

**Kansas Citys, Missouri and Kansas  
Flood Risk Management Feasibility Study**

**Engineering Appendix to the Final Feasibility Report**

**Chapter A-3**

**SURVEYING, MAPPING, AND  
OTHER GEOSPATIAL DATA  
REQUIREMENTS**



## **CHAPTER A-3 SURVEYING, MAPPING, AND OTHER GEOSPATIAL DATA REQUIREMENTS**

### **A-3.1 INFORMATION TO SUPPORT PREPARATION OF FEASIBILITY REPORT – PHASE 1 AND PHASE 2**

The need for datum consistency on the Kansas City's flood risk management project is essential. Since vertical reference datum uncertainties and deficiencies are known to exist within the Kansas City area and across the Missouri and Kansas state lines it is imperative that spatial datums be addressed during this feasibility stage and plans put in place to address these issues during detailed design.

During the time when the Kansas City's levee units were originally surveyed and constructed, benchmarks and survey control would have been set up locally around each individual unit isolated from other levee units. This independent approach of surveying and construction, although adequate at the time, is not in line with the "System's Approach" taken for the Kansas City's Flood Risk Management Project. Use of GPS based survey equipment also allows for benchmarks and control to be located further from the individual units. For example, it is possible that a benchmark used for Argentine can easily be used for Armourdale. Because the Kansas City's levees act together during a flood event to protect the area, the entire system of levee units should be surveyed, such that there is no question how elevations from one unit relates to another.

The purpose of this chapter of the feasibility report is to document the surveying, mapping and other geospatial data used or reviewed as part of the feasibility level design. From this review of data will come the recommendation to consider the entire seven levees when planning and performing survey and mapping activities for future detailed design phases. Survey data and mapping is the information base from which many engineering recommendations come and certainly the base from which detailed design and construction will begin.

#### **A-3.1.1 Kansas City Area Survey Control**

Within the Kansas City's Flood Risk Management project area, there are several systems of survey control in existence. These systems are maintained by various entities.

##### **A-3.1.1.1 Kansas City, Missouri and Missouri Department of Natural Resources – Horizontal**

The Missouri Department of Natural Resource directed the execution of a geodetic survey of part of the Kansas City, Missouri Metro Area. As part of this effort, they were able to show that all main stations were in conformity with the proposed Geometric Geodetic Survey Standards Version Four September 1, 1986 for First Order; and have been rigidly adjusted on NAD 1983 and whose coordinates have been computed on the Missouri Coordinate System of

1983 West Zone. This project also made direct ties between several NGS control stations within the area.

It is likely that this system of horizontal control will be incorporated into the survey plan for detailed design.

#### **A-3.1.1.2 Kansas City, Missouri Directrix – Vertical**

Kansas City, Missouri has an independent vertical datum plane called the Kansas City Directrix. According to an article on the KCMO Public Works website written by Sam Laffoon, former Chief of Surveys for the City of Kansas City, The Directrix was established about 1860 by the city engineer of that time. In 1892, a resolution by the council of Kansas City stated that the Kansas City Directrix was a plane 721.84 above mean sea level. Later records show that precise levels from Beloxi, Mississippi determined it to be 723.24 above sea level. After the general adjustment of 1929, the Geodetic Surveys changed their elevations in this area so that the equation was again about 721.24. Then in 1948 they announced the results of “releveling” that changed the equation to near 722.30, which is the conversion factor used today.

It is likely that this system of vertical control will NOT be incorporated into the survey plan for detailed design.

#### **A-3.1.1.3 Unified Government of Wyandotte County**

The Unified Government use NOAA's National Geodetic Survey (NGS) system of points. This national system is discussed below.

#### **A-3.1.1.4 US Army Corps of Engineers**

The Corps of Engineers establishes survey control depending on the subject matter. The Corps has set up local control, used the NGS system, or other local controls already established. Harbor lines were established many years ago and monuments set for these may still exist.

It is likely that US Army Corps of Engineers monuments that can be found in the project area will be incorporated into the survey control system.

#### **A-3.1.1.5 National Geodetic Study**

The NGS defines and manages a national coordinate system. This network, the National Spatial Reference System (NSRS), provides the foundation for transportation and communication; mapping and charting; and a multitude of scientific and engineering applications.

NGS conducts aerial photography surveys near airports in the United States and its possessions to position obstructions and aids to air travel. NGS also maps the coastal regions of the United States and provides data for navigational charts. There are numerous NGS monuments throughout the Kansas City's Seven Levees Project area.

It is likely that this system of vertical control will be incorporated into the survey plan for detailed design.

