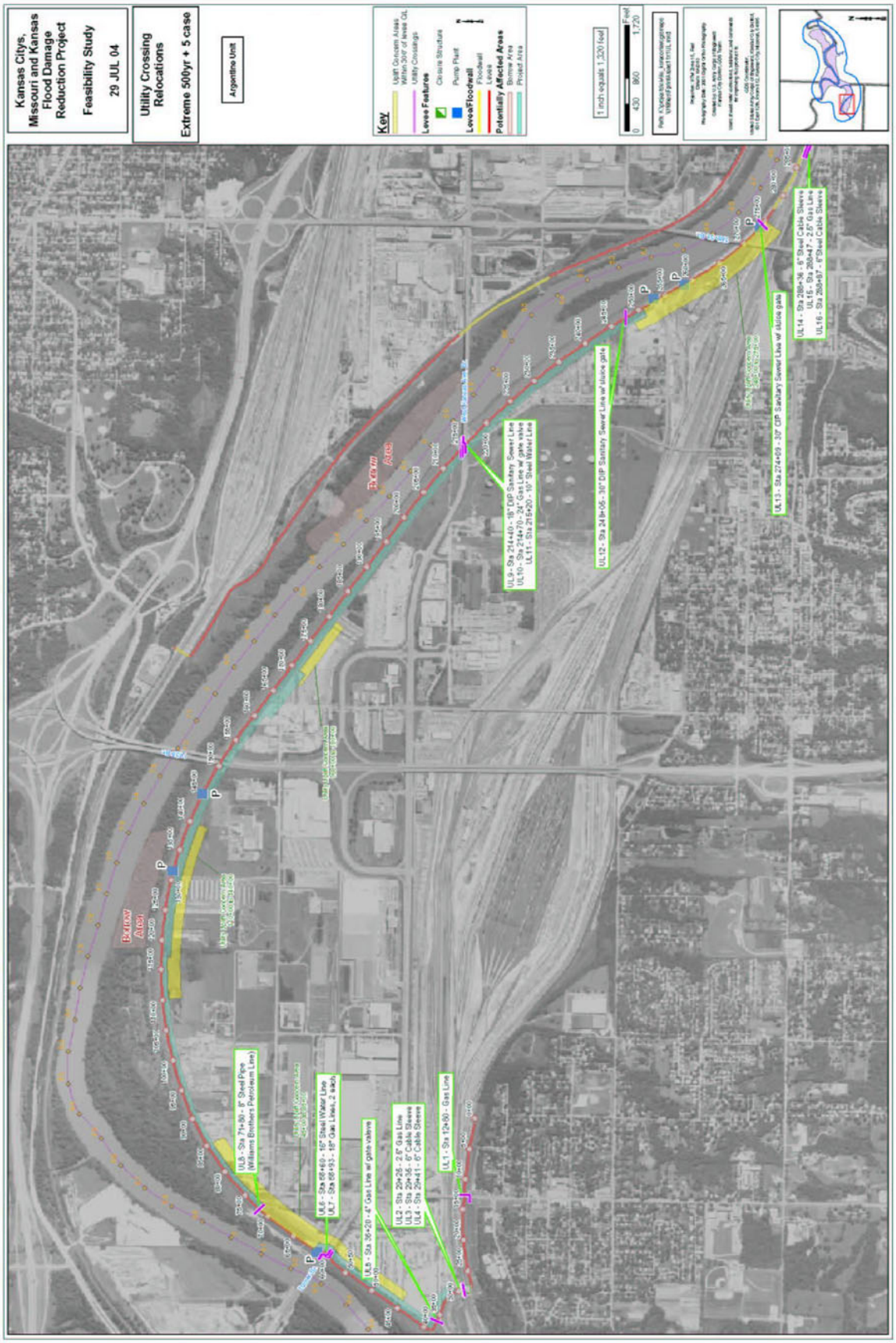


EXHIBIT A-11.13
Argentine Unit Utility Crossing Detail

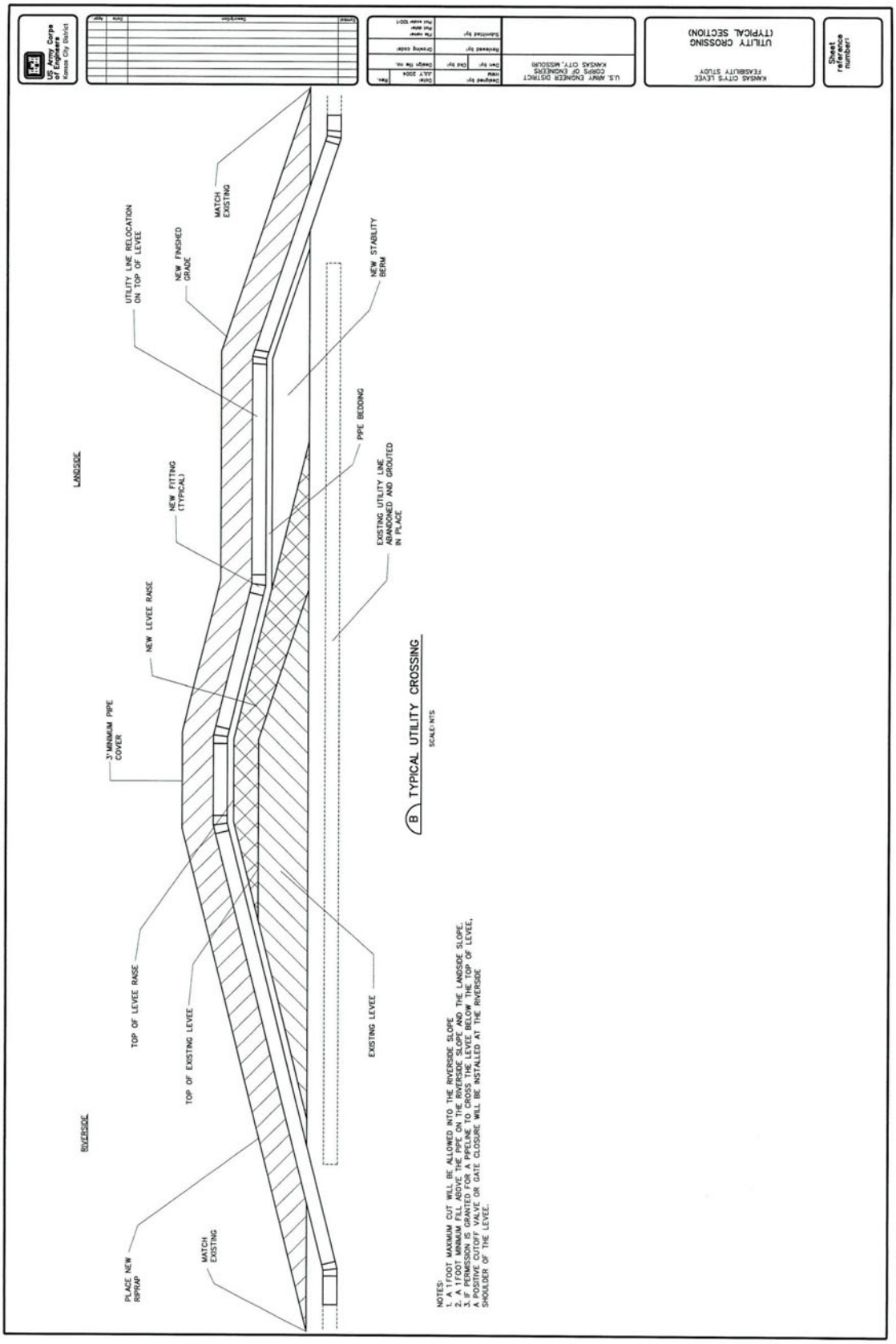


EXHIBIT A-11.14
Argentine Tower Photo

EXHIBIT A-11.15
Argentine Utility Uplift

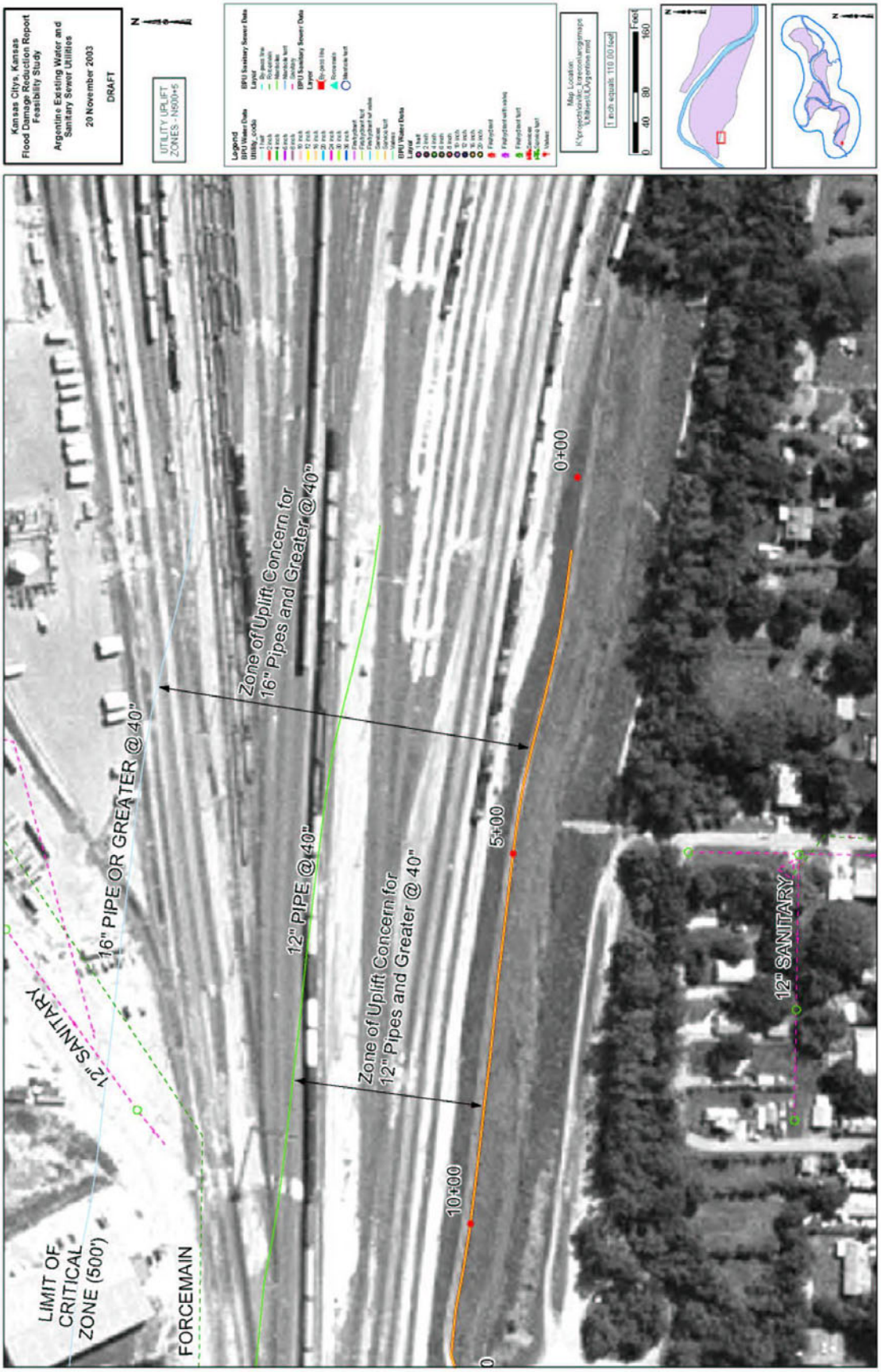


EXHIBIT A-11.16
Argentine Utility Uplift

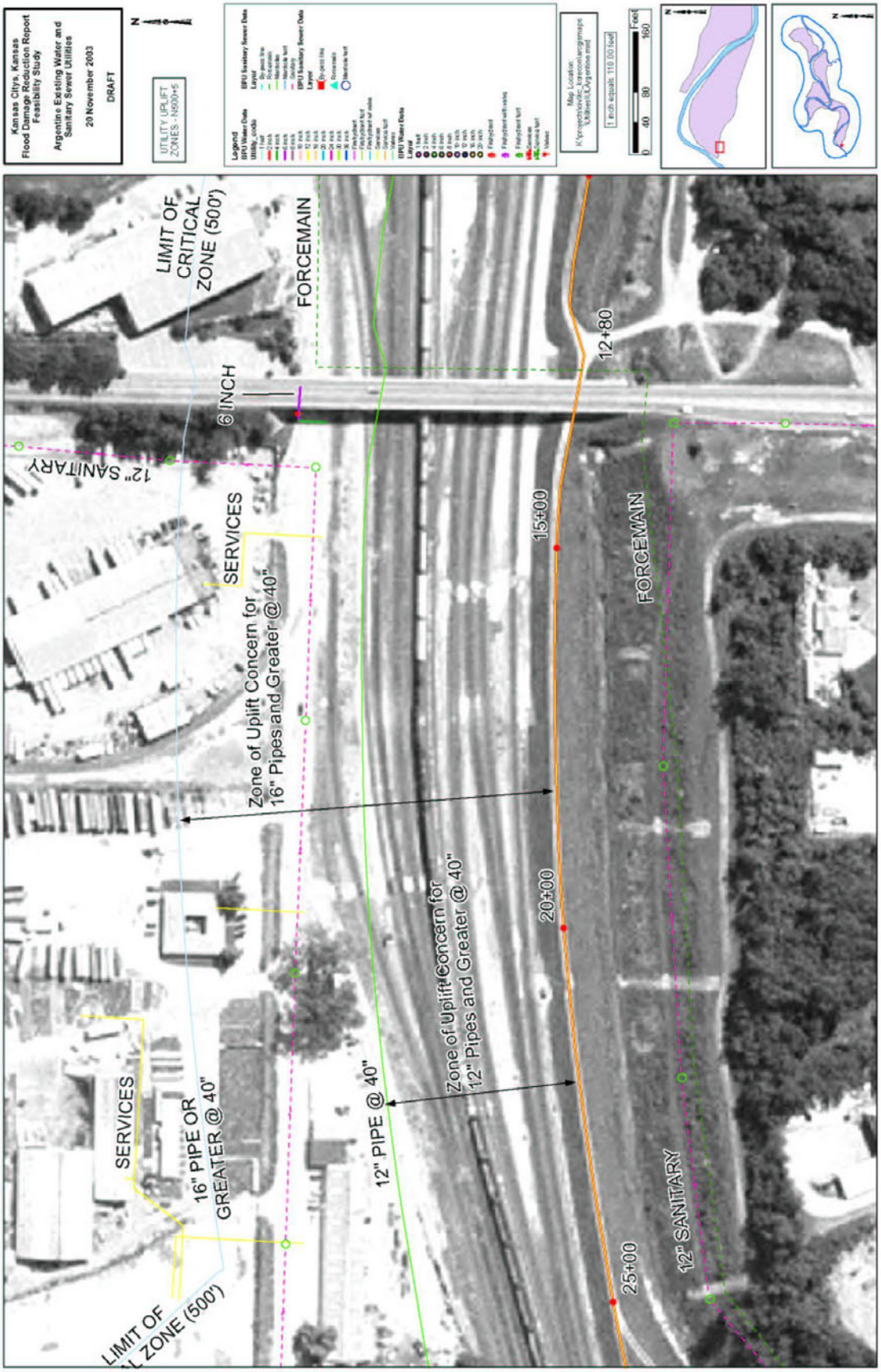


EXHIBIT A-11.17
Argentine Utility Uplift

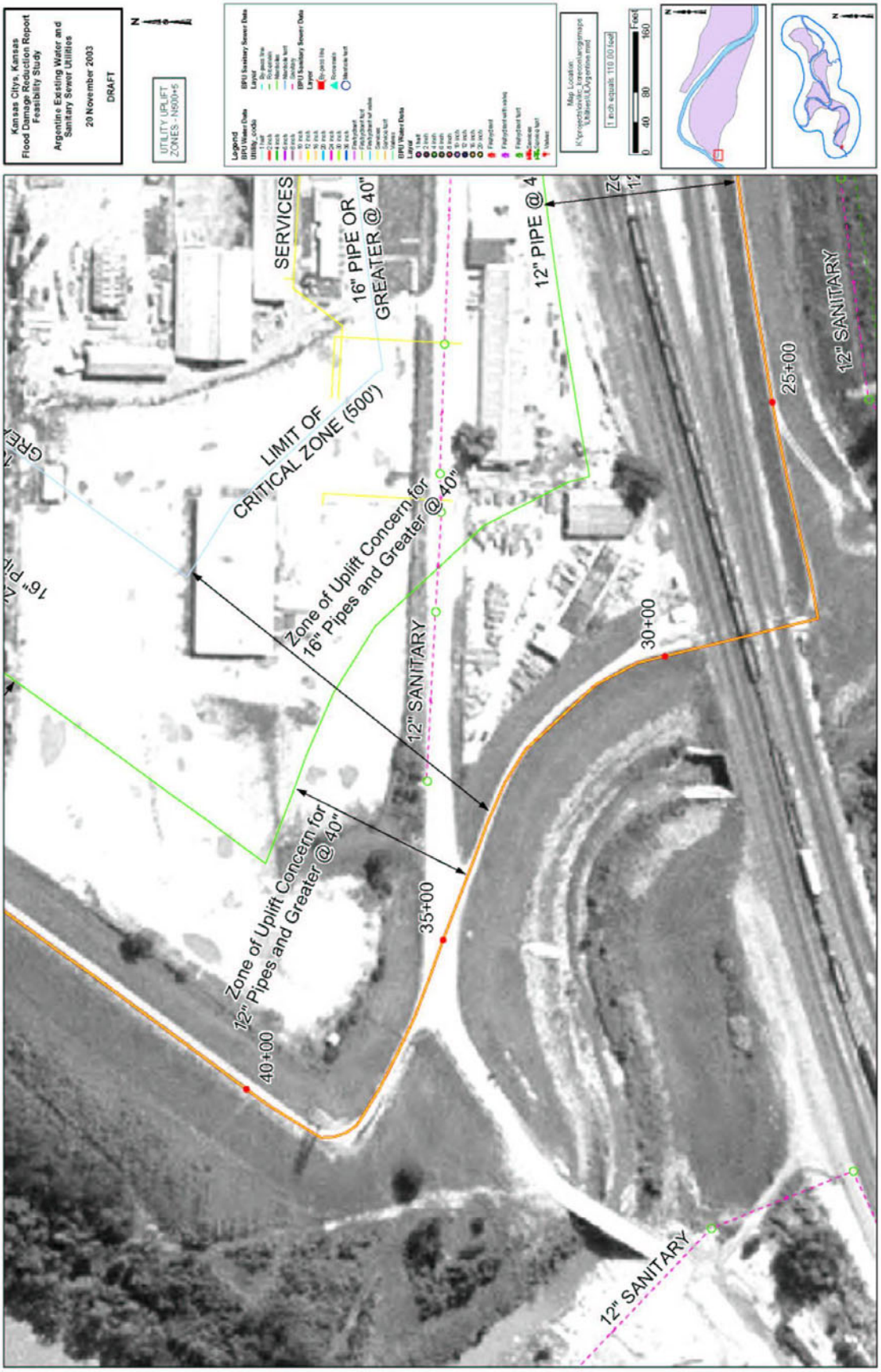


EXHIBIT A-11.18
Argentine Utility Uplift

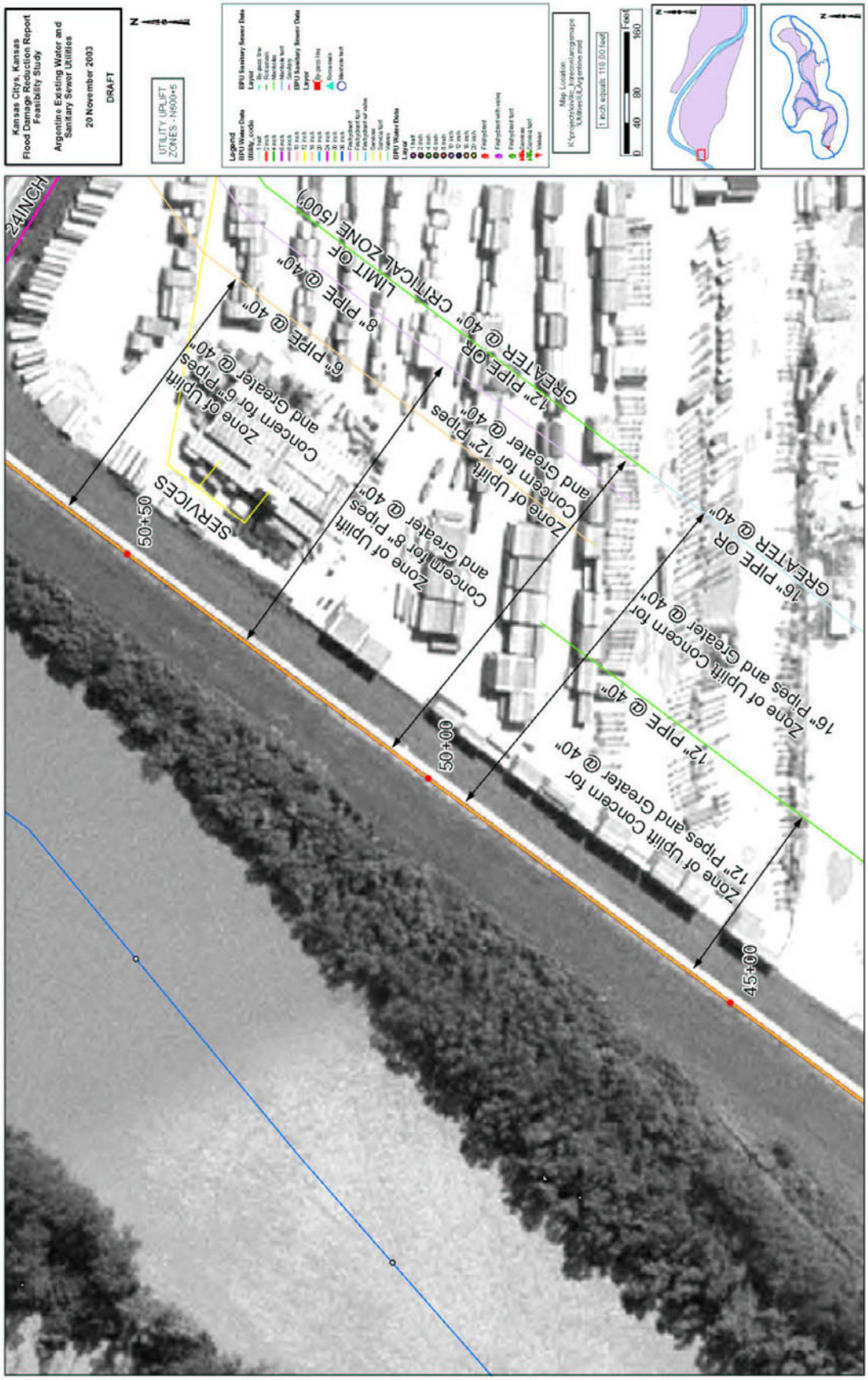


EXHIBIT A-11.19
Argentine Utility Uplift

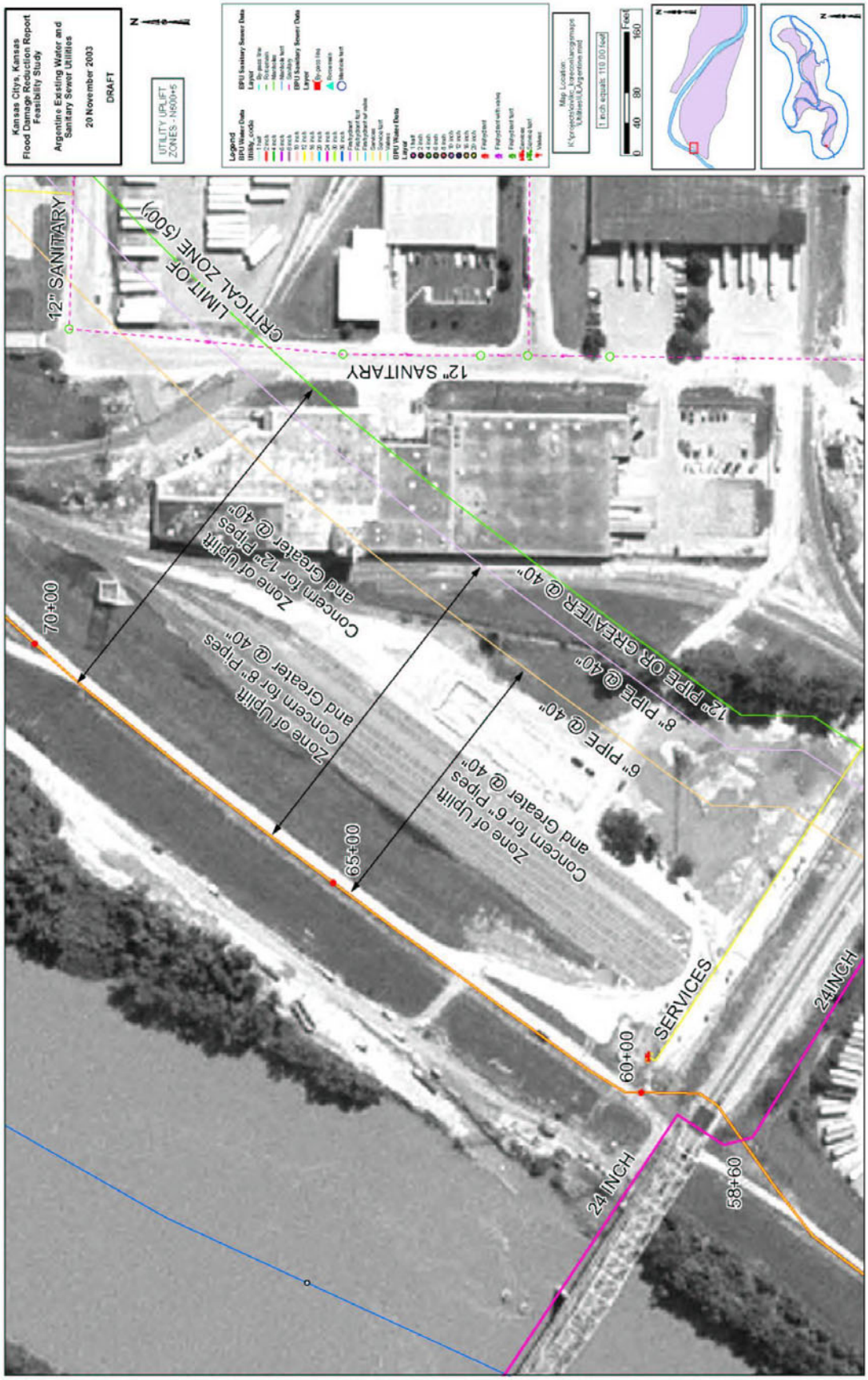


EXHIBIT A-11.20
Argentine Utility Uplift

EXHIBIT A-11.21
Argentine Utility Uplift

EXHIBIT A-11.22
Argentine Utility Uplift

EXHIBIT A-11.23
Argentine Utility Uplift

EXHIBIT A-11.24
Argentine Utility Uplift

EXHIBIT A-11.25
Argentine Utility Uplift

EXHIBIT A-11.26
Argentine Utility Uplift

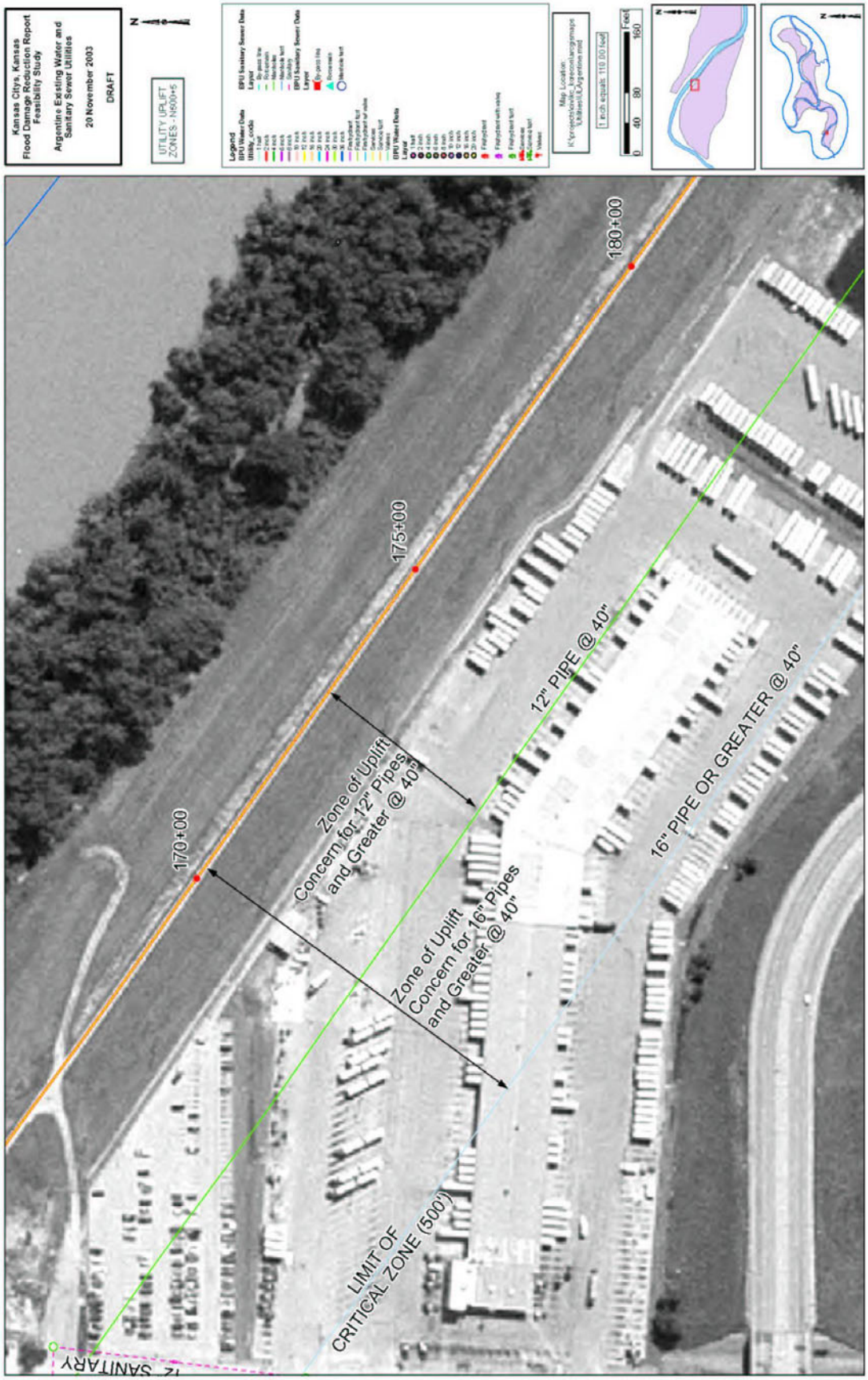


EXHIBIT A-11.27
Argentine Utility Uplift

EXHIBIT A-11.28
Argentine Utility Uplift

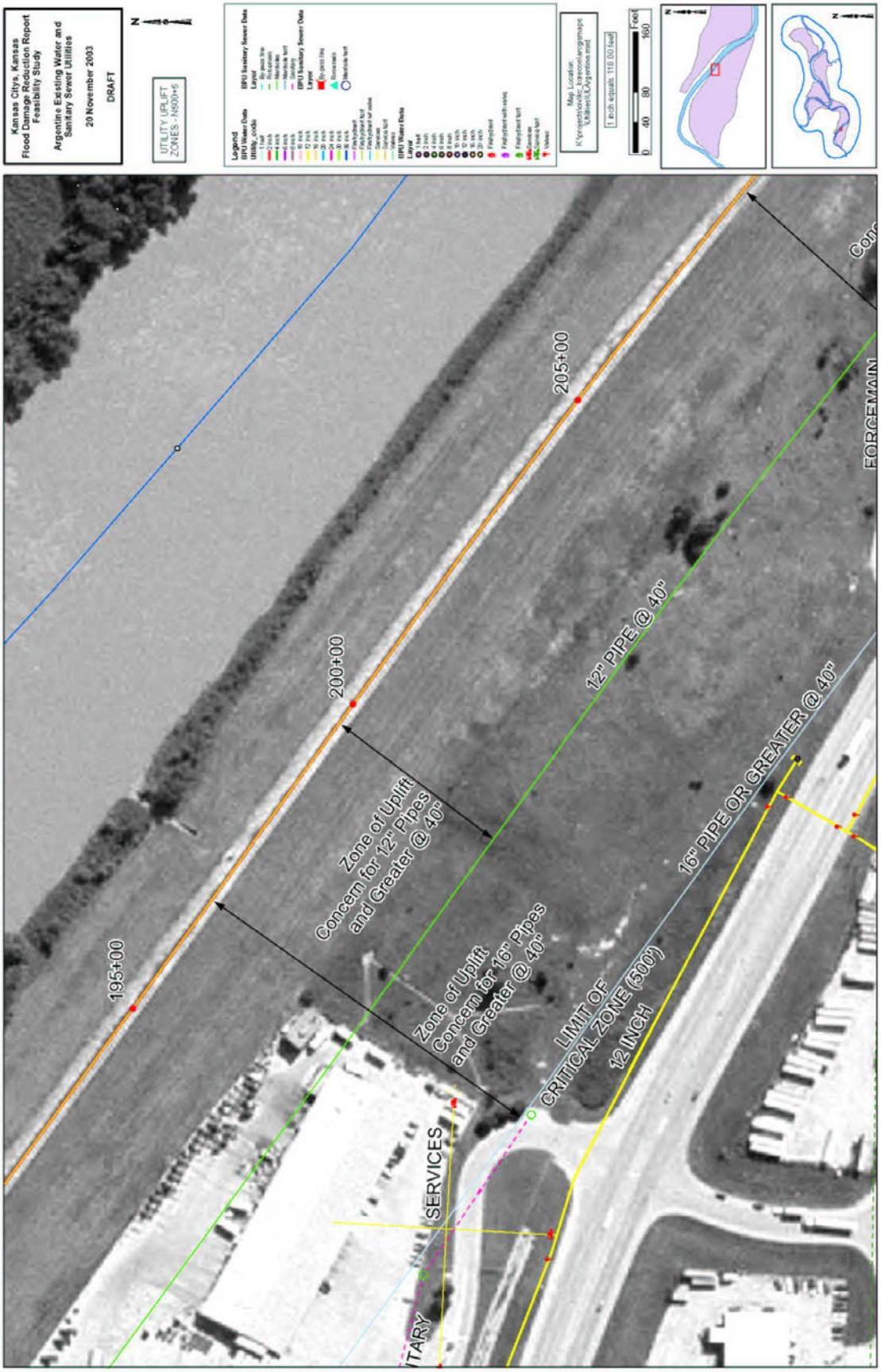


EXHIBIT A-11.29
Argentine Utility Uplift

EXHIBIT A-11.30
Argentine Utility Uplift

EXHIBIT A-11.31
Argentine Utility Uplift

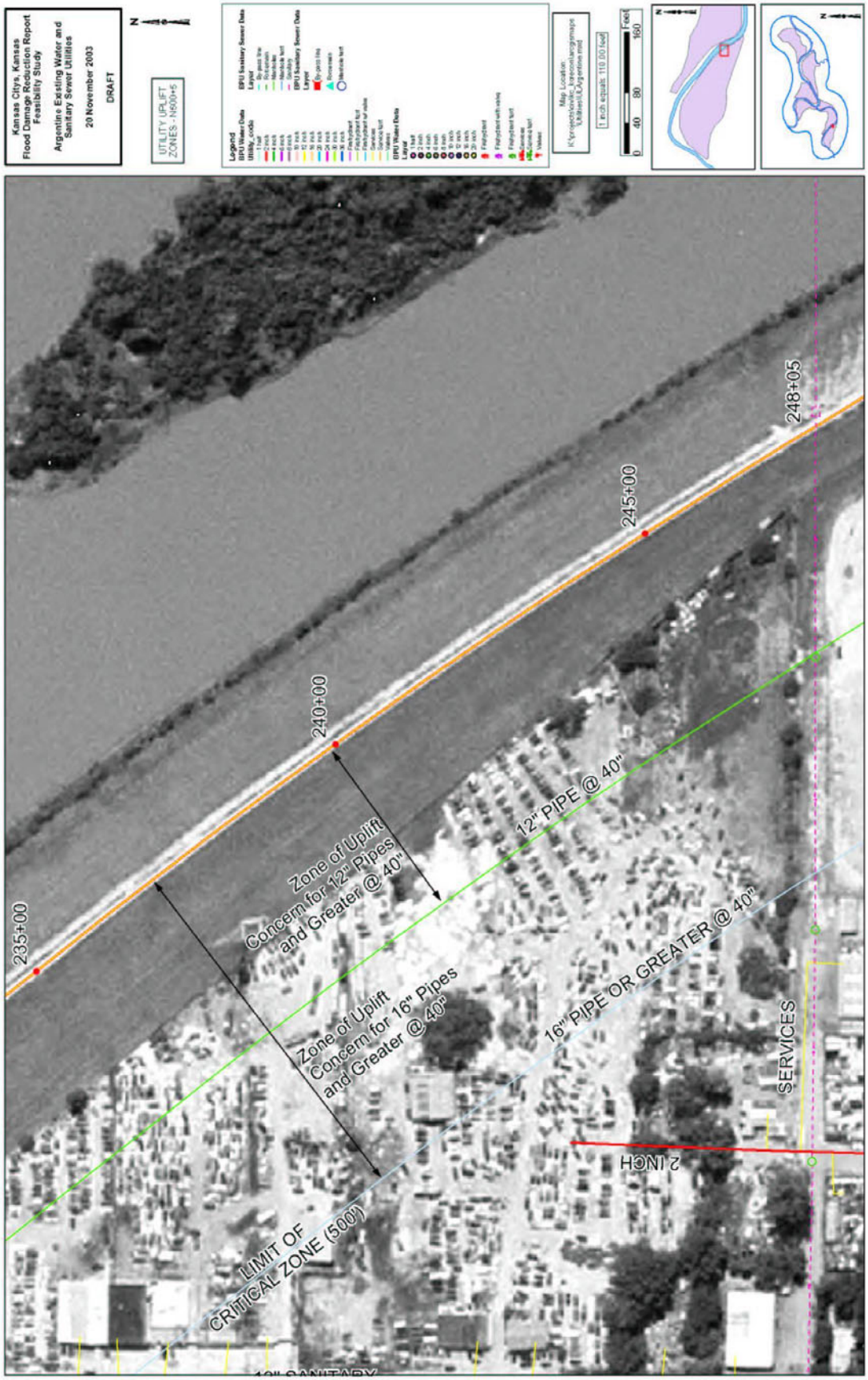


EXHIBIT A-11.32
Argentine Utility Uplift

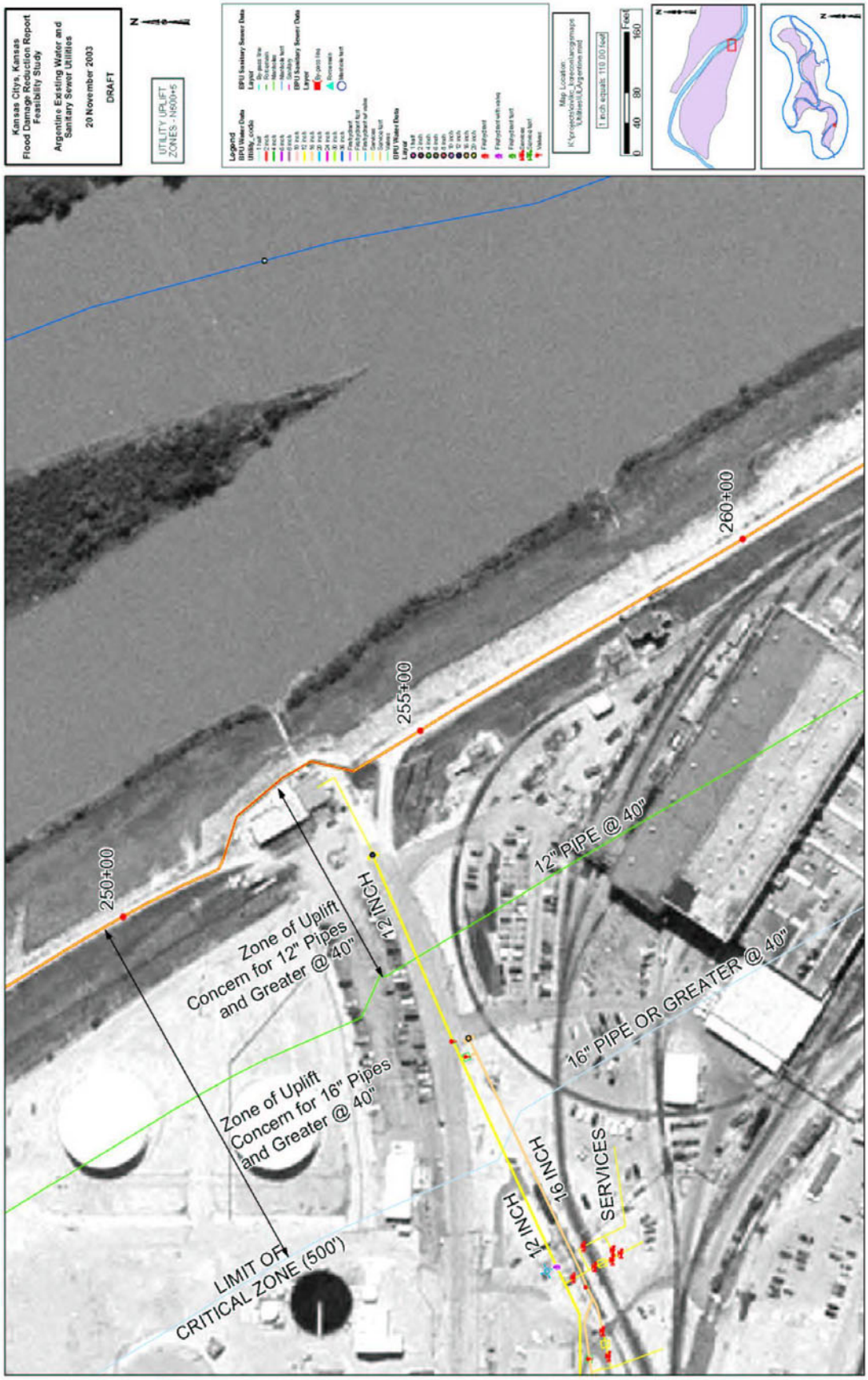


EXHIBIT A-11.33
Argentine Utility Uplift

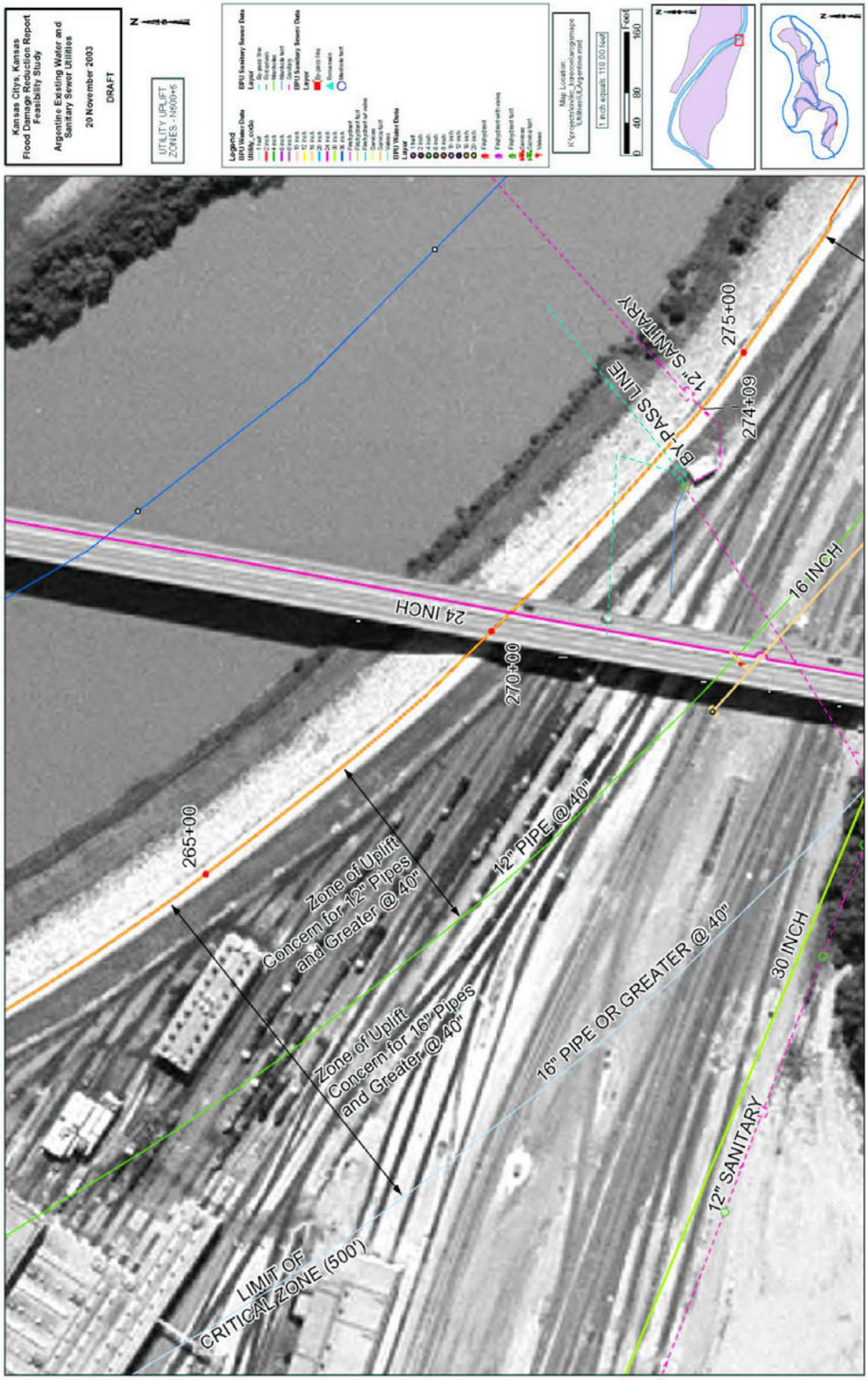


EXHIBIT A-11.34
Argentine Utility Uplift

EXHIBIT A-11.35
Harlem Area Collector System

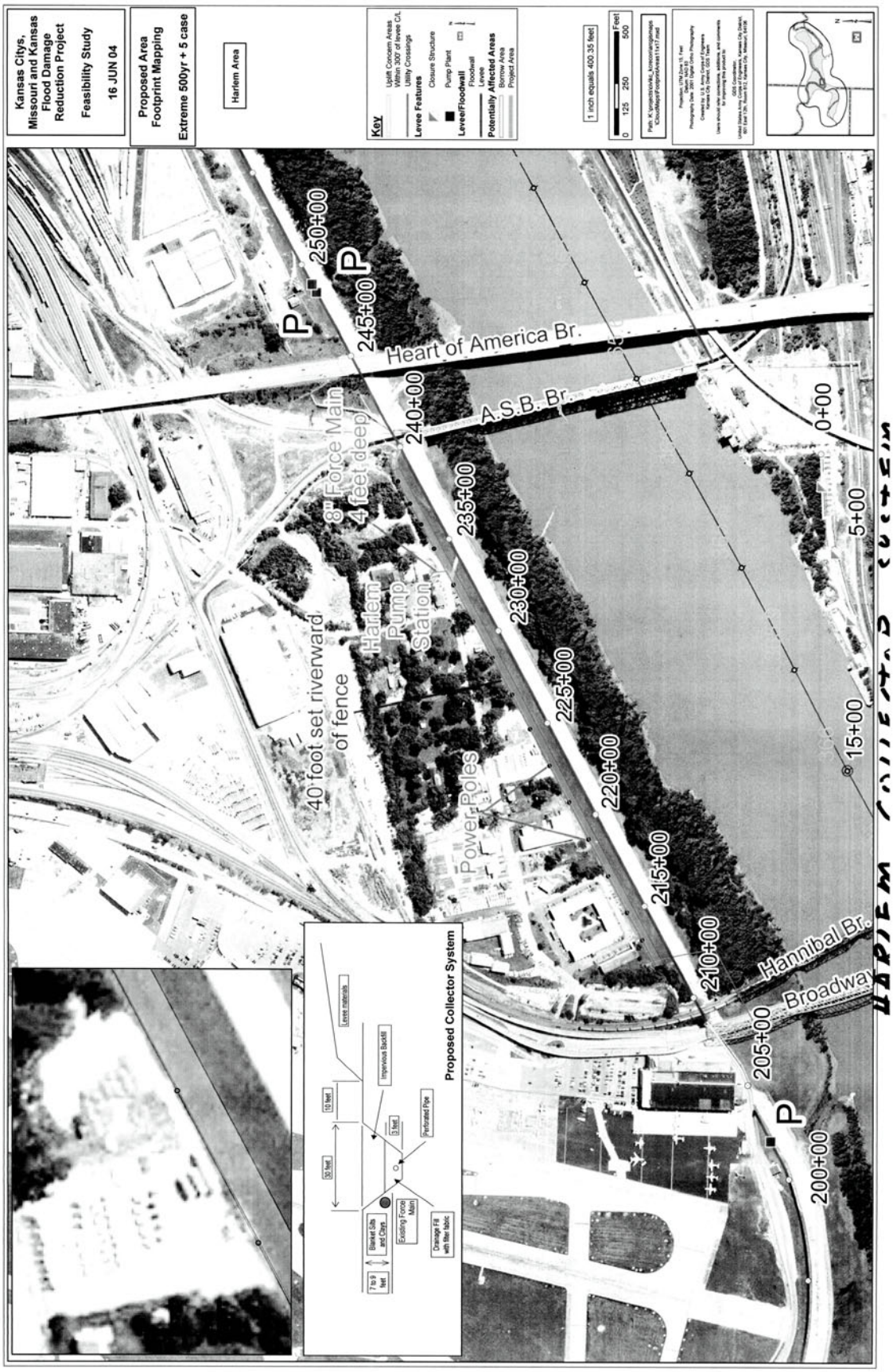


EXHIBIT A-11.36
North Kansas City – Lower (Harlem Area) Calculations

Calculated by RGJ
Checked by HWM

1/

NRC/Harbor
Wet Well/Pumping & Util. Relocations

Ron Jansen, EC-GC
3/11/04

1) Consider wet well(s)/pumping
- goal is to evacuate underseepage Qs from series of relief wells (See Attachment) p. 11
- consider ~~(See Attachment) pp. 12-22~~ into per John Giacomo, dtd 3/9/04
- consider current design concept of "several" modules, interconnected by pipe (i.e. a header system)
- consider ~~24~~ 18" pipe per Lock (wall)
- consider 13.4 cfs @ 0.2ft; 18 cfs @ crest (0.2ft + 5') per Lock

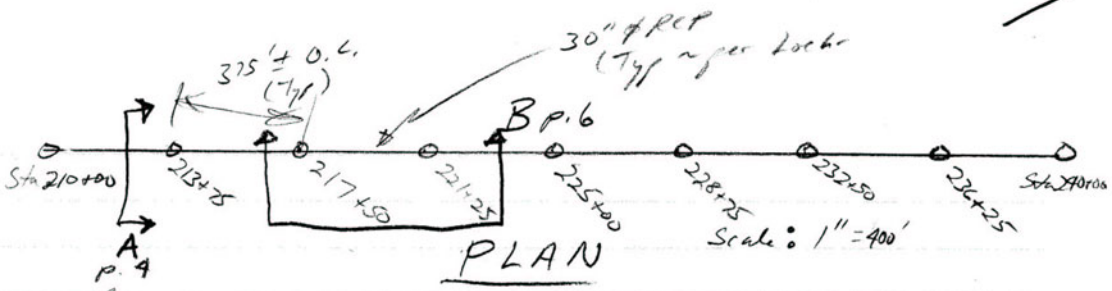
Basic question is will it work?
If not, what needs to be changed?
Any other questions?

Length ~ 210+00 → 240+00 (~~Approx~~ 3000')

Per Lock, assume 6 MHs ~ 1 each and ~~is~~ equally spaced
~~Use~~ Use 9 instead to keep spacing ≤ 400' (industry std. for O&M)

Calculated by RGJ
Checked by HWM

2



Assume 6' Ø CAST IN PLACE RCP (largest commonly avail std. size)

Assume 4 pumps per Giacomo (Verify)

$\frac{18 \text{ ft}^3}{\text{s}} * \frac{7.481 \text{ gal}}{\text{ft}^3} * \frac{60 \text{ s}}{1 \text{ min}} \cong 8,080 \text{ gpm}$

13.4 cfs = 6015 gpm

Note that undersewage Q will start well before 0.2Ø level, so we'll check several data points.

Per Joh. Giacomo, prefer to use 4 pumps
→ Need $\frac{8080}{4} = 2020$ gpm per pump

- Can already see that 16C 4045 D is NG (too small).

- ✓ head requirement & determine # of 6" (OR LARGER) pumps req'd

Calculated by RGJ
Checked by HWM

3

Use levee crest = 760.00 (actually varies from 759.00 - 759.40)

Buried collector pipe will be 7-10' deep, 18"Ø

Assume ground surface − 5' = 740 − 5 = 735

for starting elev.

⇒ EH/ Rq'd ≅ 760 − 735 = 25'

Assume suction lift rq'd = 15'

(i.e. set pump intake @ 10' above ground surface.

Note that pump is ~~trailer~~ mounted, i.e. it's already several feet ~~above~~ the ground).

Assume 6"Ø intake & discharge for Hf calculation.

Per scaled dwg... need about 200 Lf

- Use Hazen/Williams

for C = 100, Ø = 6", Q = 2020 gpm

Hf = 89'

∴ If we use four 6" pumps, as planned, each pump needs to be capable of pumping 2020 gpm @ (89 + 25) = 114' TDH and doing so w/ 15' suction lift.

(Neglects velocity head & minor losses)

⇒ 16 C 4045D provides only 1110 gpm @ 114' TDH

⇒ Need 8080/1110 ≅ 8 pumps

Calculated by RGJ
Checked by HWM

4/

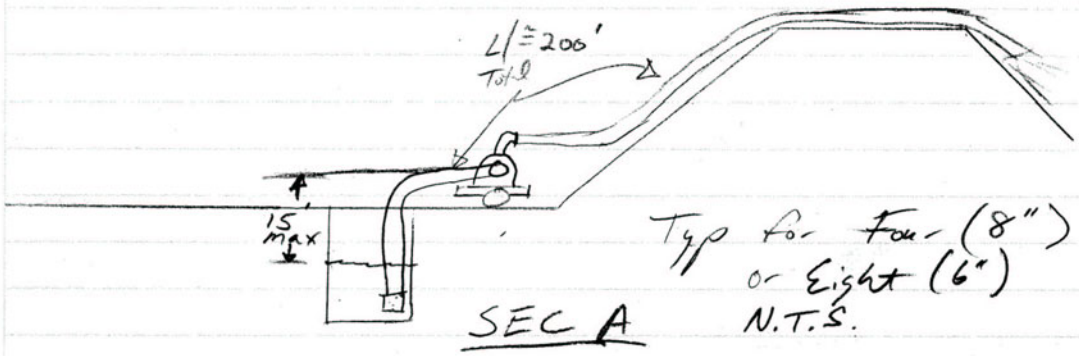