### **A-3.1.2 Surveys**

#### **A-3.1.2.1 O&M Manuals and Record Drawings**

The O&M Manuals and Record Drawings were reviewed and used extensively during the feasibility level design. A records search was performed to determine what survey information was available during the design and construction of the Armourdale Unit. O&MM Plate No. 164 shows the Bench Marks that were used during the 1962 modification to the Armourdale Unit. See Exhibit A-3.1. These bench marks have not been confirmed and are not known to have been used by subsequent surveys conducted by the Corps of Engineers for this feasibility level design in early 2000's.

#### **A-3.1.2.2 2000 Surveys for Miscellaneous Feasibility Level Design Efforts**

A centerline survey of the top of levee was conducted in April of 2001 for all seven units in the Kansas City protection system. The survey was conducted for verification of the O&M Manual elevations and used as a baseline for the hydrologic and hydraulic analyses. See attached Exhibit A-3.2 showing the centerline survey elevations plotted along approximate levee stationing.

A review of the centerline survey indicated that some areas along the levee were lower than shown in the O&M Manual. Based on this, a resurvey of portions of the centerline was conducted in late 2003. The results of the resurvey confirmed that, in comparison with the original design elevations, several areas were lower. The following are the sections of levee units that were resurveyed:

CID-MO Unit – Station 73+00 to Station 89+37  
CID-KS Unit – Station 0+00 to Station 3+00  
Fairfax-Jersey Creek Unit – Station 27+00 to Station 30+00  
Fairfax-Jersey Creek Unit – Station 303+00 to Station 295+00  
North Kansas City Unit – Station 90+00 to Station 110+00  
North Kansas City Unit – Station 265+00 to Station 285+00  
Armourdale Unit – Station 93+00 to Station 102+00  
Armourdale Unit – Station 246+00 to Station 252+00

In addition, the area between the CID-MO and East Bottoms Units was resurveyed to verify the intended line of protection (existing "high ground"). Contour mapping suggested that this area does not provide the same level of protection as the CID-MO or East Bottoms Units.

### **A-3.1.3 Geospatial Data**

Around the beginning of Phase 1 of the Feasibility Level Design, the GIS members of the team were tasked with acquiring geospatial data from GIS vendors, local municipalities, etc. As this study area covers two different state plane zones, it was decided that all project geospatial data be in UTM zone 15, which covers the whole study area.

Geospatial data used for this project includes the following:

- Acquired Data (see Exhibit A-3.3 for graphical summary)
  - In 2004, the Unified Government of Wyandotte County provided two-dimensional survey data of the Argentine and Armourdale Units. This topographic and planimetric AutoCAD mapping (103 files) has a projection of Kansas State Plane, North (feet), NAD 83. The elevations are based on Mean Sea Level, North American Vertical Datum (NAVD) of 1929. The 2D contours have a 2-foot interval. Concerning utility data, sanitary sewer, water, and electric, AutoCAD data was acquired from three different points of contact within the Unified Government of Wyandotte County. Again, all of the utility data had a projection of Kansas State Plane, North (feet), NAD 83.
  - The governments of Cass County, Missouri, the City of Kansas City, Missouri, and Wyandotte County, Kansas each provided relatively current land parcel spatial data and accompanying tabular data detailing appraised value, assessed value, land use, and ownership information.
  - The project team purchased 3D data (ASCII point and break line data) that the contractor used to produce the Wyandotte County 2D contours. This 3D data was used to help identify the projected toe of levee for the various proposed raise alternatives. This data had the same datum as the Wyandotte County information: Kansas State Plane, North (feet), NAD 83 and North American Vertical Datum (NAVD) of 1929.
- Existing In-House (Corporate) Data
  - The project team used Missouri River Microstation mapping. The Missouri River mapping was created in 1998 and 1995 and has a projection of UTM Zone 15 (feet), NAD 83. The topographic data, or 3D contours, have a 4-foot interval and a vertical datum of NGVD 29 feet.
  - ESRI, GDT, and Navtech data sets were used as references. These USACE licensed, commercially derived, data sets are essentially census spatial data with more attribution and accuracy. These data sets were in a variety of projections and needed to be manipulated for use within the project.
  - USGS's Digitally Ortho-rectified Quarter Quadrangles (DOQQ) black and white imagery was used throughout this project as import background and

navigation information. The DOQQs have a 1-meter resolution. The dates of these DOQQs range from 1991 to 1997. The DOQQs are a part of the GIS team members' corporate data holdings, which were acquired through regional geospatial data clearinghouses.

- The USACE-KCD purchased commercially made digital ortho-rectified color imagery of the Kansas City metropolitan area. This imagery has a 2-foot resolution. The date of this imagery is June 2001.
- Projects – Phase 1 and Phase 2 Feasibility Level Design
  - Data Acquisition – October 2000 through March 2001 – Phase 1  
Much of this time was used to data mine for Kansas River spatial data and arrange for acquisition of this data.
  - Data Processing – March 2001 through May 2001 – Phase 1  
All of the Wyandotte County AutoCAD data was converted to Microstation format and then projected from Kansas State Plane, North (feet), NAD 83 to UTM Zone 15 (feet), NAD 83.
  - Public Hearing Support – May 2001 through June 2001 – Phase 1  
The GIS members of the project team were tasked with mapping support for the Phase 1 June public meeting. The maps mainly showed each levee unit's zone with aerial photography behind it.
  - HEC-FDA Model Inputs (Economic and H&H support) – October 2001 through March 2003 – Phase 1  
The GIS members of the project team were tasked with mapping support for the economics field inventory efforts. After acquiring the land parcel spatial and tabular data from the sources listed above, this land parcel data and their parcel numbers were displayed over the top of contour, building, and road name spatial data with the DOQQ's as a background. These maps helped the USACE economists acquire information about possible damage assessment associated with levee failure. The USACE economists used these maps to complete field studies to gather new, accurate data about building wealth in the Kansas City metro area.

The GIS members of the project team were also tasked with mapping support for the H&H efforts. H&H team members requested a set of comparison maps showing the relationship between river miles and existing levee structures where they cross the top of levee centerline. This data later aided in comparing the top of levee elevation to the water surface elevation of a 0.2% chance of exceedance (500-yr) flood event.

- Levee Raise Layouts (existing & new top of levee) – February 2003 through June 2004 – Phase 1

The GIS members of the project team were tasked with creating a map set showing the location of existing levee structures where they cross the top of levee centerline. Color-coded station number text was included to coincide with the Levee/Floodwall Features Inventory spreadsheet information and to help categorize each feature's point. The project team needed this mapping for eventual use in this engineering appendix document.

The GIS members of the project team were also tasked with creating a map set showing the location of specific zones of inundation near selected pump stations. Again, the project team needed this mapping for eventual inclusion in this engineering appendix.

Lastly, the GIS members of the project team were tasked with creating a map set showing the footprints of potentially affected areas, borrow areas, and utility line (UL) uplift concern areas. Also needed was the location of existing levee structures where they cross the top of levee centerline. The project team needed this mapping to analyze areas of concern.

➤ Feature Inventory Delineation Maps – September 2003 through December 2003 – Phase 1

The GIS members of the project team were tasked with adding onto the information created with the existing condition maps by adding top-of-levee elevation and description text to the existing levee station text. By adding this information to the map, map users are able to gather most of the aforementioned spreadsheet information without referring to the spreadsheets.

➤ Utility Site Maps – November 2003 through June 2004 – Phase 1

For the Argentine Unit, the GIS members of the project team were tasked with creating a map set that shows specific zones of uplift concern for utilities data. This map set also shows utilities data with text.

Also for the Argentine Unit, the GIS Section created a map set showing where utilities cross the levee. At these crossings, there are specific text boxes giving data about the crossings.

Hard copies of gas maps were obtained from Kansas Gas Energy to supplement electronic information obtained. Both hard copy and electronic data was referred to when evaluating impacts to utilities.

➤ Real Estate Support – December 2001 through June 2004 – Phase 1

The GIS members of the project team were tasked with creating map plates similar to those created for the economic field survey discussed above, but without the contour information. Real estate personnel on the project team needed this information for their analysis.

For the Argentine Unit, the real estate team members needed a group of maps showing the three alternatives being considered: raising the levee to a 500

year level of protection, raising it to 500-year plus 3 feet, and raising it to 500-year plus 5 feet. Each of these alternatives has a different set of files that include stability berms, proposed levee raise, proposed I-walls, proposed floodwalls, temporary right of ways, and outside COE property areas that the COE may have to purchase. This map set was generated for a sponsor meeting on 28 January 2004.

➤ Feature Inventory Delineation Maps – September 2006 through May 2007 – Phase 2

GIS members were tasked with similar activities during Phase 2 and Phase 1. They created feature delineation maps for the Armourdale Unit consisting of the following information:

- Existing Levee Stationing
- Existing Levee Features
- Recommended N500+3 raises and features
- Utility crossings
- Real Estate Parcels and right of way

#### **A-3.1.4 Datum Relationship**

Table A-3.1 shows the sources of survey and mapping data that was used during the Armourdale feasibility level design. During Phase 1 of the feasibility design, the PDT determined that a common datum was needed when referencing various sources of data. The horizontal datum would be UTM Zone 15, NAD 83 and the vertical datum would be NGVD 29. When data was obtained in a datum other than that desired, it was converted before using. The attached table shows that all sources of data used during feasibility had the same datum. An attempt was made to determine if any of the surveys conducted used any of the same benchmarks or monuments. It was desirable to perform a check between any of the sources of data. We were unable to determine if any of the surveys used any of the same benchmarks or monuments. However, because a consistent horizontal and vertical datum was used, the data should be relatively compatible for feasibility purposes with no known discrepancies.