Try 8" pump (original estimate)

Now, have 200 LF 8" ϕ inlet/outlet
C = 100, H_f = 22'

Now, TDH = 22 + 25 = 47'

and operating pt is 2200 gpm @ 47' TDH

⇒ Need 4 pumps



Typ for ~~Four~~ (8") or Eight (6")

SEC A N.T.S.

*Note that cycle times will not be an issue, since any number of pumps could be shut down as $Q_{incoming}$ decreases.

Check for Q_{min}, given One larger 8" pump operating.

Calculated by RGJ
Checked by HWM

5

Per Mfg's rep (Tony Chirco) in 3/11/04 Telcon, there is no prescribed cycle time. But takes approx 60s to cycle up & 60s to cycle down. And in general, don't want pumps constantly cycling.

SO... Assume 6 starts / hour (industry std for < 25 hp dry pit)

Note that Q_{min} occurs when $Q_{min} = Q_{pump}/2 = 10_{gpm}$

That is, when $Q_{min} \cong 1100$ gpm $\cong 2.5$ cfs (Corresponds to ~~2~~ 5 year event)

See Looks.

Then, $V_{storage} = \frac{*Q}{4}$

$= (10_{gpm})\left(\frac{1100\,gal}{min}\right) * \left(\frac{1}{4}\right) = 2750$ gal

Assume 6'ϕ MHs (Better for access AND $V_{storage}$)

$V_{storage} = \frac{\pi d^2}{4} = \frac{\pi(36)}{4} = 28.27$ cf $= 211.5$ gal per foot of depth

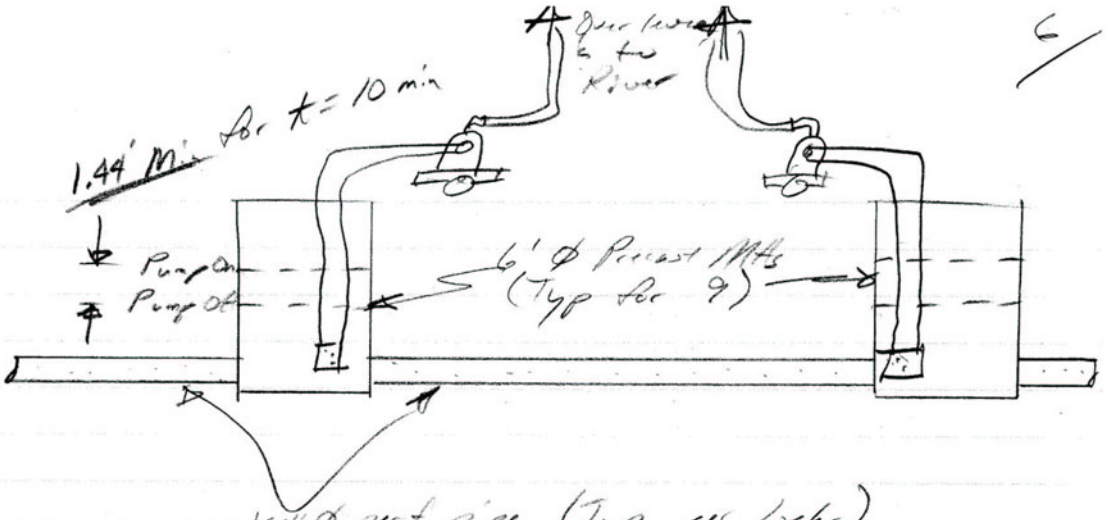
$211.5 * 9 = 1903.68$ gal/ft depth

~~0~~ $V_{storage} = 2750$ is provided in only 1.44' of depth

Storage req'd

(OK)

Calculated by RGJ
Checked by HWM



SEC B N.T.S.

Check capacity of pipes, i.e. we've assumed that all 9 MHs are interconnected and essentially act as one big wetwell. Can 18" Ø pipe equalize flow to each MH??

Note, that for high stages, pipe will be full & under pressure. Assume 2' head.
Use Hazen & Williams
For 375 LF 18" Ø C = 100 under 2' head
(i.e. $H_f = 5$ ⇒ calc Q)
⇒ Q ≅ 3327 gpm (Approx)

This is a ROUGH approximation, but illustrates that 18" Ø is sufficient to ensure adequate flow/equalization to each MH.

Calculated by RGJ
Checked by HWM

7

Pumping Summary

A) Need NINE 60" ∅ CAST IN PLACE MHs, as on p. 2. Keeps MH spacing < 400', for maintenance & ensures adequate flow equalization & ensures enough locations for placement of pumps.

B) Need EIGHT 16C4045 pumps to handle flow at crest. Operating pt for each pump is 1110 gpm @ 114' TDH. This is a 6" pump, and comps assume 6"∅ intake & outlet piping. Could potentially increase pump capy by using 8" discharge line, but this is NOT RECOMMENDED ~ too far out on curves.

C) Alternately, could use FOUR T8AS-4045T pumps, spaced approx. equally. Operating pt for each pump is 2200 gpm @ 47' TDH.

D) NO special wet well provisions are required, i.e. 5'∅ MHs interconnected by 18"∅ pipe provide sufficient storage volume to prevent short cycling.

Calculated by RGJ
Checked by HWM

8

2) Where does water go, once Harlem area floods? How long to place pumps?
Ref file e:\civ\kansas_citys\civil\basemaps\moRiver\topoplanmaps\Allku-7.20.01 contours.dgn (Attached) P.24

Low point "trough" generally follows N. Grand Ave & onto Atlantic St. (See Topo Map)
Crest within overflow is approx 744.

When Harlem area "spills over" 744, water spreads out to a very large area in NKC. (approx 1400 Ac — see map). It appears that water would NOT get into NKC airport until several ft higher elev. (Not confirmed)

What is storage Cap'y of Harlem area?
From USTN, approx. area is 35 Ac (1.52 M ft^2)

Assume depth of $\frac{(744-737)}{2} = 3.5'$ (i.e. Ave depth is approx half of max depth)

$V = 1.52\,M\,(3.5) = 5.32\,M\,ft^3$

Calculated by RGJ
Checked by HWM

9

How long to fill?

@ ~~18~~ cfs, $5.32 \times 10^6 \text{ ft}^3 \times \frac{s}{18 \text{ ft}^3} \times \frac{\text{hr}}{60 s} \times \frac{\text{hr}}{60 \text{ hr}} \times \frac{\text{day}}{24 \text{ hr}}$

$= 3.4$ days

@ 13.4 cfs (500 year level) 4.6 days

Note that Q will start in small and gradually increase as river stages rises.

→ Should have ample time to place pumps.

3) Any utility relocations req'd?

Reference util dwgs from Jim Dunajcik 3/4/04 pp. 25+ (Water, Sewer Plan/Profile, Pump Sta, FM, Perf Mains)