#### **A-3.2 SURVEY INFORMATION NEEDED FOR DESIGN, PLANS, AND SPECIFICATIONS**

Survey information used during feasibility was from a combination of sources of varying degrees of age and accuracy. While this data is acceptable for feasibility, it is inadequate for design and construction. A completely new survey will be conducted prior to developing plans and specifications for construction. The development of plans and specifications requires a higher degree of accuracy and detail in regards to existing elevations, structures, utilities, and other items. Project at the following levee units have been preliminarily recommended as a result of the Seven Levees Feasibility Level Design:

North Kansas City – Harlem, National Starch

Fairfax - BPU  
East Bottoms – Blue River Confluence  
Argentine – Full Levee Raises  
Armourdale – Full Levee Raise  
CID – Full Levee Raise

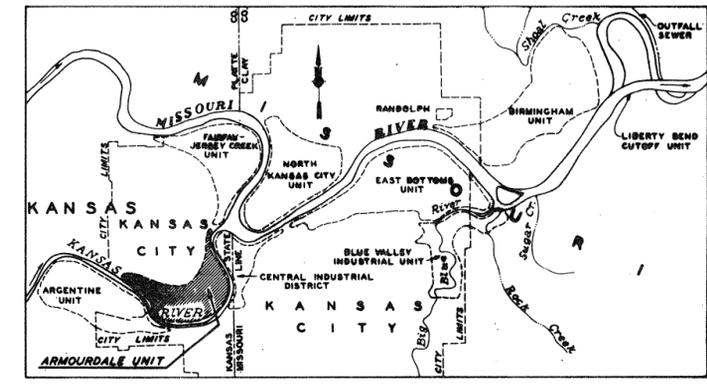
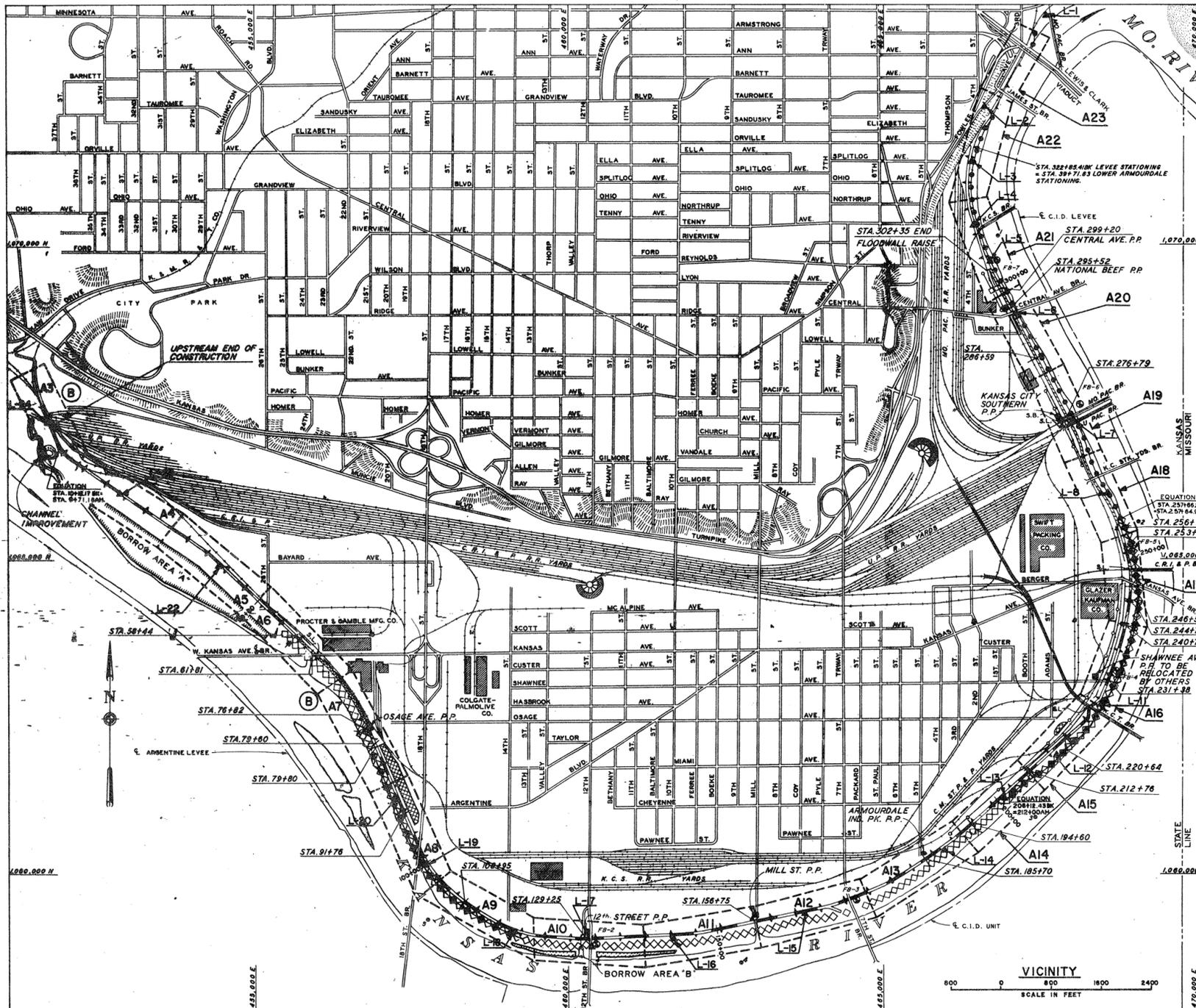
According to Engineering and Design Interim Guidance for a Preliminary Evaluation of Vertical Datums on Flood Control, Shore Protection, Hurricane Protection and Navigation Projects, dated October 31, 2006, projects that are defined by a superseded datum such as NGVD 29, are in need of updating. Since the entire Kansas City's system was designed and constructed in NGVD 29, it is recommended that detailed survey efforts necessary to conduct detailed design (PED) be done in NAVD 88. This recommendation acknowledges that risk exists with interchanging data with different datum. Designers will need to know and understand from where their data originates. While vertical control will be NAVD 88, horizontal control will be UTM Zone 15 (feet), NAD 83.