Gravity Sewers: Assume TWELVE Sanitary MHs to be replaced for uplift (w.i.n. 500')

Assume that PIPE w.i.n. 500' will be relocated -

Totals:	10" ϕ	8" ϕ		12" ϕ
	58.6	37.9	147.6	182
	~~172~~	122.2	60	261.3
	(231)	420	411	18
		197.8	61	(461.3)
		226.5 (1978)	314.3	

Calculated by RGJ
Checked by HWM

10

Pump Sta/FM: Assume OK as is.
Pump sta. A/E dwgs incorporated COE comments (10/14/99). FM is up/over 6" conc. encased, with vac. break/AR valve.

Water: From dwgs, looks like approx. 1500 lf 8"ϕ CIP with ~~500'~~ Relocate

In general, most utils. are a considerable distance from levee (Natl. extreme eastern p.g. area. Should be no major physical interference w/ collector pipe.

Utilities Summary

Remove/Replace MHs and lower lines 2' as indicated below.

Sanitary MHs: 12 ea.

8"ϕ Sanitary Sewer: 1998 lf

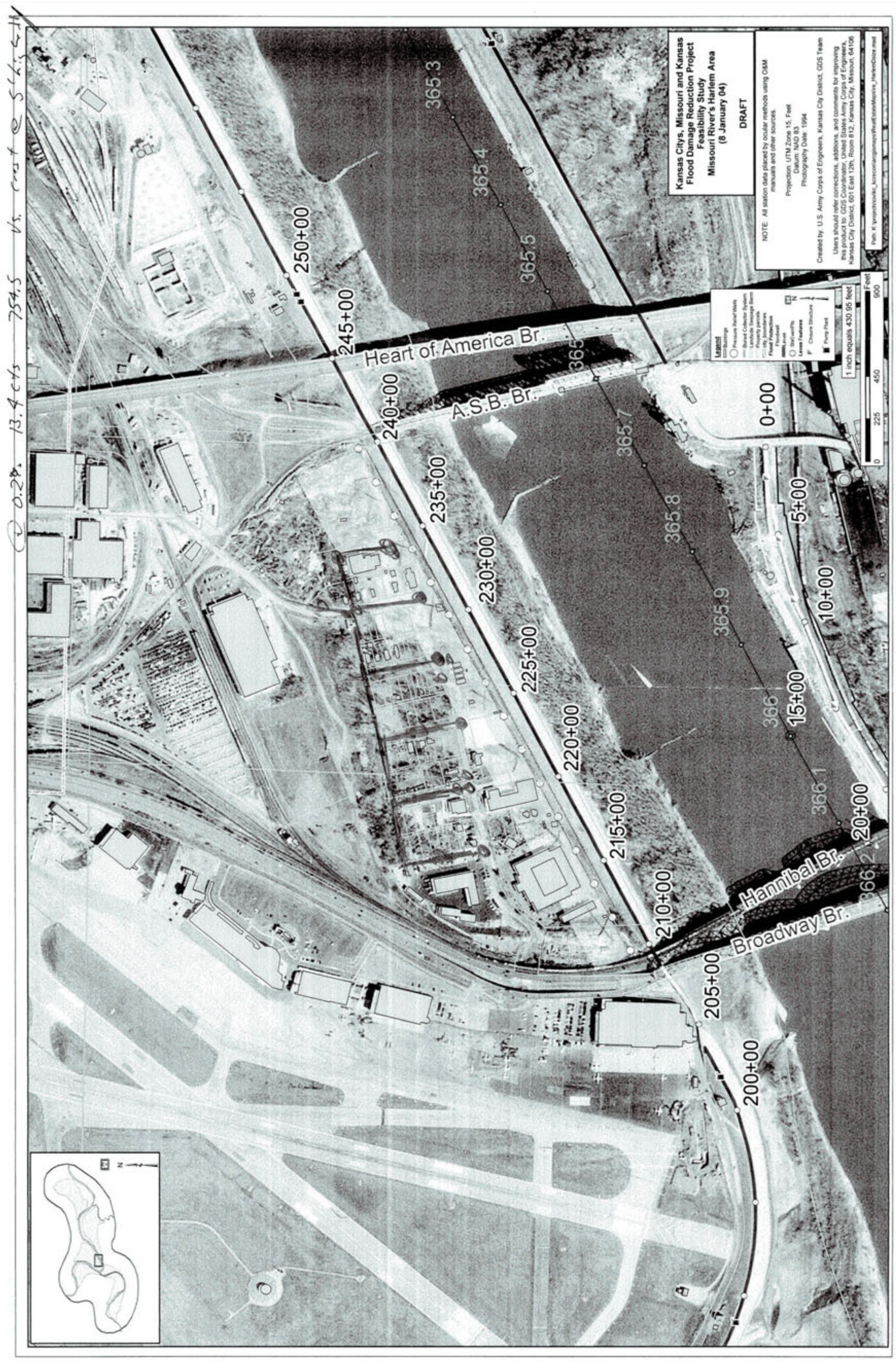
10"ϕ Sanitary Sewer: 231 lf

12"ϕ Sanitary Sewer: 461 lf

8"ϕ Water: 500 lf

Not Req'd discr per 7/23 M. Scott/Zoehr. Buried collector system alleviates land-side uplift concerns.

Requirement May be reduced, pending add'l info from City & consultation w/ EC-DS.


Kansas Citys, Missouri and Kansas
Flood Damage Reduction Project
Feasibility Study
Missouri River's Harlem Area
(8 January 04)
DRAFT
NOTE: All station data placed by ocular methods using O&M manuals and other sources.
Projection: UTM Zone 15, Feet
Datum: NAD 83
Photography Date: 1994
Created by: U.S. Army Corps of Engineers, Kansas City District, GDS Team
Users should refer corrections, additions, and comments for improving this product to: GDS Coordinator, United States Army Corps of Engineers, Kansas City District, 601 East 12th, Room 812, Kansas City, Missouri, 64106
1 inch equals 430.95 feet
0 225 450 900 Feet
Heart of America Br.
A.S.B. Br.
Hannibal Br.
Broadway Br.
250+00
245+00
240+00
235+00
230+00
225+00
220+00
215+00
210+00
205+00
200+00
0+00
5+00
10+00
15+00
20+00
365.3
365.4
365.5
365.7
365.8
365.9
366
366.1
366.2

12

Jansen, Ronald G NWK

From: Giacomo, John J NWK
Sent: Tuesday, March 09, 2004 9:05 AM
To: Jansen, Ronald G NWK
Subject: FW: Gorman-Rupp Pump Quote ** T8A60S-4045T**, G04-014


T8A60S-4045T Spec 2.pdf


T8A60S-4045T Spec 1.pdf


T8A60S-4045T O&M.pdf

Ron,

The attachments below are applicable to the two larger 10 inch pumps. We are now looking at four 6 inch pumps. The internet should also have the cut sheets you need. If you have any problem accessing Gorman-Rupp on the internet, let me know. Thanks. John Giacomo

-----Original Message-----
From: tchirico@gormanrupp.com [mailto:tchirico@gormanrupp.com]
Sent: Wednesday, February 25, 2004 1:28 PM
To: Giacomo, John J NWK
Cc: McKissack, Grady L NWK
Subject: Gorman-Rupp Pump Quote ** T8A60S-4045T**, G04-014

Dear John,

Thanks again for providing the Gorman-Rupp Company the opportunity to provide pricing. Please find below the recommended pump model for the revised condition point of 35' TDH @ 2000 GPM. Please refer to Gorman-Rupp Reference number G04-014 for future reference to this quote.

Pump Model: T8A60S-4045T
Description: 8" x 8" Self Priming Centrifugal Pump with Auto Start package
Price mounted on Base: $22,691.00 Net Each
Price mounted on Wheel Kit: $24,348.00 Net Each
Note: This trailer is a high speed trailer rated at 35 - 55 MPH equipped with torsional spring axle and fenders
Price mounted on Highway Trailer (D.O.T.): $25,391.00 Net Each
Note: This trailer is a highway D.O.T. approved and rated at 55 MPH equipped with brakes, lights, fenders, reflectors, chains ect.

Delivery: 6 - 8 Weeks

Accessories
Auto-Start with dual floats, Price: $35.00 Net Adder.
Auto-Start with EPS liquid level control with submersible transducer, Price: $2381.25 Net Each Adder.
Battery, Price: $85.00 Net Each

(See attached file: T8A60S-4045T Spec 2.pdf)(See attached file: T8A60S-4045T Spec 1.pdf)(See attached file: T8A60S-4045T O&M.pdf)

If you have any questions or comments please do not hesitate to call, fax or email.