Based on the data reviewed and the directives recently initiated by USACE Headquarters, it is recommended that all surveys completed for any of the Kansas City Levees Units, be coordinated and looped together to establish reliability and consistency among the system. The existing control systems in existence around the area should prove sufficient to complete the loops. However, because there are known deficiencies between various control systems, the survey task will not be straight forward but require research and care in selecting monuments. An overall loop encompassing all of the seven levee units may not be feasible under any one approved project, thus a plan to loop the entire system will be created consisting of several interconnected subloops. See the attached Exhibit A-3.4 depicting this concept. It is anticipated that surveys will incorporate state of the art GPS technology allowing for easier connectivity between units.

### **A-3.3 SUPPLEMENTAL EXHIBITS AND TABLES**



EXHIBIT A-3.1  
1962 Modification Armourdale Unit Bench Marks



**LEGEND**

Levee raise	---
Existing levee	---
Floodwall raise	---
Floodwall on existing levee	---
Existing floodwall	---
Existing channel slope protection	---
Sandbag gap	S.B.
Stoppog gap	S.L.
Existing pumping plant	---
Pumping plant (New)	---
Existing retaining wall	---
Retaining wall (New)	---
Borrow area	---
Buildings (business and industrial)	---
Channel improvement	---
Raise gatewell on existing drainage structure	---
Existing drainage structure to remain undisturbed	---
Drawing number	A9
Area fill	---
Relief well system	---
Existing Protection-other units	---
Miles above mouth of Kansas River	---
Flood warning gage and number	FB-3
Existing T.B.M. (for description see below)	L-18
(A) Riprap levee raise only	---
Riprap overlay on existing slope protection	---
Riprap levee raise and riprap overlay on existing slope protection	---

(A) Color Code:  
Blue color indicates work required for underseepage control  
Red color indicates all other new construction required.  
Black indicates existing conditions.

(A) NOTE:  
All stations and ranges shown in this set of Drawings refers to the Base Line shown.

**BENCH MARK DATA**

**BENCH MARK NO.**

L-3 Point is 256' upstream (S) of Mo. Pac. R.R. Signal light no. 2859R and is approx. midway between James St. Bridge and K.C. Southern R.R. Bridge, 85.7' E. of E. rail of E. Mo. Pac. switch track.  
New standardized brass cap, type no. 1, set in concrete, flush with surface, at edge of rock revetment on riverward edge of levee, on left bank of Kaw River. Cap is stamped "L-3", 1953. Elev. 760.21

L-5 Point is 445.55' upstream from centerline of R.R. tracks at extreme W. end of K.C. Southern R.R. Bridge over Kaw River and is on left bank of river, is 76.2' E. of nail and disc in E. side of brace post for power pole and 84.8' N.E. of centerline of R.R. track at head block.  
New standardized brass cap, type no. 1, set in concrete and flush with surface on riverward shoulder of levee at edge of rock revetment. Cap is stamped "L-5", 1953. Elev. 759.88