Thank you

Anthony M. Chirico
Market Manager
Government/OEM

1

13

Phone: 419-755-1343
Fax: 419-755-1251
tchirico@gormanrupp.com

The Gorman-Rupp Company
305 Bowman Street
Mansfield, Ohio 44901
419-755-1011
http://www.gormanrupp.com

"Giacomo, John J NWK" <John.J.Giacomo@nwk02.usace.army.mil>

To: "'tchirico@gormanrupp.com'" <tchirico@gormanrupp.com>

cc: "McKissack, Grady L NWK" <Grady.L.Mckissack@nwk02.usace.army.mil>

Subject: RE: Gorman-Rupp Pump Quote

02/25/2004 12:50 PM

Anthony,

The number of pumps has changed from 2 to 4. Please provide model numbers and costs for four pumps of the same type as the two pumps. Each of the four pumps shall be 2000 gpm at 35 feet of head. Also please provide the heavy duty trailer.

If possible, I would need the information by tomorrow afternoon.

Thanks,

John Giacomo

-----Original Message-----
From: tchirico@gormanrupp.com [mailto:tchirico@gormanrupp.com]
Sent: Monday, January 26, 2004 10:52 AM
To: Giacomo, John J
Subject: Gorman-Rupp Pump Quote

14

Dear John,

Thank you for your interest in Gorman-Rupp and the quality products that we offer. As a branch of the US Government, you are authorized to purchase directly from the Gorman-Rupp company or purchase from an authorized Gorman-Rupp distributor in your territory. Please find below the recommended pump models for a condition point of 30'TDH @ 3500 GPM. Please refer to Gorman-Rupp reference number G04-014 for future reference to this quote.

Option #1
Pump Model: T10A60-B-F5L
Price: $33668.00 Net Each
(See attached file: T10A60-B-F5L.pdf)

Option #2
Pump Model: PA10A60-6068T
Price: $35846.00 Net Each
(See attached file: PA10A60-6068T.pdf)

Option #3
Pump Model: PA12A60-B-BF6L
Price: $47264.oo Net Each
(See attached file: PA12A60-B-BF6L.pdf)

Standard Commercial Packaging
Certificate of Conformance
Inspection/Acceptance at Destination
F.O.B. at Origin (Buyer is responsible for shipping cost)
Terms: Net 30
Quote valid for 60 Days

If you have any questions or comments please do not hesitate to call, fax or email.

Thank you

Anthony M. Chirico
Market Manager
Government/OEM
Phone: 419-755-1343
Fax: 419-755-1251
tchirico@gormanrupp.com

The Gorman-Rupp Company
305 Bowman Street
Mansfield, Ohio 44901
419-755-1011
http://www.gormanrupp.com

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Thank you
****
****

John Giacomo

<John.J.Giacomo@usac e.army.mil>

To: mailform@gormanrupp.com, grmail@ds-creative.com

cc:

Subject: Construction Sales Form

01/26/04 09:44 AM

Immediate Need!

Message submitted - 1/26/2004

-Submitted By-
John Giacomo - Mechanical Engineer
CORPS of Engineers
601 East 12 th Street
Kansas City , Missouri Jackson 64106

Phone: 816-983-3228
Fax: 816-426-2377
Email: John.J.Giacomo@usace.army.mil

4

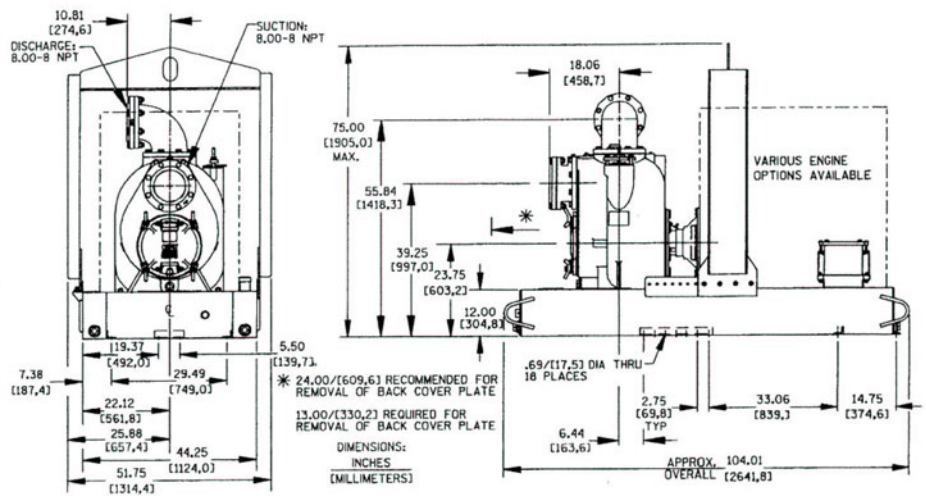
16

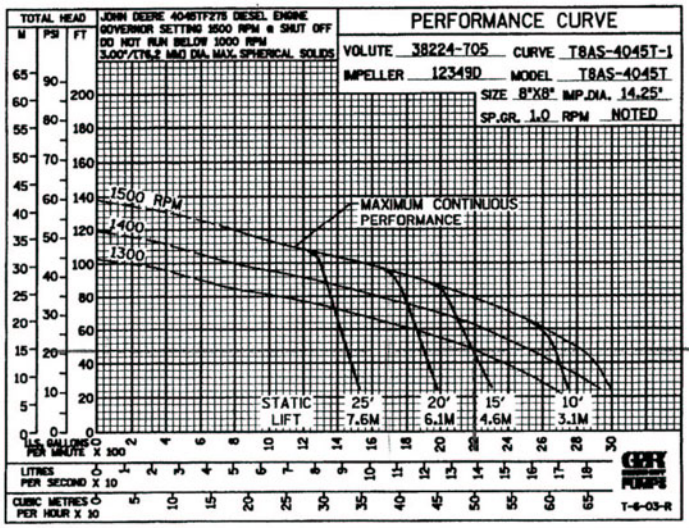
Company's Primary Business:
Government

-Pump Selection-
Application: De-watering
Type of liquid pumped: water
Solids in Liquids checked? Yes
Gallons per minute required: 3500
Total feet of head: 30
Additional Requirements -
Need Contractor's price for trailer mounted air-cooled gasoline unit.I have a meeting at 1:30 Kansas City time and if possible would like a price by then.
Thanks.

17

Specification Data	APPROXIMATE DIMENSIONS and WEIGHTS		SKID BASE	2-WHEEL
SECTION 45, PAGE 1650		NET WEIGHT:	4085 LBS. (787 KG.)	4595 LBS. (891 KG.)
		SHIPPING WEIGHT:	4285 LBS. (833 KG.)	4595 LBS. (891 KG.)
		EXPORT CRATE SIZE:	288 CU. FT. (8,1 CU. M.)	





GORMAN-RUPP PUMPS

THE GORMAN-RUPP COMPANY • MANSFIELD, OHIO

GORMAN-RUPP OF CANADA LIMITED • ST. THOMAS, ONTARIO, CANADA

Specifications Subject to Change Without Notice

Printed in U.S.A.

The Gorman-Rupp Company
P.O. Box 1217
305 Bowman Street
Mansfield, OH 44901
USA
Phone: (419) 755-1011
Fax: (419) 755-1251
www.gormanrupp.com

GORMAN-RUPP PUMPS

Fax

To:	**John Giacoma** **Army Corp of Engineers**	From:	Tony Chirico
Fax:	816-426-2377	Pages:	4
Phone:	816-983-3228	Date:	March 9, 2004
Re:	Specification and Curve	CC:	

Dear John;

Please find attached the specification data sheet and curve for the pump model 16C20-4045D as requested per your phone message dated 3/9/04 @ 3:30 PM.

If you have any questions or comments, please do not hesitate to call: 419-755-1343, fax: 419-755-1251 or email: tchirico@gormanrupp.com.

Thank you,

Tony Chirico
Market Manager, Government/OEM

ACEU

GORMAN-RUPP PUMPS

Self Priming Centrifugal Pump

Diesel Engine Driven

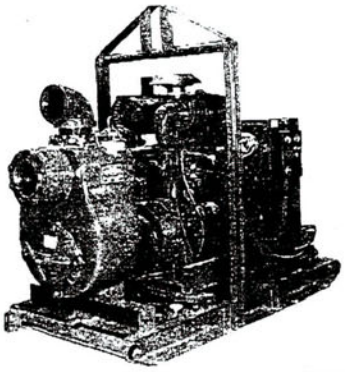
Models 16C2–4045D *and* 16C20–4045D

Size 6" x 6"

CERTIFIED PERFORMANCE

70 MT

Total Head		Capacity of Pump in U.S. Gallons per Minute (GPM) at Continuous Performance				
P.S.I.	Feet					
63.7	147	420	420	420	420	420
54.2	125	610	870	930	930	930
43.4	100	660	945	1150	1340	1340
32.5	75	680	960	1188	1420	1510
21.7	50	700	960	1200	1450	1560
Suction Lift		25'	20'	15'	10'	5'



PUMP SPECIFICATIONS

Size: 6" x 6" NPT (152 mm x 152 mm) - Female.
Casing: Gray Iron No. 30. Maximum Operating Pressure 109 psi (7,6 kg/cm²).*
Open Type, Two Vane Impeller: Ductile Iron No. 65-45-12. Handles 3" (76,2 mm) Diameter Spherical Solids.
Impeller Shaft: Stainless Steel No. 17-4.
Replaceable Wear Plate: Carbon Steel Plate.
Removable Cover Plate: Gray Iron No. 30; 41 lbs. (18,6 kg).
Intermediate Bracket: Gray Iron No. 30.
Seal Plate: Gray Iron No. 30.
Seal: (Model 16C2–4045D) Double, Grease-Lubricated with Spring Loaded Grease Cup. Sintered Bronze Stationary Seal Seats. Steel Rotating Faces. Maximum Temperature of Liquid Pumped, 110°F (43°C).* Maximum Suction Pressure 10 psi (0,7 kg/cm²).
(Model 16C20–4045D) Mechanical, Oil-Lubricated, Floating, Self-Aligning. Tungsten Titanium Carbide Rotating and Stationary Faces. Stainless Steel No. 316 Stationary Seat. Fluorocarbon Elastomers (DuPont Viton® or Equivalent). Stainless Steel No. 18-8 Cage and Spring. Maximum Temperature of Liquid Pumped is 160°F (71°C).*
Seal Liner: (Model 16C2–4045D) Bronze No. C93700.
Shaft Sleeve: (Model 16C20–4045D) Alloy Steel No. 4130.
Flap Valve: Neoprene */Steel Reinforcing.
Radial Bearing: Open Single Ball.
Thrust Bearing: Open Double Ball.
Bearing Lubrication: Oil.
Flanges: Gray Iron No. 30.
Gaskets: Resistant Synthetic Rubber, Cork, Vegetable Fiber, Compressed Synthetic Fibers, and PTFE.
Hardware: Standard Plated Steel.
Oil Level Sight Gauge.

Standard Equipment: Hoisting Bail. Skid Base. 90° Discharge Elbow. Strainer.

Optional Equipment: Two Wheel Truck Assembly with P225/75R15 Pneumatic Tires. Battery. Over-the-Road Trailer (Meets D.O.T. and Transport Canada Requirements).

**Consult Factory for Applications Exceeding Maximum Pressure and/or Temperature Indicated.*

WARNING!

Do not use in explosive atmosphere or for pumping volatile flammable liquids.

ENGINE SPECIFICATIONS

Model: John Deere 4045DF150 "Power Tech."
Type: Four Cylinder, Four Cycle, Liquid Cooled Diesel Engine.
Displacement: 276 Cu. In. (4,5 liter).
Governor: Mechanical.
Lubrication: Forced Circulation.
Air Cleaner: Dry Type.
Oil Reservoir: 9 U.S. Qts. (8,5 liter) Dry; 8 U.S. Qts. (7,5 liter) Refill.
Fuel Tank: 38.9 U.S. Gals. (147 liter).
Full Load Operating Time: 13.3 Hrs.
Starter: 12V Electric.

Standard Features: Low Oil Pressure and High Coolant Temperature Safety Shut Down Switches. Instrument Panel Includes: Tachometer, Hourmeter, Coolant Temperature Gauge, Oil Pressure Gauge, Vernier Throttle Control, On/Off Key Switch and Voltmeter. Muffler */Guard and Weather Cap.

JOHN DEERE PUBLISHED PERFORMANCE:
Maximum Continuous BHP 72 (54 kW) @ 2500 RPM

GORMAN-RUPP PUMPS

THE GORMAN-RUPP COMPANY • MANSFIELD, OHIO

GORMAN-RUPP OF CANADA LIMITED • ST. THOMAS, ONTARIO, CANADA

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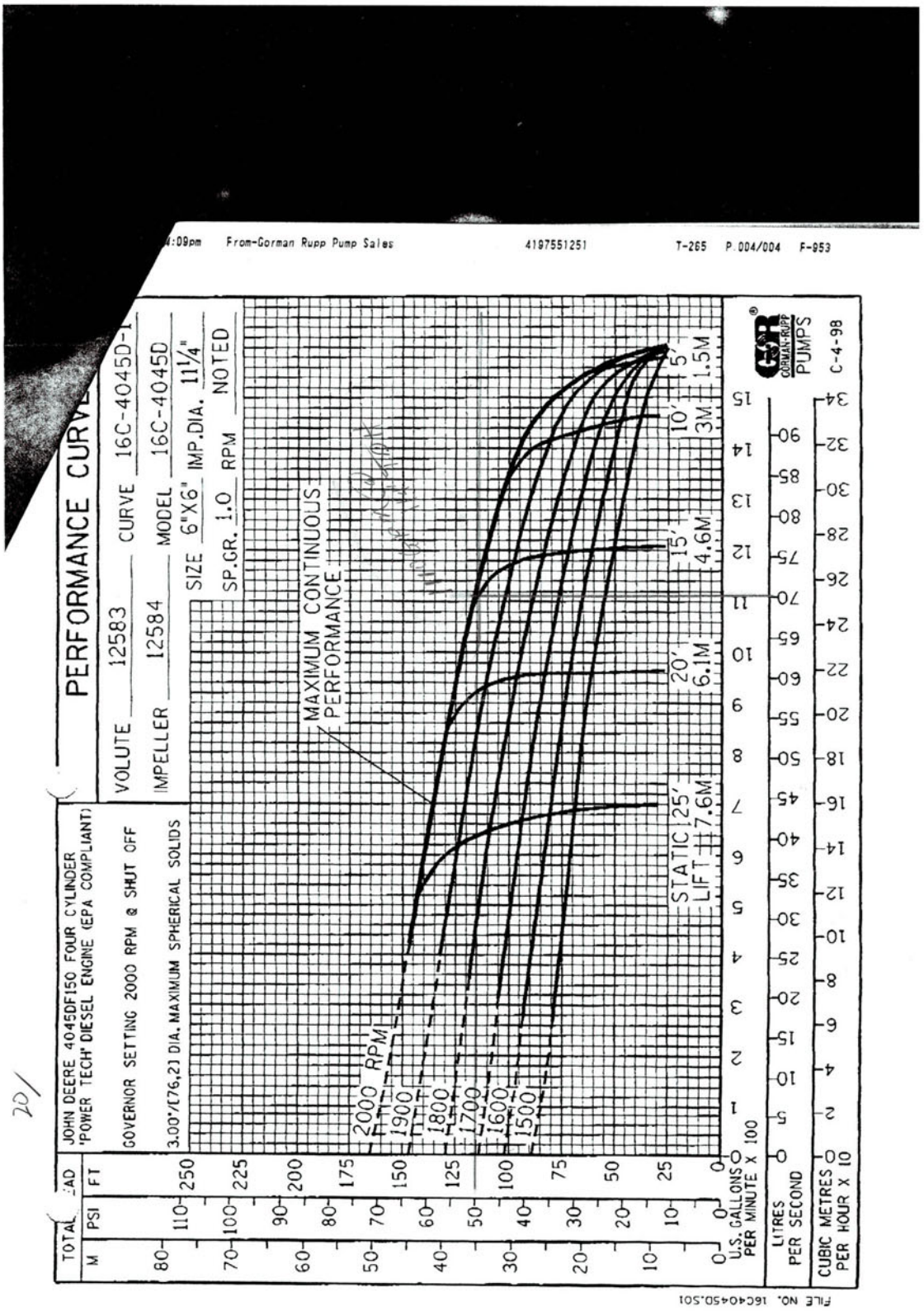
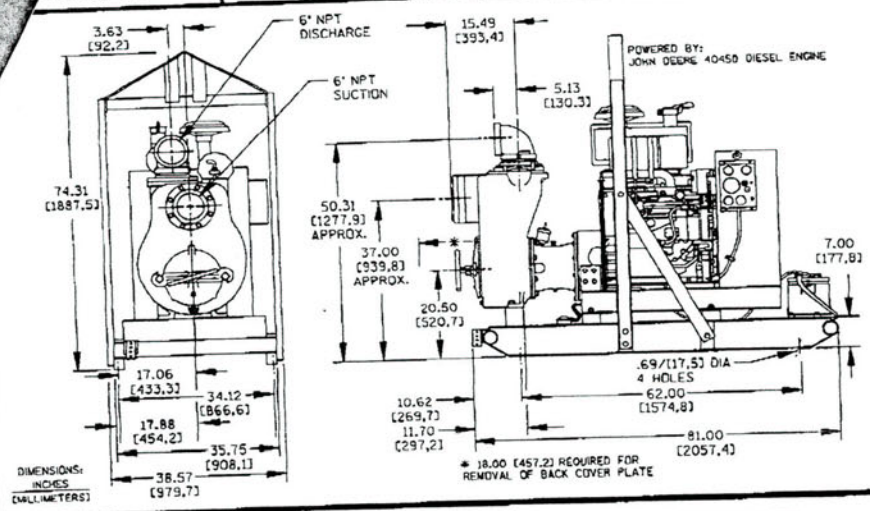
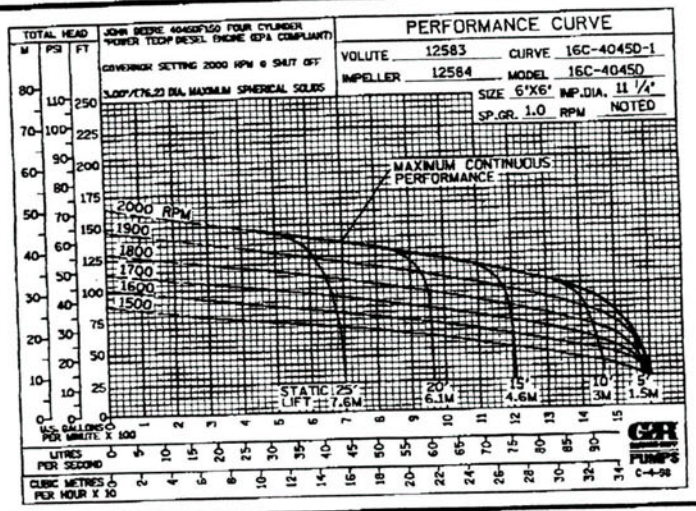

:09pm From-Gorman Rupp Pump Sales 4197551251 T-265 P.004/004 F-953
PERFORMANCE CURVE
VOLUTE 12583 CURVE 16C-4045D-1
IMPELLER 12584 MODEL 16C-4045D
SIZE 6"X6" IMP.DIA. 11¼"
SP.GR. 1.0 RPM NOTED
JOHN DEERE 4045DF150 FOUR CYLINDER 'POWER TECH' DIESEL ENGINE (EPA COMPLIANT)
GOVERNOR SETTING 2000 RPM @ SHUT OFF
3.00"(76,2) DIA. MAXIMUM SPHERICAL SOLIDS
MAXIMUM CONTINUOUS PERFORMANCE
2000 RPM
1900
1800
1700
1600
1500
STATIC LIFT 25' 7.6M
20' 6.1M
15' 4.6M
10' 3M
5' 1.5M
TOTAL HEAD M PSI FT
U.S. GALLONS PER MINUTE X 100
LITRES PER SECOND
CUBIC METRES PER HOUR X 10
GORMAN-RUPP PUMPS
C-4-98
FILE NO. 16C4045D.S01

ication Data	APPROXIMATE DIMENSIONS and WEIGHTS		SKID BASE	2-WHEEL
ON 45, PAGE 1460		NET WEIGHT:	2620 LBS. (1188 KG.)	2890 LBS. (1311 KG.)
		SHIPPING WEIGHT:	2709 LBS. (1229 KG.)	2890 LBS. (1311 KG.)
		EXPORT CRATE SIZE:	141 CU. FT. (4 CU. M.)	159 CU. FT. (4,5 CU. M.)





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John Here is a price on the 6" pumps & hoses Gorman Rupp Model 16C20-4045D John Deere Diesel Engine

Delivered Price Each Pump $17,175.00
6" Suction Hose Priced Each $183.00
6' Cotton Mill Discharge Hose 50' Long $125.00 Each section
John Hope these will work for you let me know

Thank You

Kurt Dysart

Hertz Equipment Rental & Sales
707 E 16th St
Kansas City, MO 64108

Mobile # 816-305-0867
Fax # 866-999-0818
Nextel ID # 29885

John Here is a quote on the 6" pumps

	Day	Week	Month	
6" Pump	165.00	495.00	1477.00	Each Pump
Suction Hose	17.00	45.00	110.00	Each Section 20'
Discharge Hose	35.00	105.00	285.00	Each 50' section

Must have 3-4 day notice to collect equipment

To Keep the sold units on yard would run a rate of $200.00 a month storage pumps, hoses, etc. Giving 1-2 days notice we can check out units to make sure properly running Field service runs $70.00 an hour plus parts. If units are stored at Hertz, is not responsible for theft, or damage to units. These are rough costs on storage & maint.

Kurt Dysart

Hertz Equipment Rental & Sales
707 E 16th St
Kansas City, MO 64108

Mobile # 816-305-0867
Fax # 866-999-0818


Approx within
744 Contour
24
A/ ≈ 1400 Ac
Total
A/ ≈ 354 Ac
B

25/

Dimensions Field Verified in Bad Water, OK&DD May '04

Expect FM @ edge of excavation
CIP installed 1970±

Should be OK; minor shoring / tieback may be rigid (Not a cost factor)

Poor poles will require bracing - Many are already done for FM Work. Minor add'l bracing rigid (Not a significant cost factor)

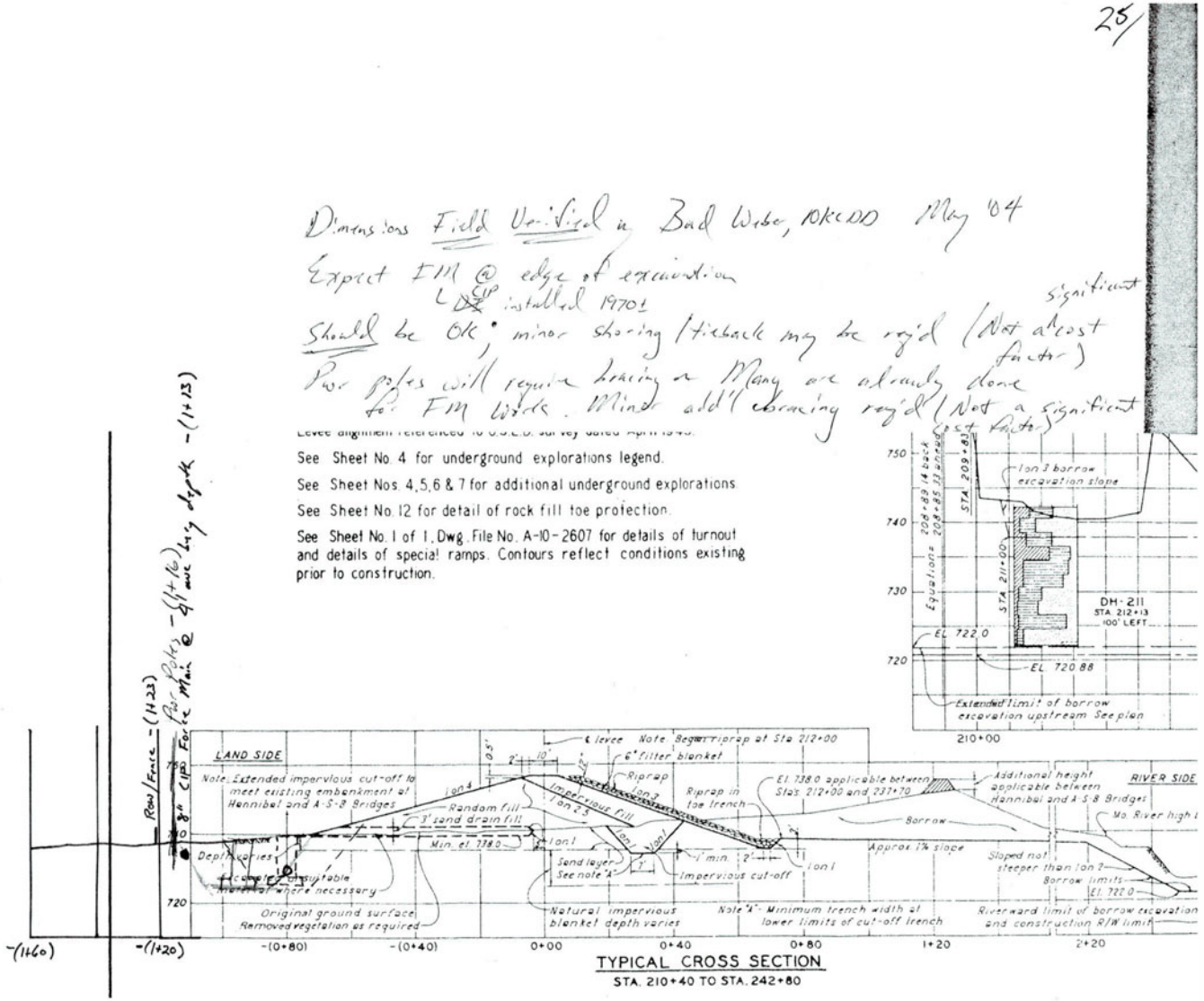
Levee alignment referenced to U.S.C.E. survey dated April 1945.

See Sheet No. 4 for underground explorations legend.

See Sheet Nos. 4, 5, 6 & 7 for additional underground explorations.

See Sheet No. 12 for detail of rock fill toe protection.

See Sheet No. 1 of 1, Dwg. File No. A-10-2607 for details of turnout and details of special ramps. Contours reflect conditions existing prior to construction.



TYPICAL CROSS SECTION
STA. 210+40 TO STA. 242+80

EXHIBIT A-11.37
Fairfax – Jersey Creek (BPU Floodwall)

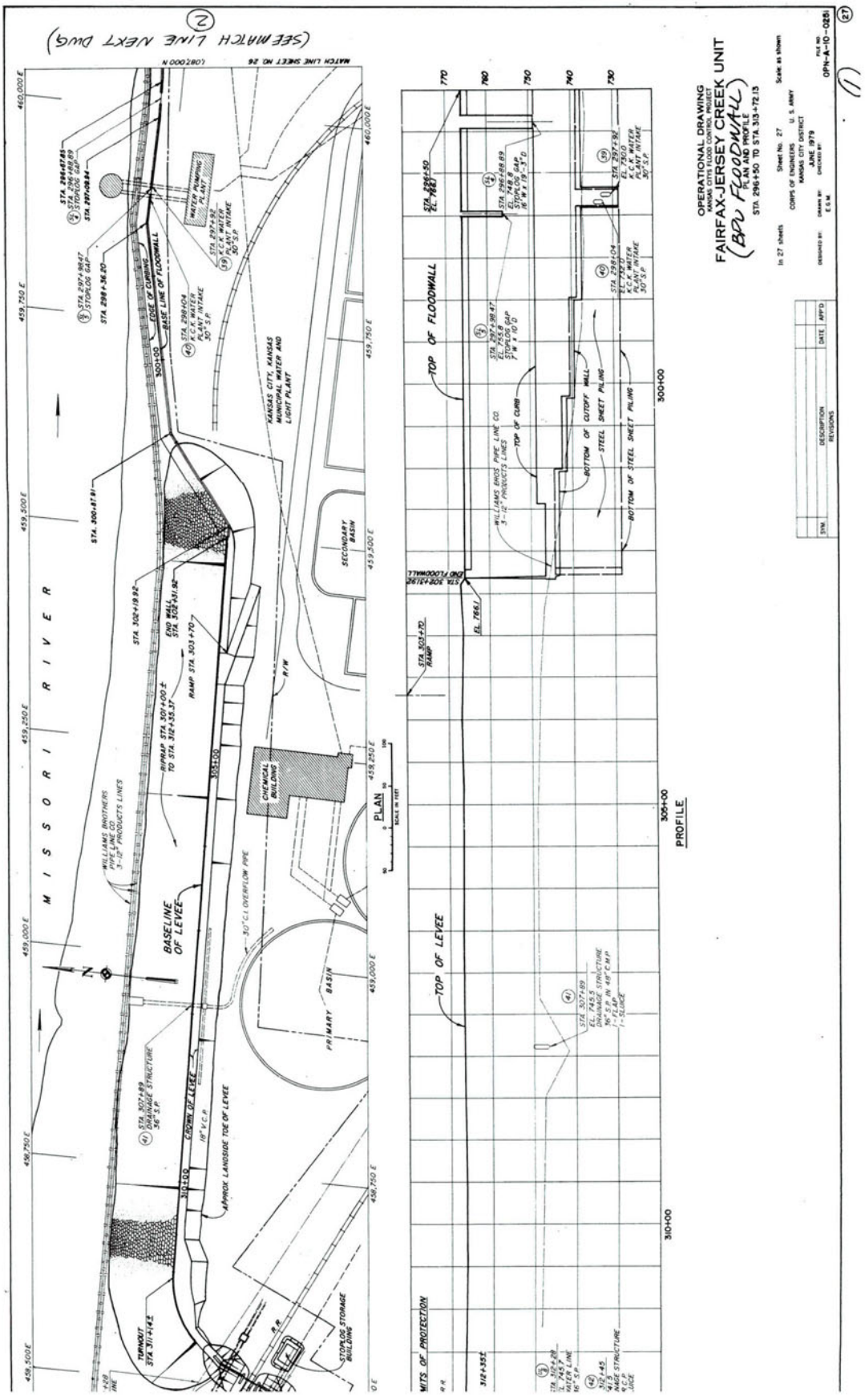


EXHIBIT A-11.38
Fairfax – Jersey Creek (BPU Floodwall)

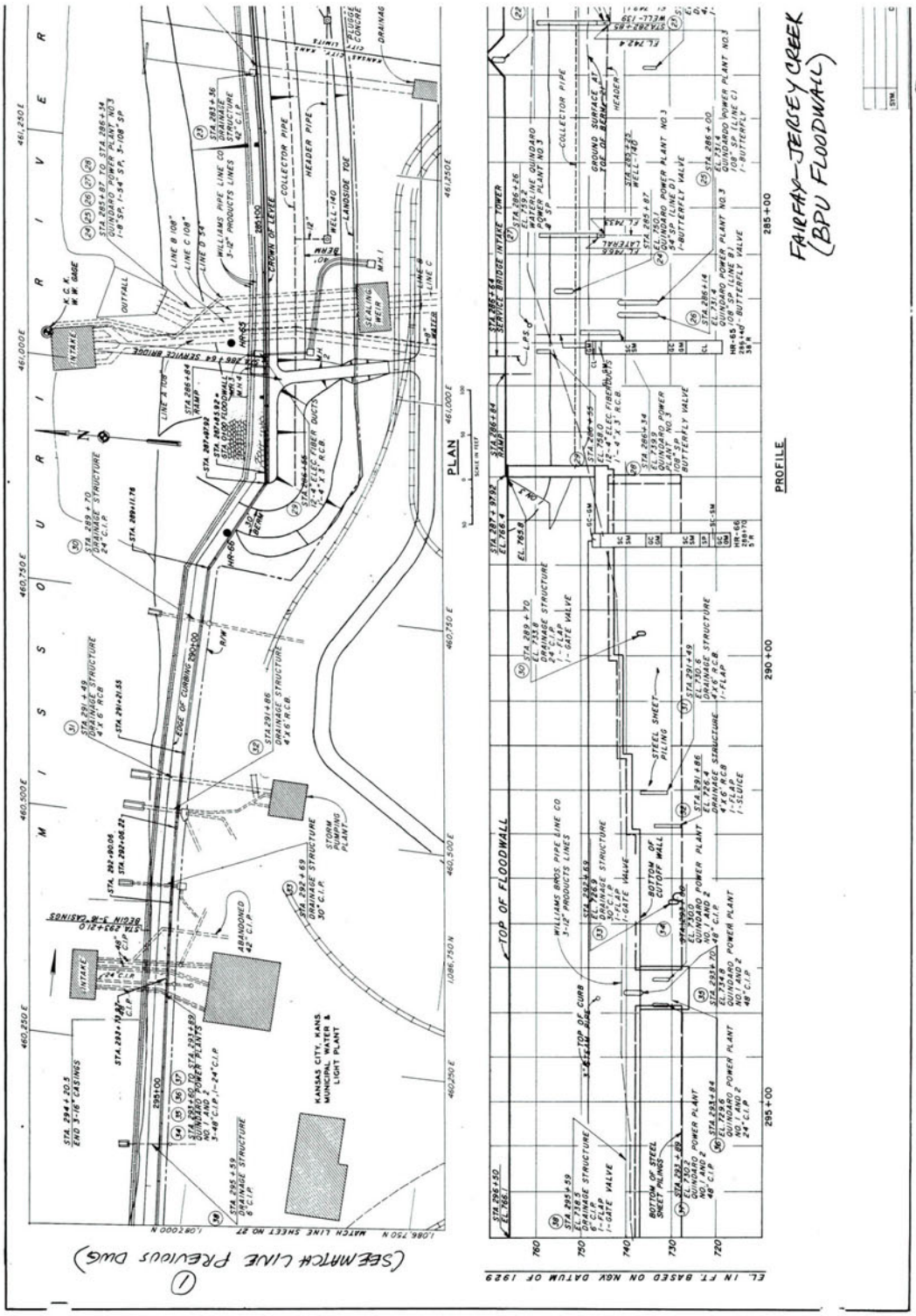
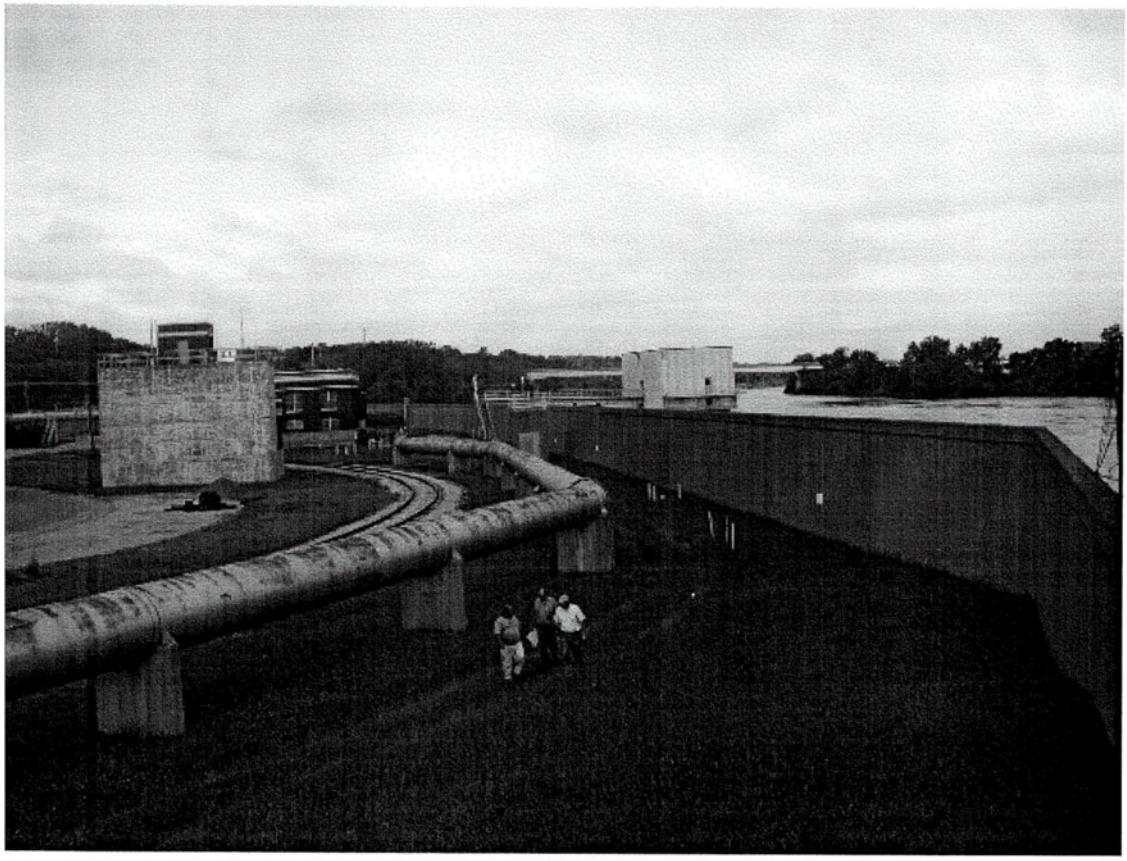


EXHIBIT A-11.39
Fairfax – Jersey Creek (BPU Floodwall)



FAIRFAX - JERSEY CREEK (BPU FLOODWALL)
LOOKING WEST

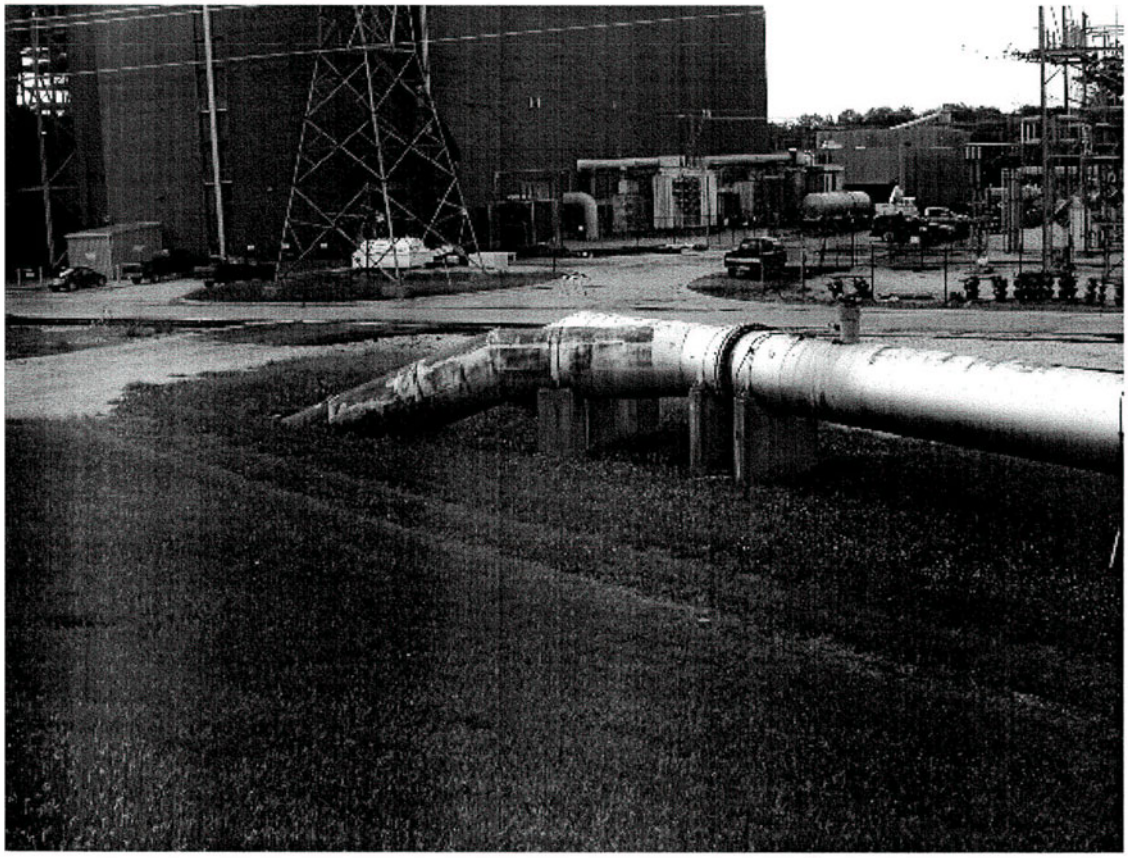
(1)

EXHIBIT A-11.40
Fairfax – Jersey Creek (BPU Floodwall)

FAIRFAX - JERSEY CREEK (BPU FLOODWALL)
LOOKING EAST

(2)

EXHIBIT A-11.41
Fairfax – Jersey Creek (BPU Floodwall)



FAIRFAX – JERSEY CREEK (BPU FLOODWALL)
BEGINNING OF ABOVE GROUND 54" WATER LINE

③

EXHIBIT A-11.42
Fairfax – Jersey Creek (BPU Floodwall)

FAIRFAX-JERSEY CREEK (BPU FLOODWALL)
LOOKING WEST TOWARDS ABANDONED PUMP HOUSE

(4)

EXHIBIT A-11.43
East Bottoms (Missouri and Blue Rivers Confluence Area)

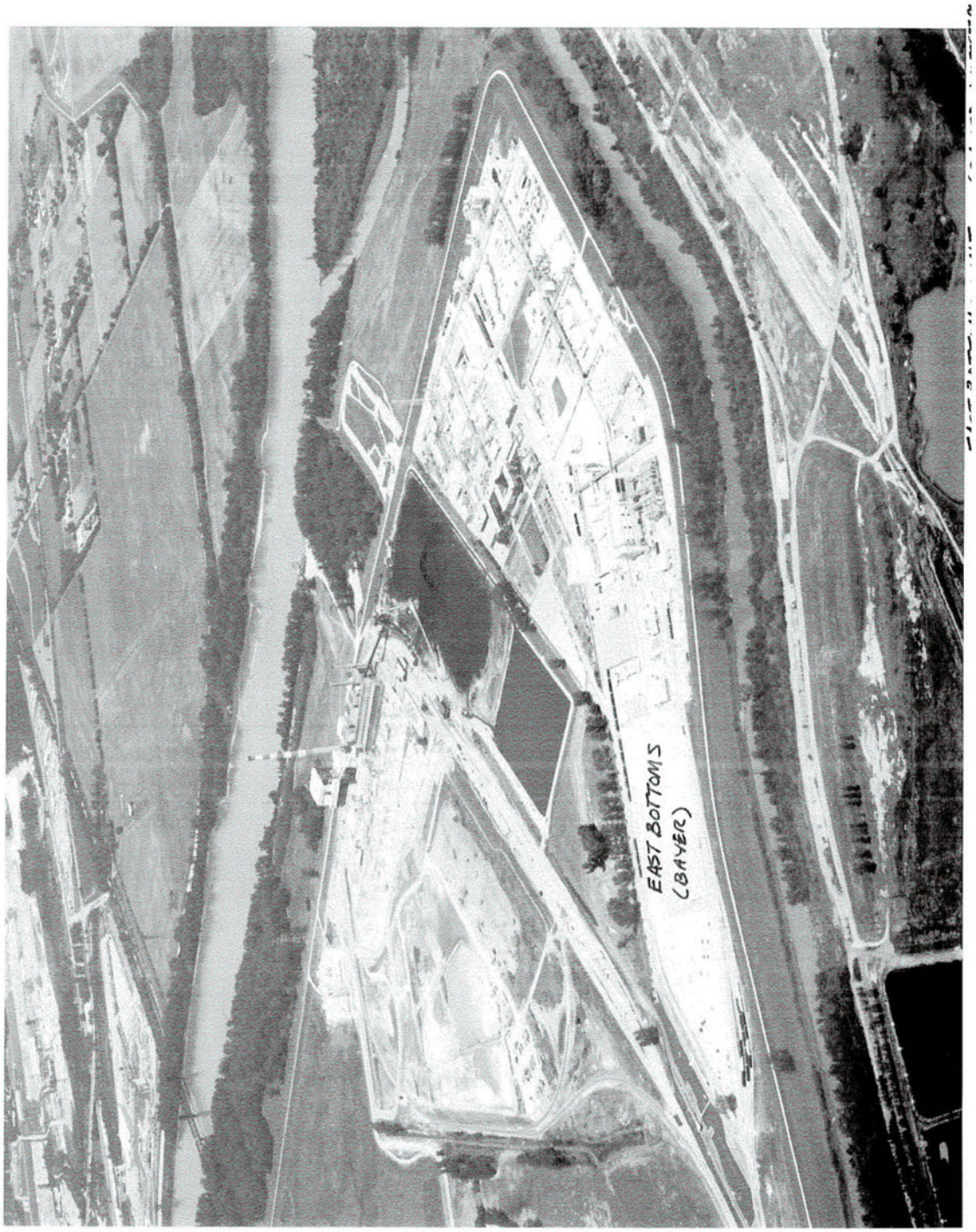


EXHIBIT A-11.44
East Bottom Utilities Uplift (Missouri and Blue Rivers Confluence Area)