L-9 Point is 668.4' downstream from centerline of C.R.I. & P. R.R. Bridge, 2945' E. of S.E. corner of concrete valve box and 64.6' E. of E. rail of switch track.  
New standardized brass cap set in concrete, flush with surface and in edge of revetment on riverward shoulder of levee. Cap is stamped "L-9", 1953. Elev. 759.87

**BENCH MARK DATA**

**BENCH MARK NO.**

L-11 Point is 115' downstream from centerline of Terminal R.R. Bridge, 6.25' westward of 2" steel pipe, 27.15' E. of red painted triangle in centerline of old floodwall at levee Sta. 228+00 and is 45.0' E. of nail and disc in post holding telephone box.  
New standardized brass cap set in concrete and 0.4' below surface and in approx. centerline of levee. Cap is stamped "L-11", 1953. Elev. 761.16

L-14 Point is 1601.5' downstream from centerline of 7th Street Bridge, on riverward shoulder of levee at top of revetment, on left bank of Kaw River. It is 52.90' S.E. of nail and disc in 8" elm tree and is 687.50' upstream from HLR-25.  
New standardized brass cap set in concrete. Cap is stamped "L-14", 1953. Elev. 763.88

L-16 Point is 1303.7' downstream from N. end of 12th Street Bridge and 1355' upstream from S.W. corner of Mill St. Pumping Sta. It is 2.88' N. (landward) from 2" iron pipe painted white.  
New standardized brass cap set in concrete and flush with surface on riverward shoulder of levee, at top of revetment. Cap is stamped "L-16", 1953. Elev. 764.86

L-19 Point is 1050' downstream from centerline of E. end of Argentine Bridge 319.6' S.E. of nail in lone cottonwood tree, 100' S.W. of hub set in line with smoke stack of brick bldg. to N.E.; 100' S.W. of hub set in line with K.C. Power and Light Bldg., on riverward edge of levee and is 3.0' landward from 2" iron pipe.  
New standardized brass cap set in concrete. Cap is stamped "L-19", 1953. Elev. 765.40

**BENCH MARK DATA**

**BENCH MARK NO.**

L-20 Point is approx 100' upstream from E. end of Argentine Bridge, 51.65' N.W. of nail in 30" cottonwood tree on landside of levee, 117.60' N. of N.E. corner hand rail post at N.E. corner of Argentine Bridge, 87.65' N.W. of nail in telephone pole; is on riverward shoulder of levee and is 2.9' landward from 2" iron pipe.  
New standardized brass cap set in concrete and flush with surface, on left bank of Kaw River. Cap is stamped "L-20", 1953. Elev. 755.76

L-22 Point is approx. 2025' upstream from N.E. corner of West Kansas Ave. Bridge, 124.3' N.W. of marked triangle painted red on trolley pole; 3.0' E. (landward) of 2" iron pipe and is 85.8' S.W. of red painted triangle on trolley pole.  
New standardized brass cap set in concrete, on riverward shoulder of levee, on left bank of Kaw River. Cap is stamped "L-22", 1953. Elev. 767.30

L-24 Point is between two R.R. tracks 89.0' S. of S. end of Kaw Valley R.R. Bridge, which passes over U. P. R.R. tracks, 5.4' S.W. from S.W. rail of N.E. track, 3.21' N.E. of N.E. rail of S.W. track; 23.85' W. of blue painted triangle on guy pole; 23.50' N. of blue painted triangle on power pole and 30.95' E. of blue painted triangle on power pole.  
Old standard river monument cap set in concrete, on left bank of Kaw River, Cap is stamped "L-24", 1953. Elev. 789.39

**RECORD DRAWING**

MAY 1976  
CONTRACT NO. DACW41-74-C-0093

SYM.	DESCRIPTION	DATE	APP'D.
(B)	Revised for "As Built" conditions	9/20/76	
(B)	Deleted work Sta. 0100 to Sta. 6141. Changed from Levee symbol to Floodwall Sta. 63110 to Sta. 77176	11/16/76	
(A)	Revised legend and added notes	7/23/76	