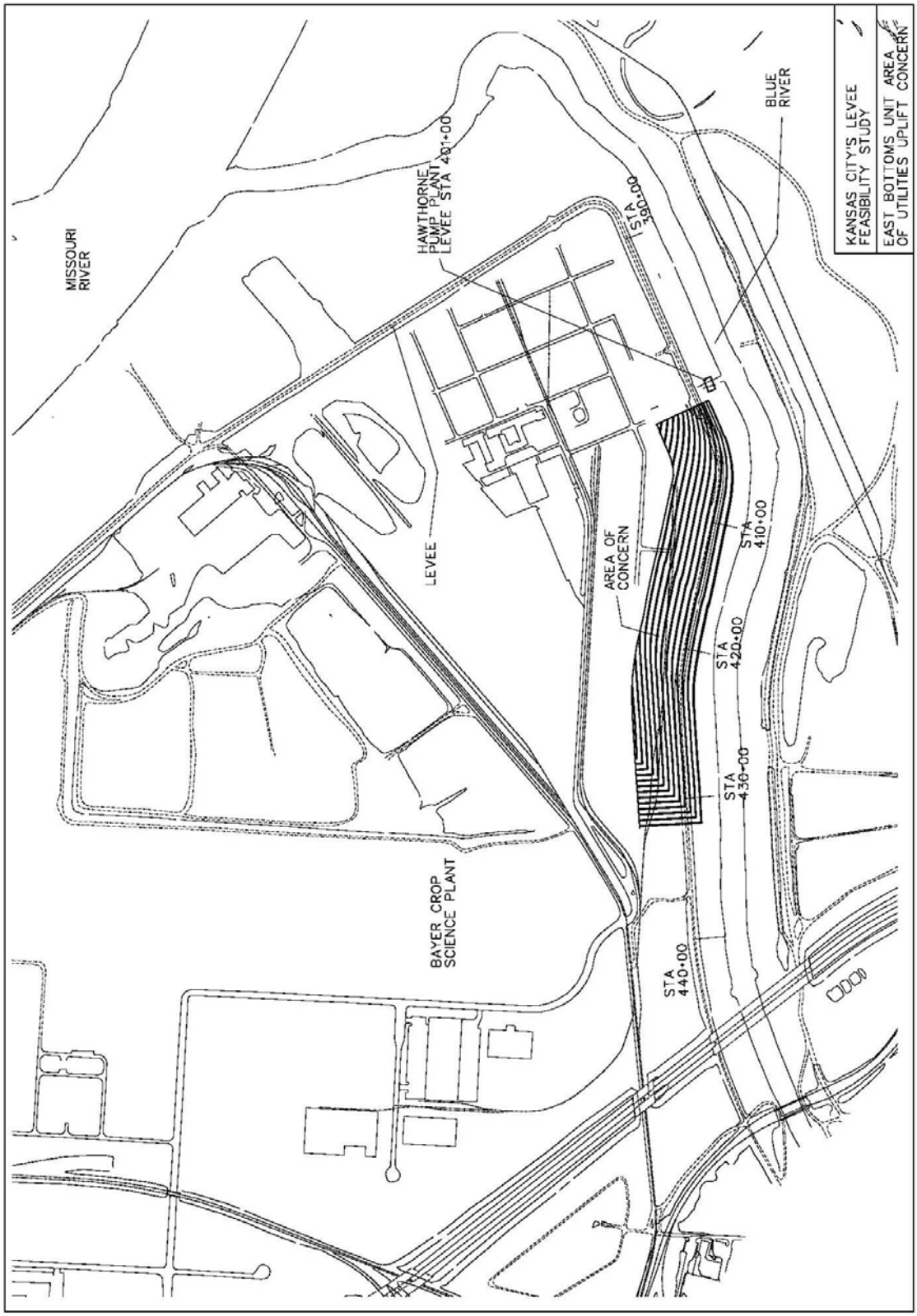


EXHIBIT A-11.45
Bayer Utility Plans

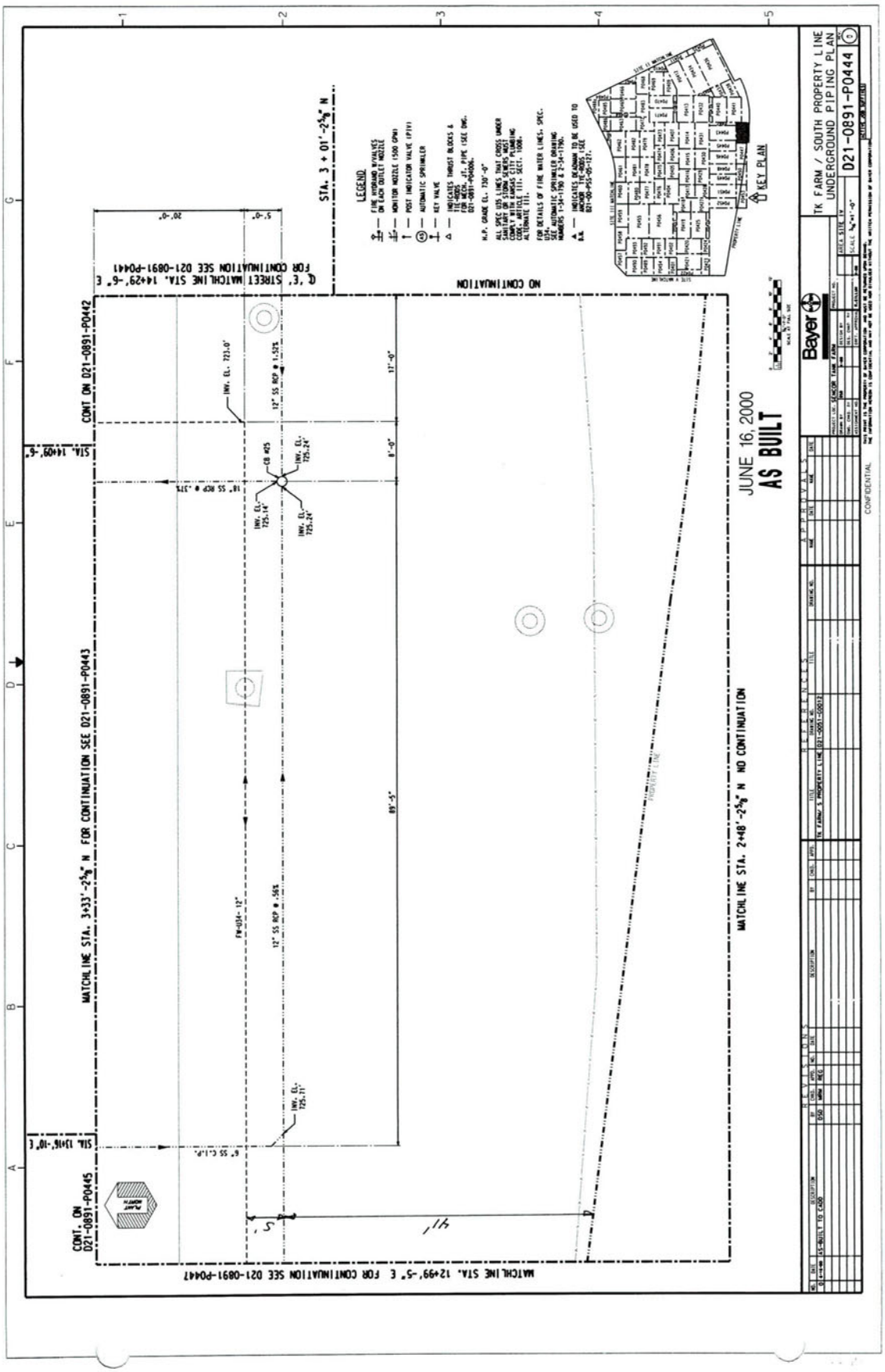


EXHIBIT A-11.45 (Continued)
Bayer Utility Plans

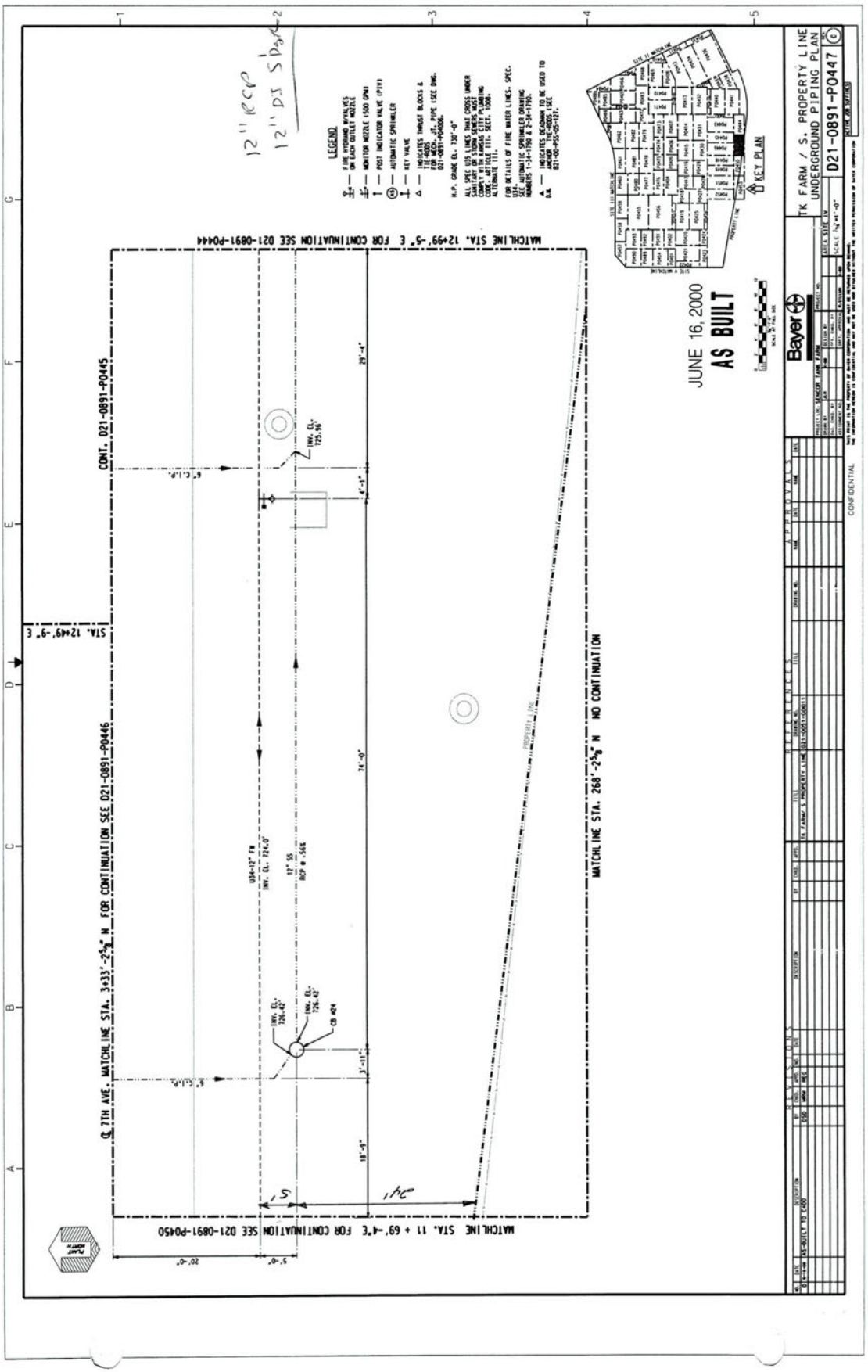


EXHIBIT A-11.45 (Continued)
Bayer Utility Plans

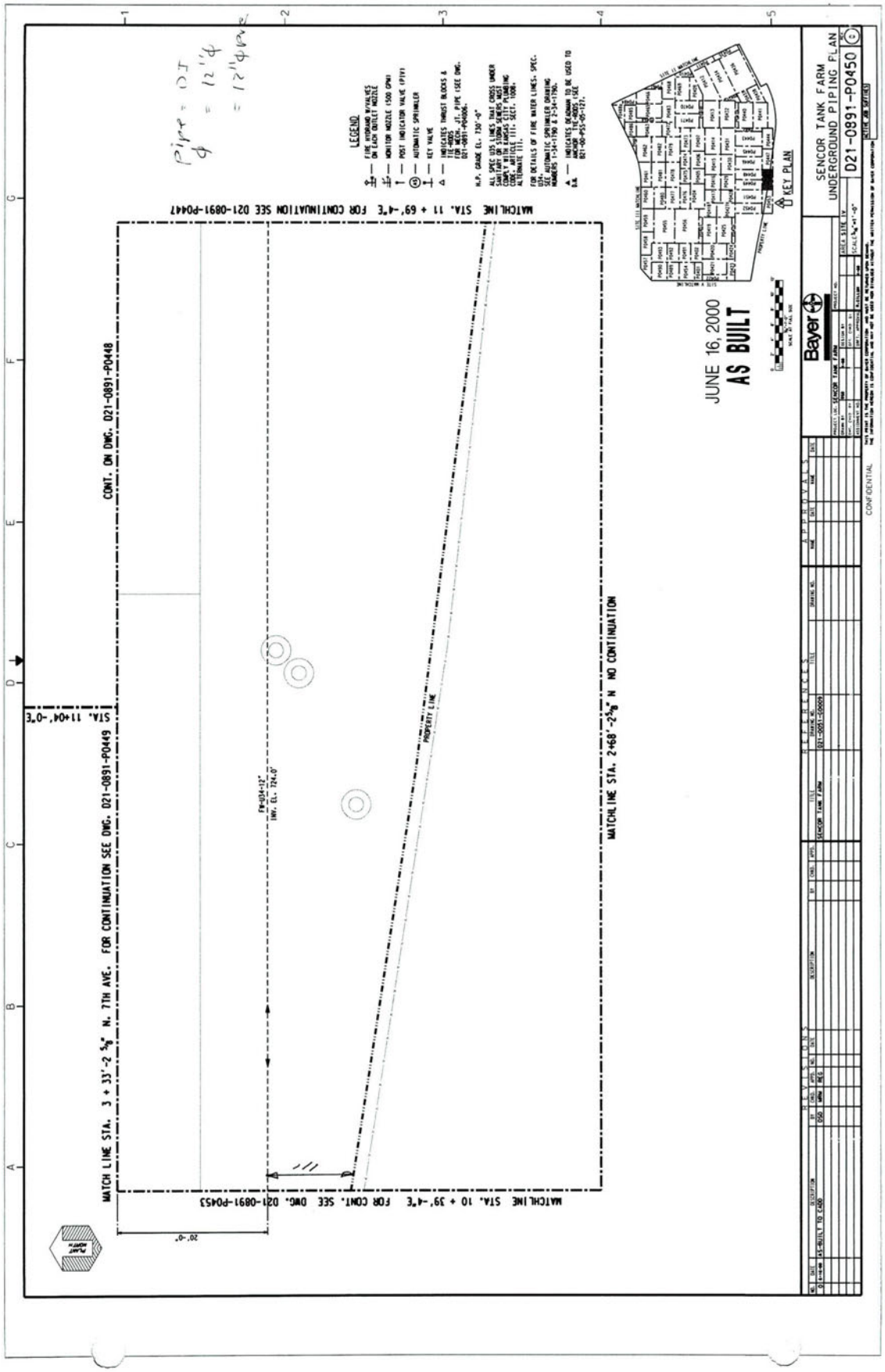


EXHIBIT A-11.45 (Continued)
Bayer Utility Plans

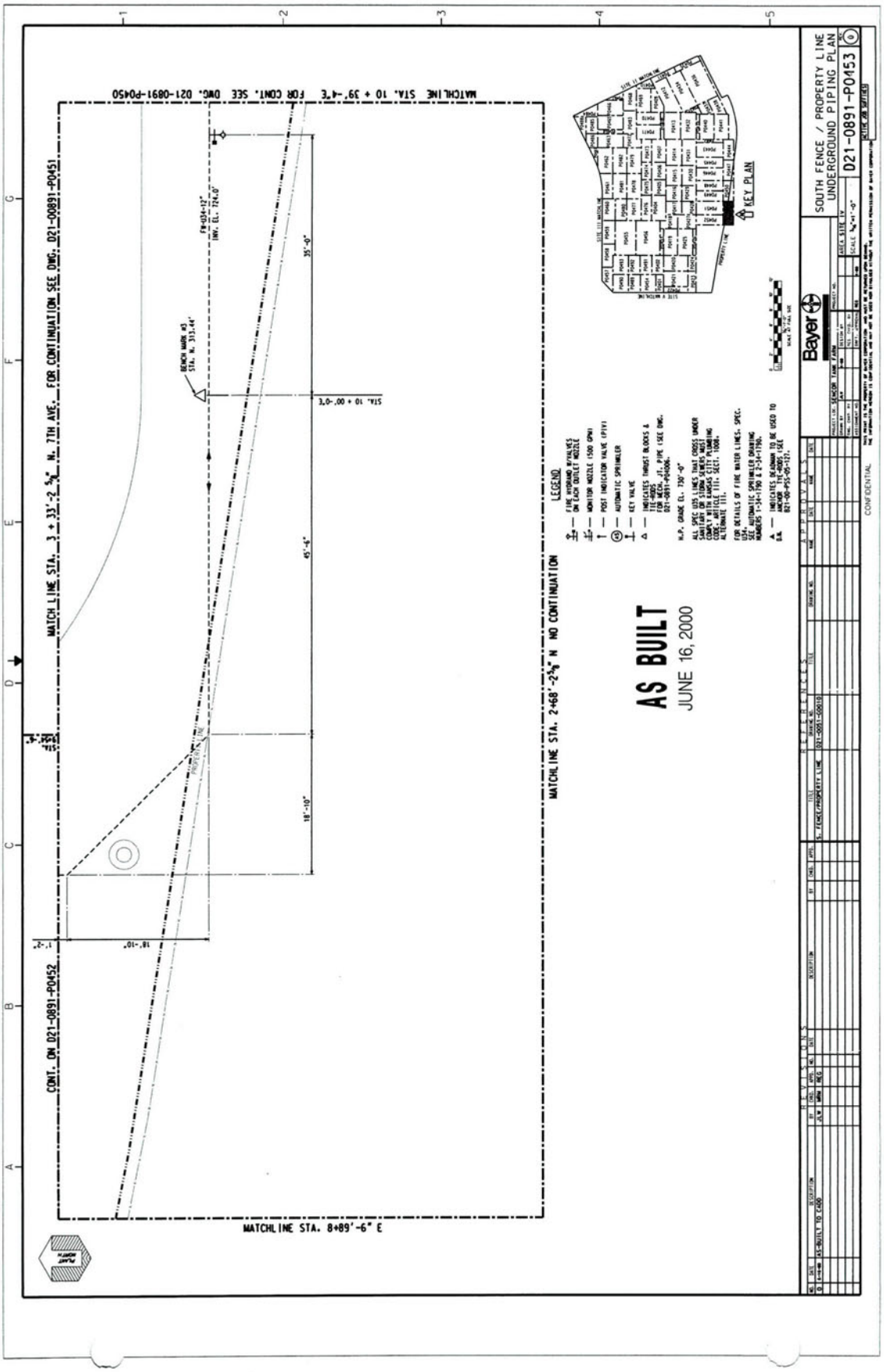
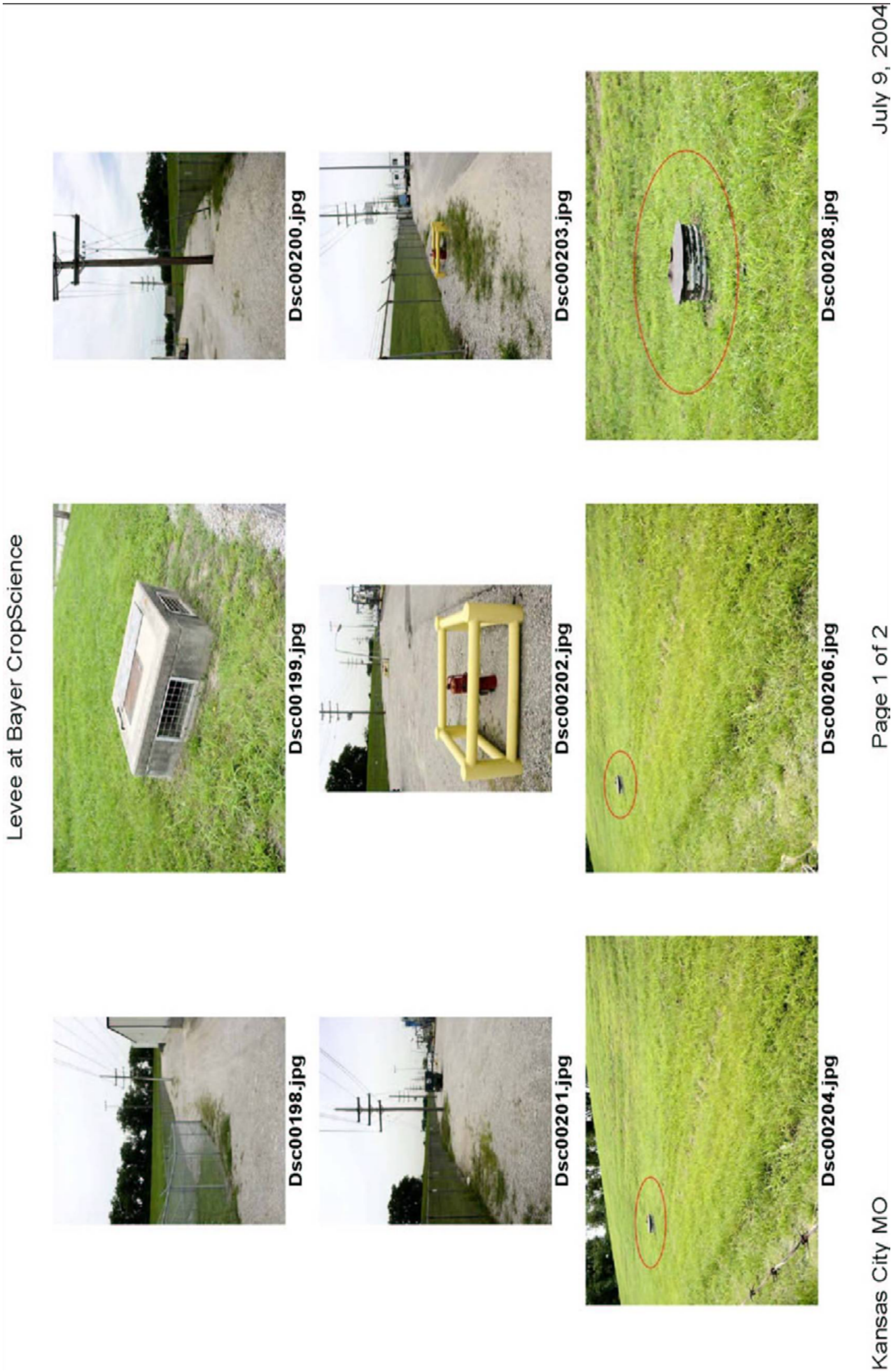


EXHIBIT A-11.46
Bayer Utility Photos



Levee at Bayer CropScience

Dsc00210.jpg

Dsc00211.jpg

Dsc00212.jpg

Dsc00214.jpg

Dsc00215.jpg

Dsc00216.jpg

Dsc00218.jpg

Dsc00219.jpg

Dsc00221.jpg

Kansas City MO   Page 2 of 2   July 9, 2004

EXHIBIT A-11.47
North Kansas City – Lower (National Starch Area)
Calculations

US Army Corps of Engineers
Kansas City District

PROJECT Kansas City Seven Levees

TASK **25cfs Pump Sizing**

DATE 06-Jan-05
INITIALS JDM
QA/QC DATE 28-Jan-05
QA/QC INITIALS RGJ

General information regarding project design.

Length of discharge line	600	ft
Design Low Water	722	ft (msl)
Highest Point in System	758	ft (msl)
Static Head	36	ft
Desired System Output	25.00	ft^3/s
	11,221	gal/min

Friction loss in discharge pipe can be found with the Hazen Williams Formula.

$h_f = (4.72*Q^{1.852}*L)/(C^{1.852}*D^{4.87})$ (AWWA M11 Eq. 3-2)

h_f	Headloss due to friction		
Q	Flow	25.00	ft^3/s
L	Length of discharge pipe	600	ft
C	Hazen-Williams Coefficient	100	
D	Inside pipe diameter		ft

Velocity head loss can be figured by the following.

$h_v = V^2/2g$ (AWWA M11 Eq. 3-8)

h_v	Headloss in feet		
V	Velocity		
g	acceleration due to gravity	32.2	ft/s^2

Minor losses were then found using the following assumptions. From AWWA M 11 Figure 3.5

Description	K	Number	$K_{subtotal}$
60 degree miter bend	0.6	4	2.4

$h_m = K(V^2/2g)$

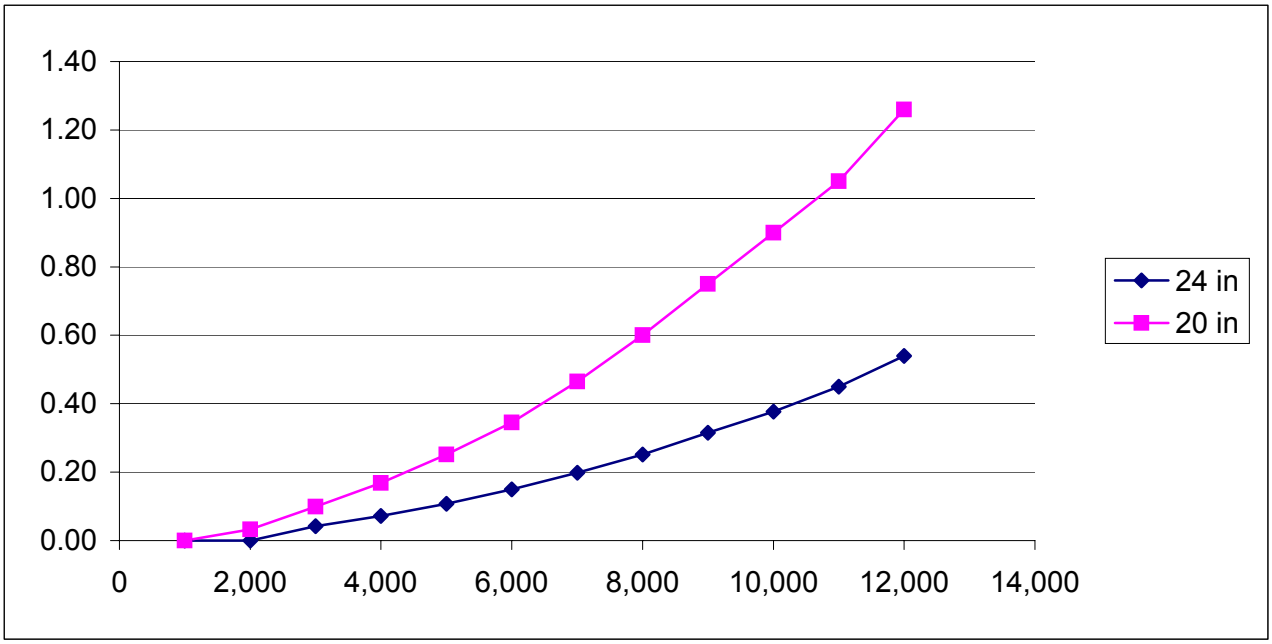
The following table presents head required for various pipe sizes

Diameter	Velocity	Head Loss (ft)				
in	*ft/s*	Static	Friction	Velocity	Minor	Total
24	7.96	36	7.43	0.98	2.36	46.8
30	5.09	36	2.51	0.40	0.97	39.9
36	3.54	36	1.03	0.19	0.47	37.7
42	2.60	36	0.49	0.10	0.25	36.8
	Used in Calculations for system curve					

Column losses for this pump were determined using pg 276 of the Fairbanks Morse 8000 Propeller Pumps Application & Reference Data

The following table presents column losses in ft/100 of column for 20 and 24 inch columns.

	20 in		24 in	
GPM	per 100ft	**Total**	per 100ft	**Total**
0	0	**0.00**	0	**0.00**
1,000	0	**0.00**	0	**0.00**
2,000	0.11	**0.03**	0	**0.00**
3,000	0.33	**0.10**	0.14	**0.04**
4,000	0.56	**0.17**	0.24	**0.07**
5,000	0.84	**0.25**	0.36	**0.11**
6,000	1.15	**0.35**	0.5	**0.15**
7,000	1.55	**0.47**	0.66	**0.20**
8,000	2	**0.60**	0.84	**0.25**
9,000	2.5	**0.75**	1.05	**0.32**
10,000	3	**0.90**	1.255	**0.38**
11,000	3.5	**1.05**	1.5	**0.45**
12,000	4.2	**1.26**	1.8	**0.54**
*	30	feet of Column		



US Army Corps of Engineers
Kansas City District

PROJECT Kansas City Seven Levees

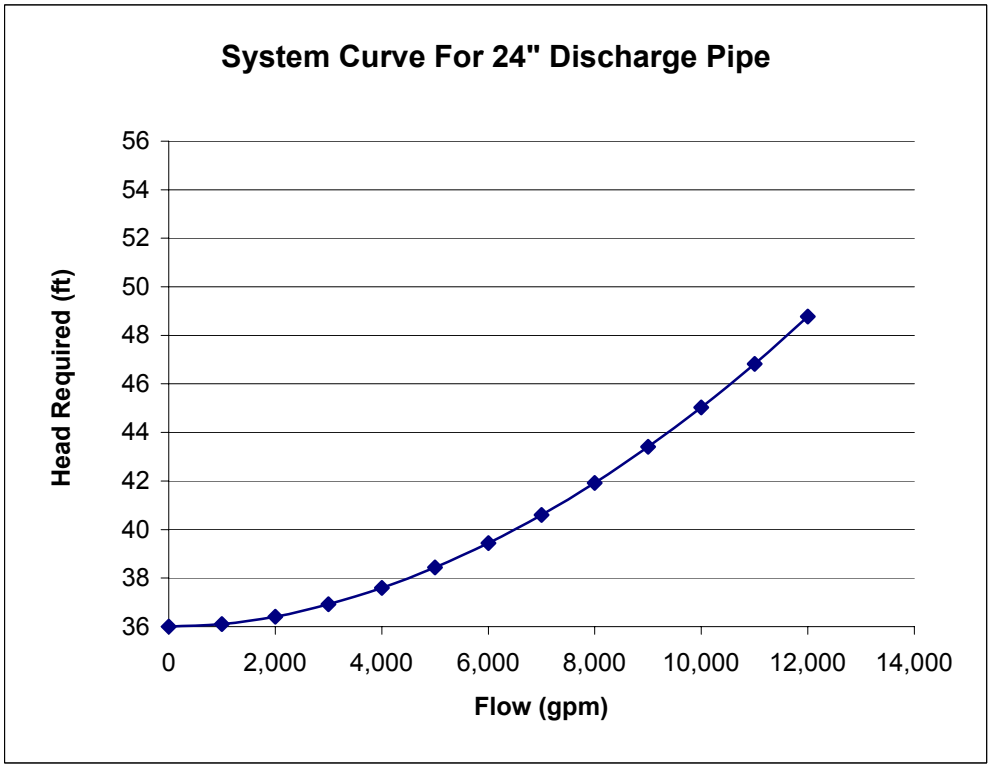
TASK **25cfs Pump Sizing**

DATE 06-Jan-05
INITIALS JDM
QA/QC DATE 28-Jan-05
QA/QC INITIALS RGJ

PRELIMINARY SYSTEM CURVE

Flow		Head			
GPM	ft^3/s	Static	Dynamic	Column	Total
0	0.00	36.00	0.00	0.00	36.00
1,000	2.23	36.00	0.11	0.00	36.11
2,000	4.46	36.00	0.41	0.00	36.41
3,000	6.68	36.00	0.88	0.04	36.93
4,000	8.91	36.00	1.52	0.07	37.60
5,000	11.14	36.00	2.33	0.11	38.43
6,000	13.37	36.00	3.29	0.15	39.44
7,000	15.60	36.00	4.40	0.20	40.60
8,000	17.82	36.00	5.67	0.25	41.92
9,000	20.05	36.00	7.09	0.32	43.41
10,000	22.28	36.00	8.66	0.38	45.04
11,000	24.51	36.00	10.38	0.45	46.83
12,000	26.74	36.00	12.24	0.54	48.78

*System Curve, given: 24 in discharge pipe



Horsepower Required at top of shaft.

Brake Horsepower = [Total head * Flow (GPM)]/[3960 * Pump efficiency]

Total Head	39.88	ft
Flow	11,221	gpm
Pump Eff.	0.855	

Brake Horsepower = 132 hp

From pg 277 of Fairbanks Morse Pumps line shaft horse power loss per 100ft of 1-15/16" shaft is 0.72 at 720 RPM

Hp line shaft loss = (loss/100ft)*setting depth/100

Loss/100ft	0.72	hp
setting depth	30	ft

Hp line shaft loss = 0.22 hp

Pump thrust = head * Kt + Ka + Setting in ft * Ks

Total Head	39.88	
Kt	101	lb/ft
Ka	125	lb
setting depth	30	
Ks	7.6	lb/ft

Pump thrust = 4,380 lb

Loss through thrust bearing = .0075hp per 1,000lb at 100rpm

RPM	880	
Thrust	4,380	lbs

Loss through thrust bearing = 0.29 hp

Motor HP = (HP_{brake} + $HP_{lineloss}$ + $HP_{lossthrustbearing}$)

Motor HP = 133

Pump station discharge when inflow equal to 1/2 the flow rate of first pump.

Pump Discharge	25	cfs
	11,221	gpm
Max starts per hr	2	
V=tQ/4	11,250	ft^3

In order to obtain required sump volume the following sump dimensions could be used.

Sump	Configuration 1	Configuration 2
Width	35 ft	45 ft
Length	35 ft	45 ft
Depth	9.5 ft	6.0 ft
Volume	11,638 ft^3	12,150 ft^3

General information regarding project design.

Length of discharge line	600	ft
Design Low Water	722	ft (msl)
Highest Point in System	758	ft (msl)
Static Head	36	ft
Desired System Output	12.50	ft^3/s
	5,610	gal/min

Friction loss in discharge pipe can be found with the Hazen Williams Formula.

$h_f = (4.72*Q^{1.852}*L)/(C^{1.852}*D^{4.87})$ (AWWA M11 Eq. 3-2)

h_f	Headloss due to friction		
Q	Flow	12.50	ft^3/s
L	Length of discharge pipe	600	ft
C	Hazen-Williams Coefficient	100	
D	Inside pipe diameter		ft

Velocity head loss can be figured by the following.

$h_v = V^2/2g$ (AWWA M11 Eq. 3-8)

h_v	Headloss in feet		
V	Velocity		
g	acceleration due to gravity	32.2	ft/s^2

Minor losses were then found using the following assumptions. From AWWA M 11 Figure 3.5

Description	K	Number	$K_{subtotal}$
60 degree miter bend	0.6	4	2.4

$h_m = K(V^2/2g)$

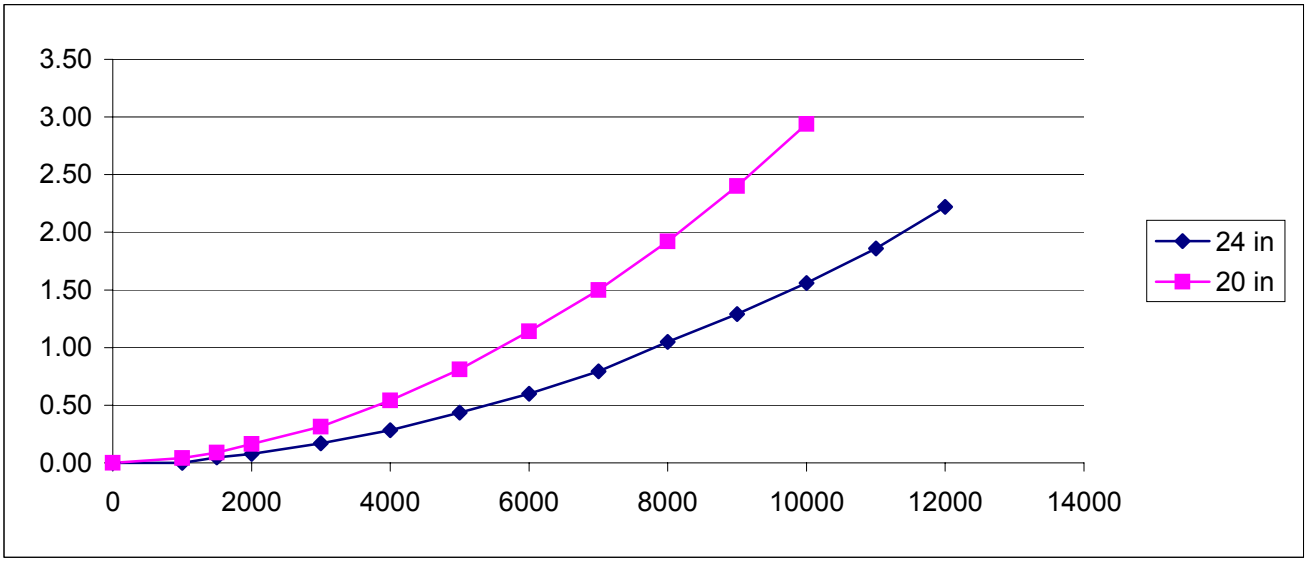
The following table presents head required for various pipe sizes

Diameter	Velocity	Head Loss (ft)				
in	*ft/s*	Static	Friction	Velocity	Minor	Total
18	7.07	36	8.36	0.78	1.86	47.0
24	3.98	36	2.06	0.25	0.59	38.9
30	2.55	36	0.69	0.10	0.24	37.0
36	1.77	36	0.29	0.05	0.12	36.5
	Used in Calculations for system curve					

Column losses for this pump were determined using pg 276 of the Fairbanks Morse 8000 Propeller Pumps Application & Reference Data

The following table presents column losses in ft/100 of column for 20 and 24 inch columns.

	16 in		18 in	
GPM	per 100ft	**Total**	per 100ft	**Total**
0	0.00	**0.00**	0.00	**0.00**
1,000	0.14	**0.04**	0.00	**0.00**
1,500	0.30	**0.09**	0.16	**0.05**
2,000	0.55	**0.17**	0.26	**0.08**
3,000	1.05	**0.32**	0.56	**0.17**
4,000	1.80	**0.54**	0.94	**0.28**
5,000	2.70	**0.81**	1.45	**0.44**
6,000	3.80	**1.14**	2.00	**0.60**
7,000	5.00	**1.50**	2.65	**0.80**
8,000	6.40	**1.92**	3.50	**1.05**
9,000	8.00	**2.40**	4.30	**1.29**
10,000	9.80	**2.94**	5.20	**1.56**
11,000	0.00	**0.00**	6.20	**1.86**
12,000	0.00	**0.00**	7.40	**2.22**
*	30 feet of Column			



US Army Corps of Engineers
Kansas City District

PROJECT Kansas City Seven Levees

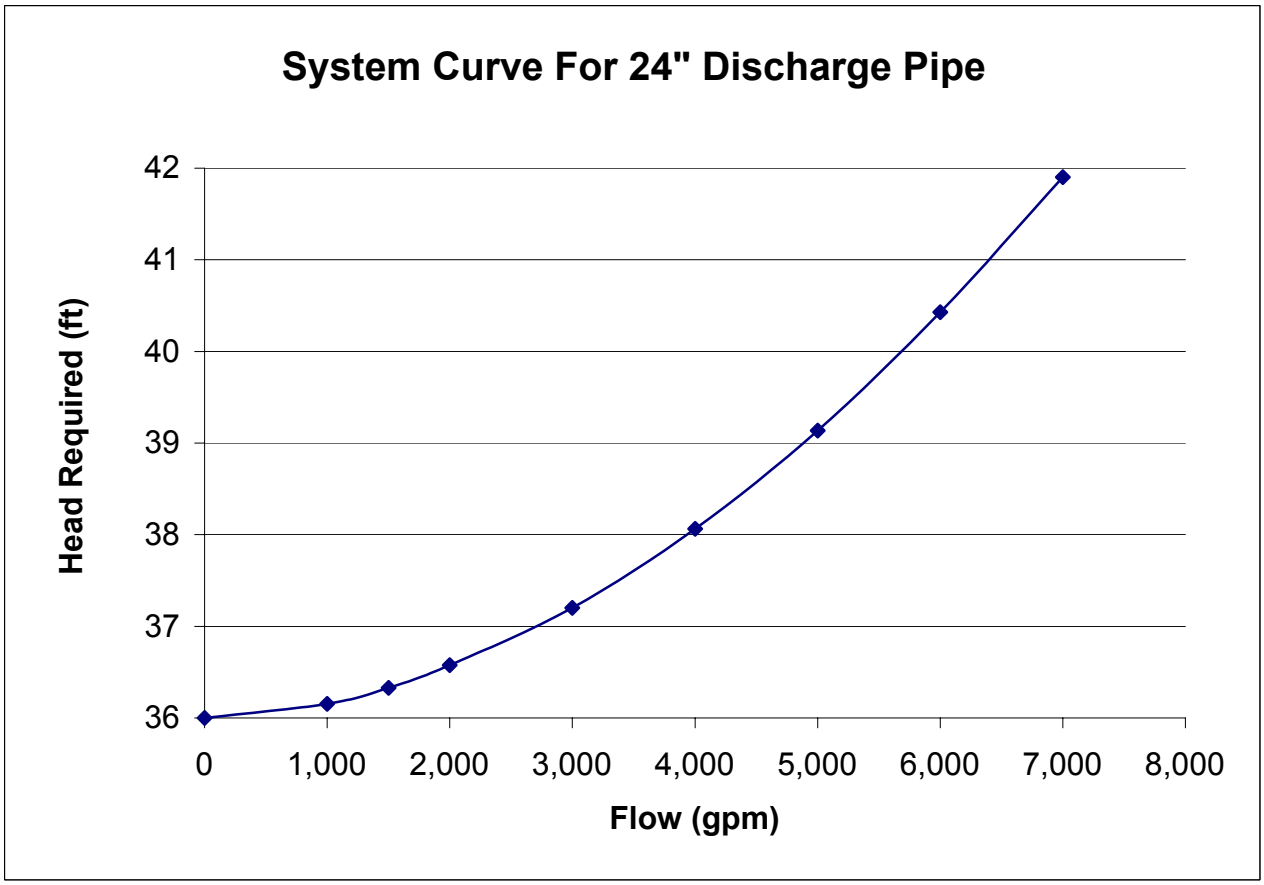
TASK **12.5 cfs Pump Sizing**

DATE 06-Jan-05
INITIALS JDM
QA/QC DATE 28-Jan-05
QA/QC INITIALS RGJ

PRELIMINARY SYSTEM CURVE

Flow		Head			
GPM	ft^3/s	Static	Dynamic	Column	Total
0	0.00	36.00	0.00	0.00	36.00
1,000	2.23	36.00	0.11	0.04	36.15
1,500	3.34	36.00	0.24	0.09	36.33
2,000	4.46	36.00	0.41	0.17	36.58
3,000	6.68	36.00	0.88	0.32	37.20
4,000	8.91	36.00	1.52	0.54	38.06
5,000	11.14	36.00	2.33	0.81	39.14
6,000	13.37	36.00	3.29	1.14	40.43
7,000	15.60	36.00	4.40	1.50	41.90

*System Curve, given: 24 in discharge pipe



Horsepower Required at top of shaft.

Brake Horsepower = [Total head * Flow (GPM)]/[3960 * Pump efficiency]

Total Head	38.89	ft
Flow	5,610	gpm
Pump Eff.	0.86	

Brake Horsepower = 64.1 hp

From pg 277 of Fairbanks Morse Pumps line shaft horse power loss per 100ft of 1-15/16" shaft is 0.9 at 900 RPM

Hp line shaft loss = (loss/100ft)*setting depth/100

Loss/100ft	0.9	hp
setting depth	30	ft

Hp line shaft loss = 0.27 hp

Pump thrust = head * Kt + Ka + Setting in ft * Ks

Total Head	38.89	
Kt	101	lb/ft
Ka	125	lb
setting depth	30	
Ks	7.6	lb/ft

Pump thrust = 4,281 lb

Loss through thrust bearing = .0075hp per 1,000lb at 100rpm

RPM	880	
Thrust	4,281	lbs

Loss through thrust bearing = 0.28 hp

Motor HP = (HP_{brake} + $HP_{lineloss}$ + $HP_{lossthrustbearing}$)

Motor HP = 64.6

Pump station discharge when inflow equal to 1/2 the flow rate of first pump.

Pump Discharge	12.5 cfs
	5,610 gpm
Max starts per hr	4
V=tQ/4	2,813 ft^3

Pump Station Discharge inflow equal to 1/2 the difference of flow rate of first pump and second pump.

Pump Discharge	12.5 cfs
	5,610 gpm
Max starts per hr	4
V=tQ/4	2,813 ft^3

In order to obtain required sump volume the following sump dimensions could be used.

Sump	Configuration 1	Configuration 2
Width	25 ft	17.7 ft
Length	25 ft	17 ft
Depth	5.0 ft	10.0 ft
Volume	3,125 ft^3	3,005 ft^3

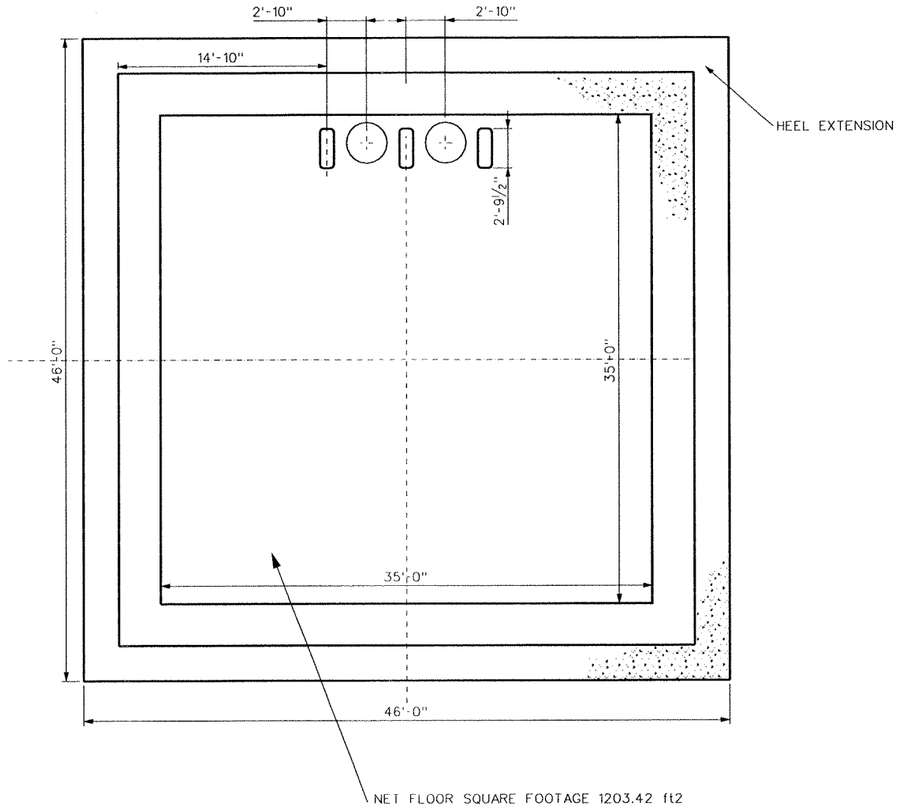
Header system pipe sizing

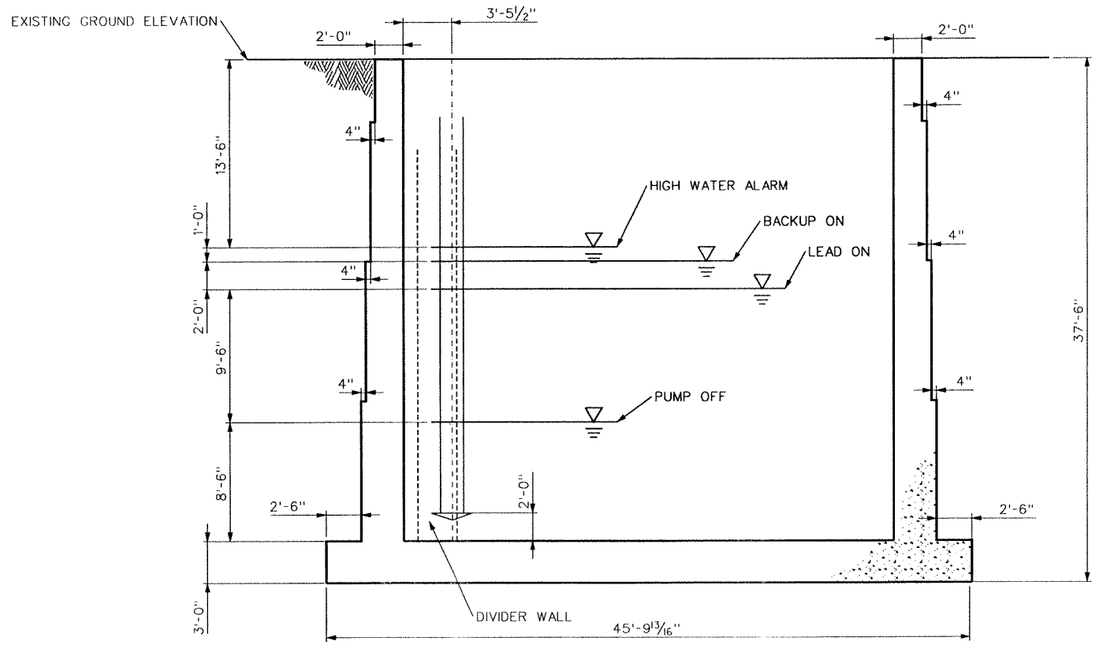
Note: Q max occurs at flow depth of approximately 0.94. Refer to Standard Handbook for Civil Engineers, 3rd Edition, pp. 22-10 to 22-12 for further information.