**KANSAS RIVER BASIN, KANSAS RIVER**  
**KANSAS CITY, KANSAS - 1962 MOD. ARMOURDALE UNIT**

LOCATION AND VICINITY

in 100 sheets  
CORPS OF ENGINEERS  
KANSAS CITY DISTRICT

Sheet No. 2  
Dwg. No. A2

Scale: as shown  
U. S. ARMY  
ENGINEER DISTRICT

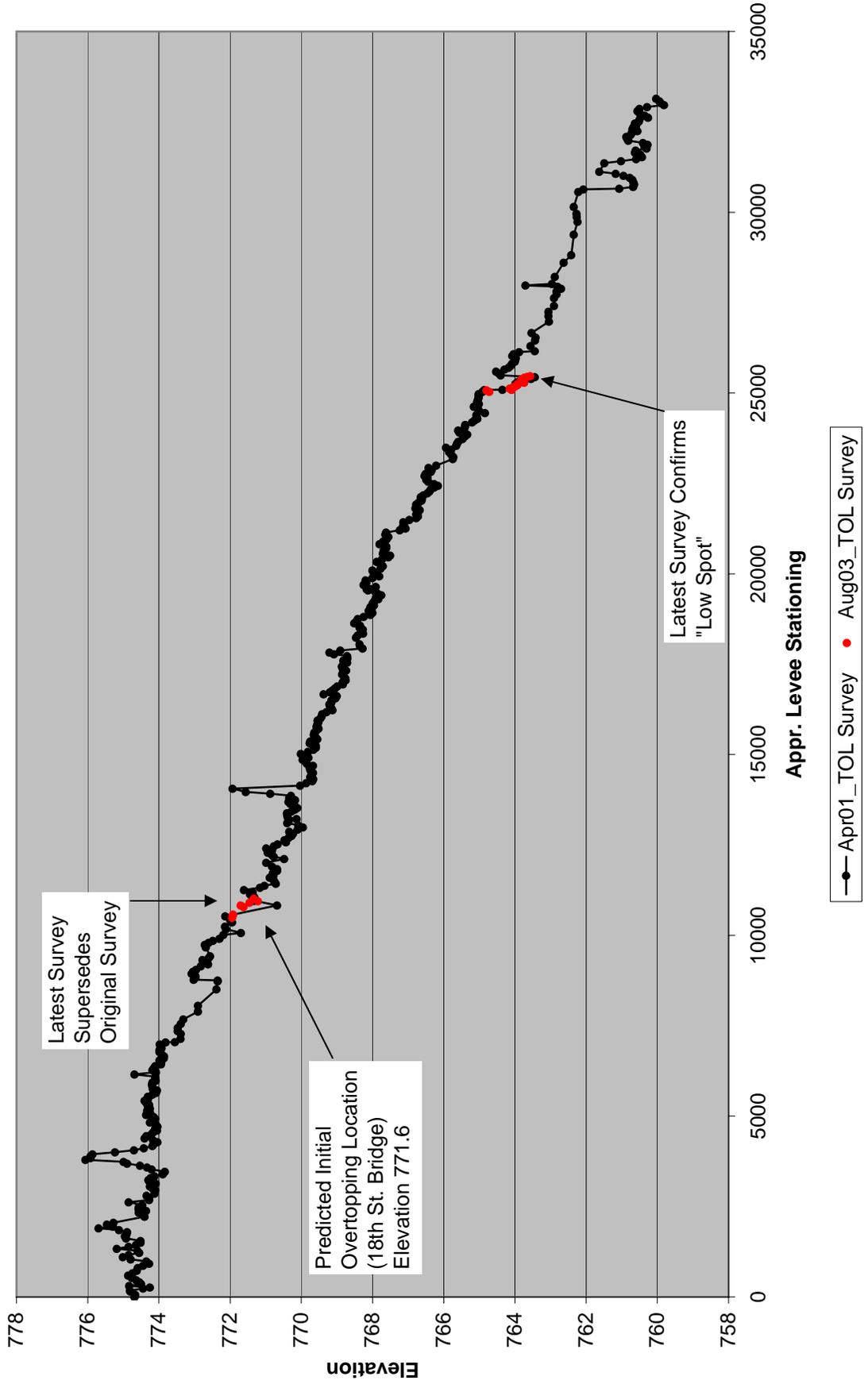
Submitted: [Signature]  
DESIGNED BY: T.A.K.-J.A.H.  
DRAWN BY: J.M.M.  
CHECKED BY: S.L.B.

Recommended: [Signature]  
CHECKED BY: S.L.B.