Pipe Diameter	30	in
Flow Depth (Qmax)	28.2	in
FL EL in	4.8	ft
FL EL out	0	ft
Length	1600	ft
Slope	0.003	
Manning's "N" (RCP)	0.012	
Flow Area	689.5	in^2
Wetted Perimeter	79.4	in
Flow	26.18	cfs
Velocity	5.47	ft/s

Refer to Standard Handbook for Civil Engineers, 3rd Edition, pp. 22-10 to 22-12 for further information.

EXHIBIT A-11.48
North Kansas City – Lower (National Starch Area)
Alternative #1 Sump Layouts





US Army Corps of Engineers
Kansas City District

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Checked by: BGJ
Submitted by: HWM
Date: X
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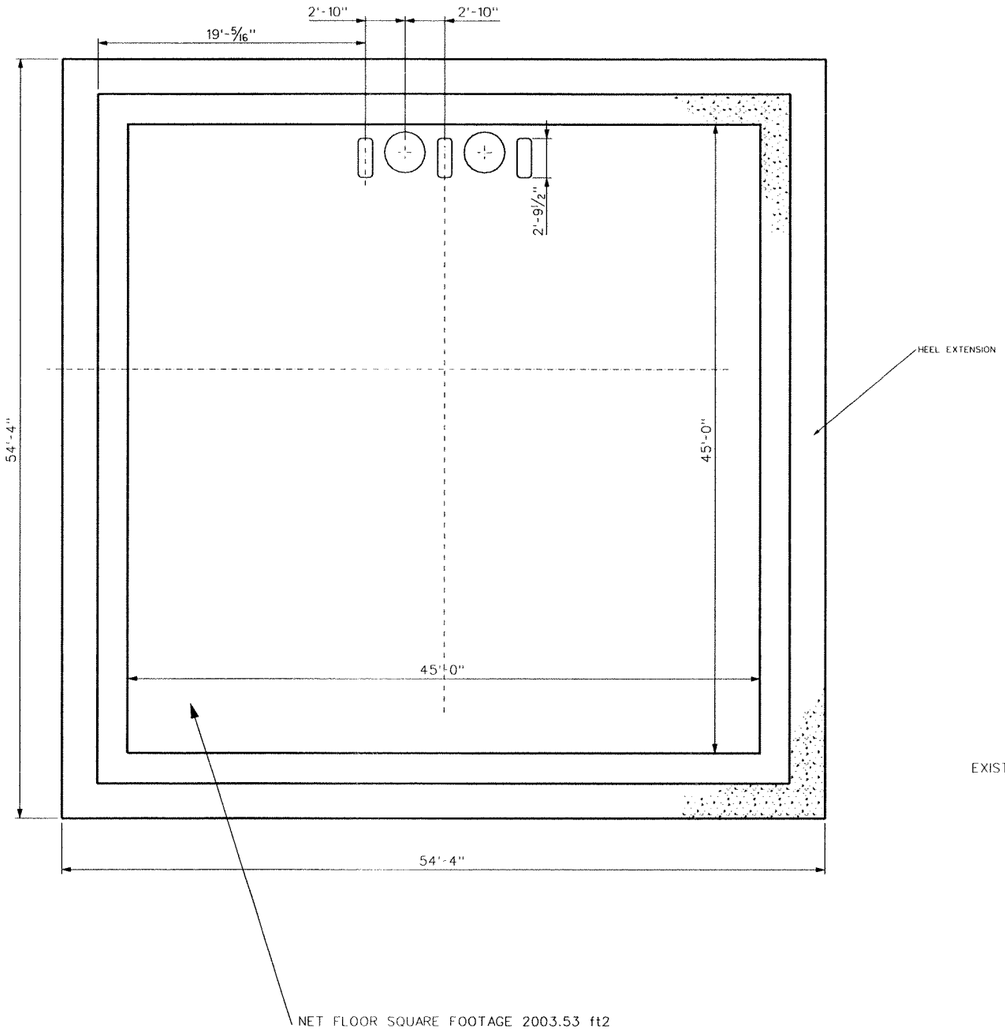
Plot scale: NONE
CADD File Name: NTL_05502

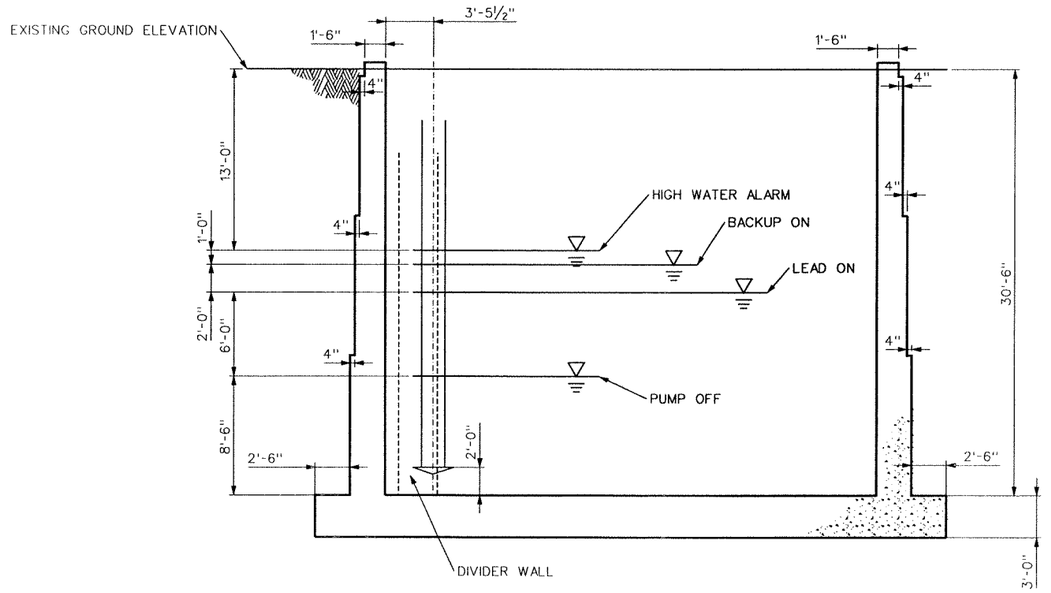
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

KANSAS CITY LEVEES
FEASIBILITY STUDY
NATIONAL STARCH
PROPOSED PUMP STATION

ALTERNATIVE 1
SUMP LAYOUT

Sheet reference number:
B2





US Army Corps of Engineers
Kansas City District

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U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

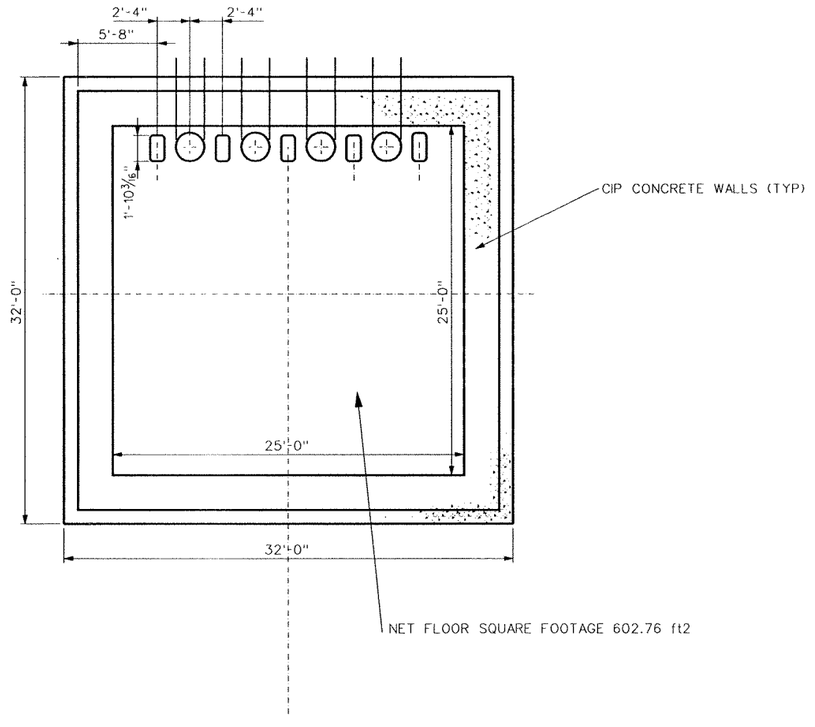
KANSAS CITY LEVEES
FEASIBILITY STUDY
NATIONAL STARCH
PROPOSED PUMP STATION

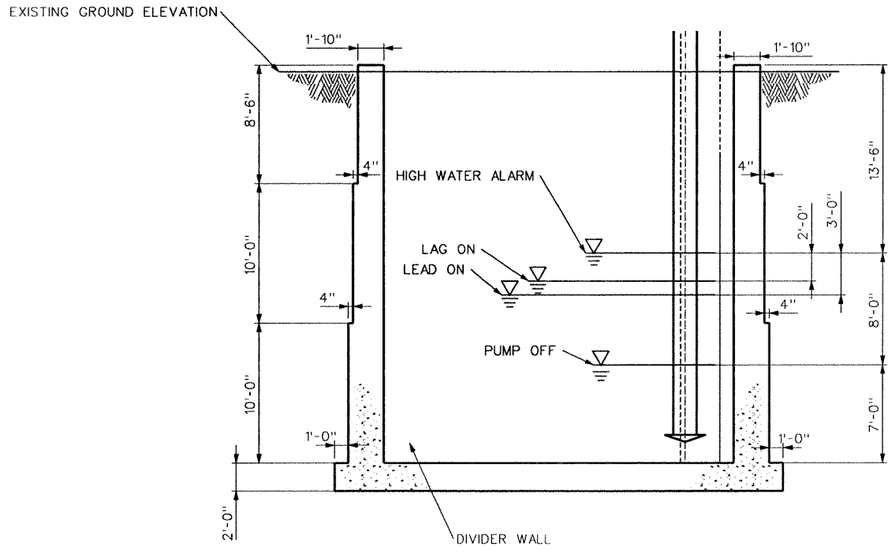
ALTERNATIVE 1
SUMP LAYOUT

Sheet reference number:

B3

EXHIBIT A-11.49
North Kansas City – Lower (National Starch Area)
Alternative #2 Sump Layouts





US Army Corps of Engineers
Kansas City District

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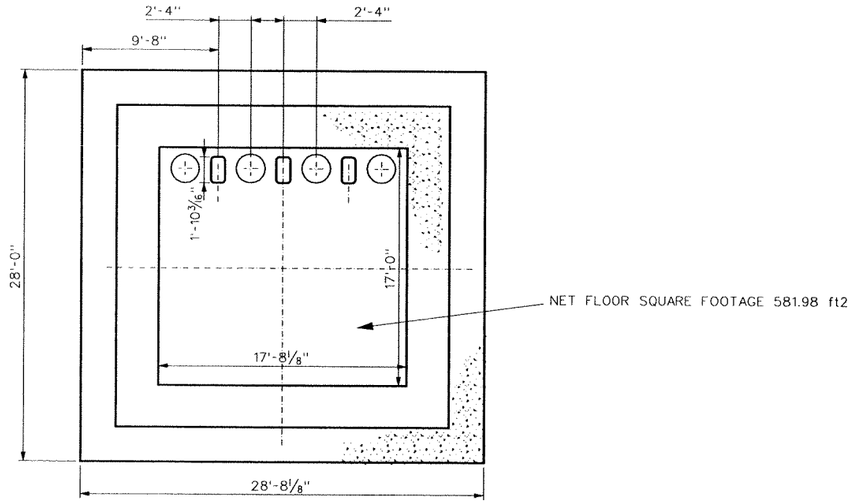
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

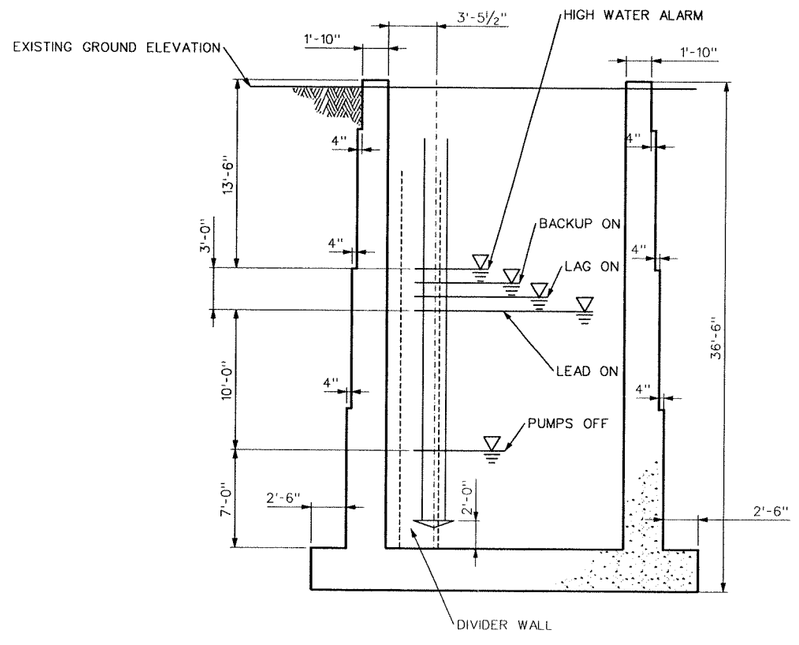
KANSAS CITY LEVEES
FEASIBILITY STUDY
NATIONAL STARCH
PROPERTY ACQUISITION

ALTERNATIVE 2
SUMP LAYOUT
RECOMMENDED ALTERNATIVE

Sheet reference number:

B4





US Army Corps of Engineers
Kansas City District

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U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

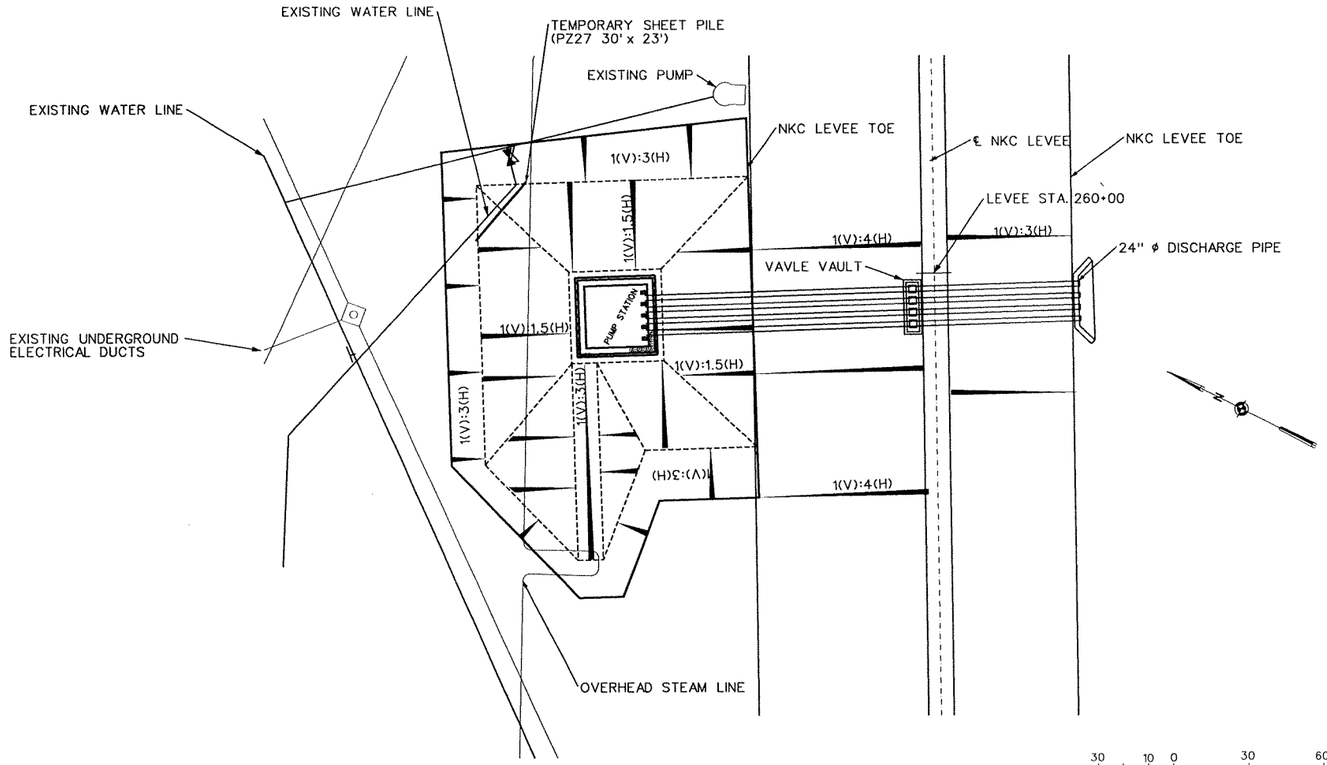
KANSAS CITY LEVEES
FEASIBILITY STUDY
NATIONAL REACH
PROPOSED PUMP STATION

ALTERNATIVE 2
SUMP LAYOUT

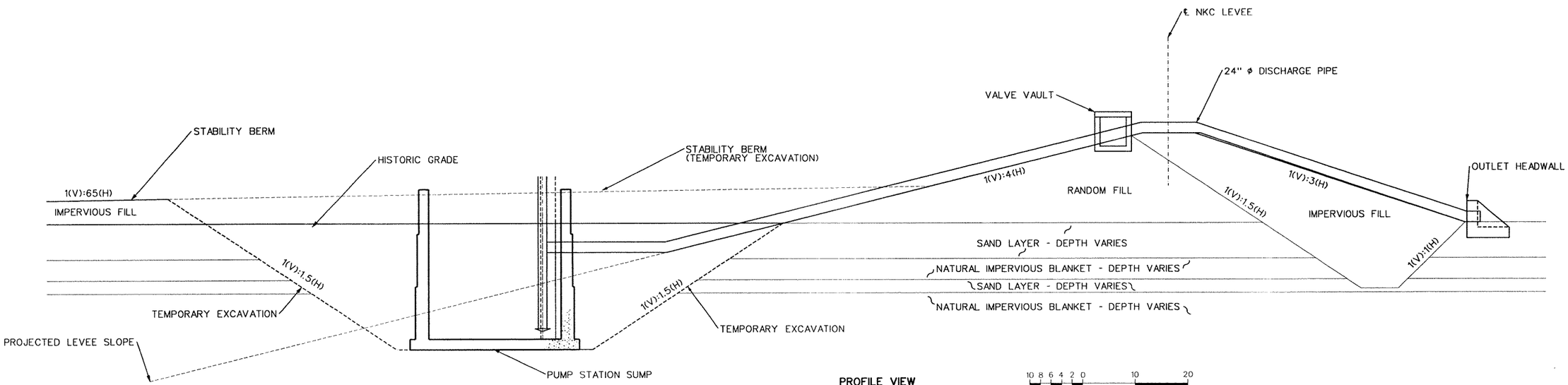
Sheet reference number:

B5

EXHIBIT A-11.50
North Kansas City – Lower (National Starch Area)
Preliminary Plan and Profile



PLAN VIEW
SCALE: 30:1



PROFILE VIEW
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US Army Corps of Engineers
Kansas City District

Symbol	Description	Date	Appr.

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Checked by: RGJ
Submitted by: HWM
Date: X
File no.:
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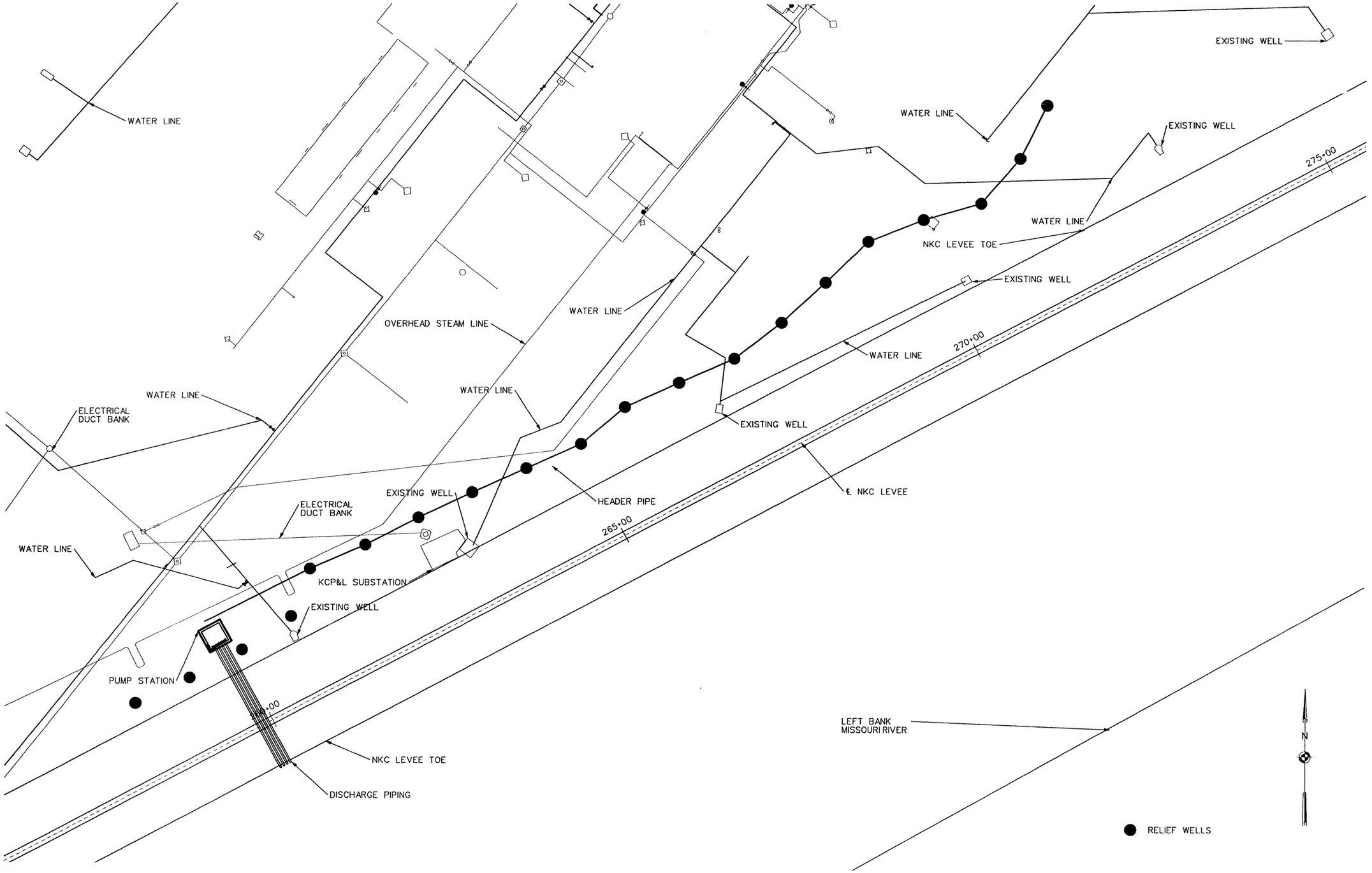
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

KANSAS CITY LEVEES
FEASIBILITY STUDY
NATIONAL STARCH
PROPOSED PUMP STATION

PLAN AND PROFILE
RECOMMENDED ALTERNATIVE

Sheet reference number:
B1

EXHIBIT A-11.51
North Kansas City – Lower (National Starch Area)
Utility Plan



US Army Corps of Engineers
Kansas City District

Symbol	Description	Date	Appr.

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U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

KANSAS CITY LEVEES
FEASIBILITY STUDY
NATIONAL STARCH
PROPOSED PUMP STATION

UTILITY PLAN

Sheet reference number:
B6