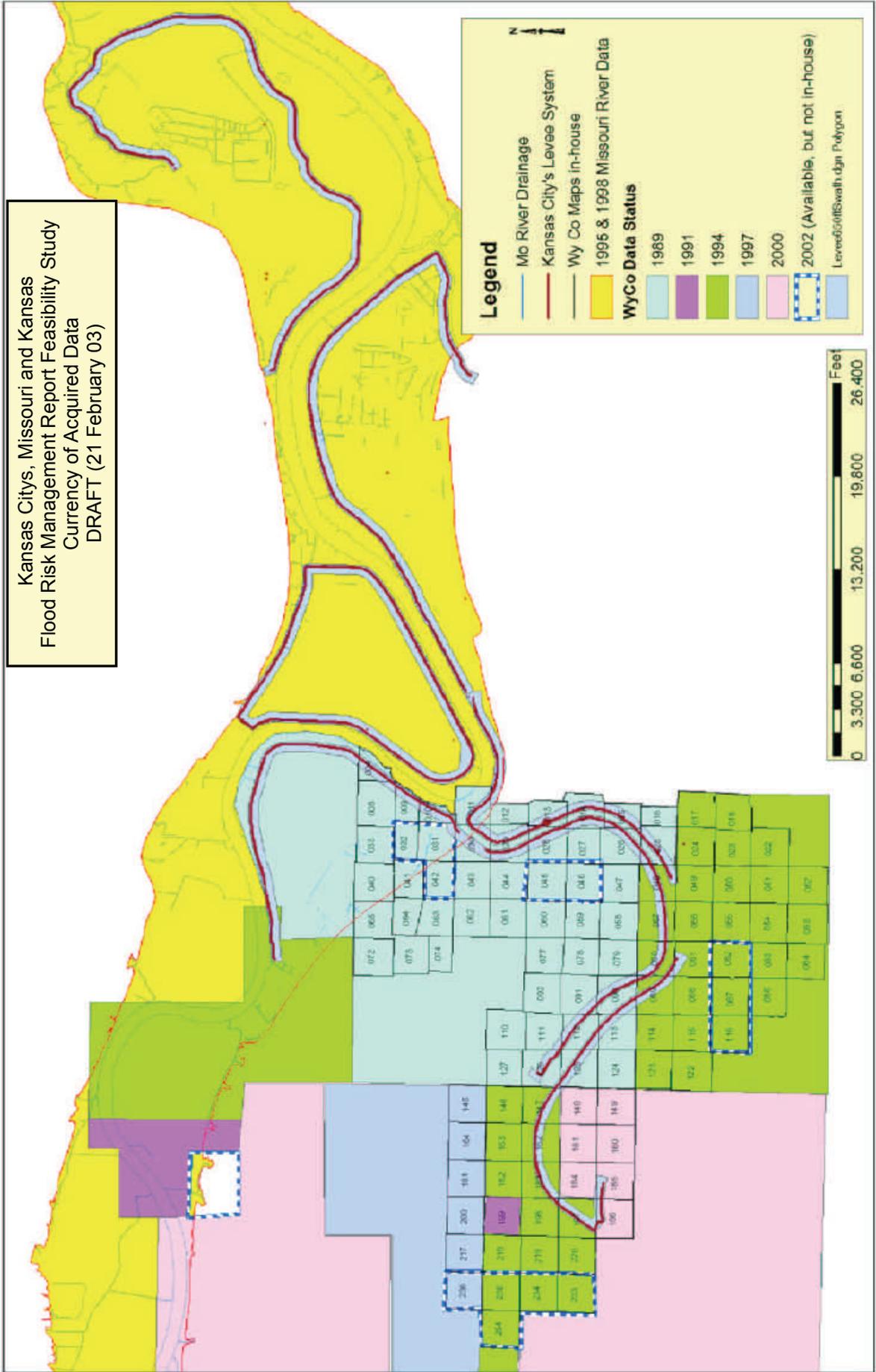
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FILE NO. A-10-6002

**EXHIBIT A-3.2**  
Centerline Survey Elevations Along Approximate Levee Stationing

**Armourdale Top of Levee (TOL)**



**EXHIBIT A-3.3**  
**Kansas City, Missouri and Kansas, Flood Risk Management Report Feasibility Study Currency of Acquired Data**



**TABLE A-3.1**  
**Sources of Survey and Mapping Data**

Kansas City Levees  
Armourdale  
Survey Datums and Benchmarks  
Date Table Created: March 5, 2007  
By: M. Corkill

Data Title and Source	Date Surveyed	Horizontal Datum		Vertical Datum		Comments	Used during Phase 2 Feasibility by:
		Original	Converted to and Used	Original	Converted to and Used		
Operation and Maintenance Manual, Record Drawing, O&MM Plate No. 164: Location and Vicinity	1972				No conversion necessary	Survey by Benton	Geotech, Civil Design
Levee Centerline Survey by KC Corps	Apr-2001 and 2003	<b>KS State Plane</b>	UTM Zone 15 (feet), NAD 83	NAVD 88 feet	NGVD 29 feet		H&H model
Unified Government of Wyandotte County (2-D data)	Various (1989-2000)	KS State Plane North (feet), NAD 83	UTM Zone 15 (feet), NAD 83		No conversion necessary	2-foot contour interval	Geotech
Unified Government of Wyandotte County (3-D data)	Various (1989-2000)	KS State Plane North (feet), NAD 83	UTM Zone 15 (feet), NAD 83		No conversion necessary	2-foot contour interval. Obtained from MJ Harden	Geotech
MO River Microstation Mapping (Aerial survey)	1995, 1998	UTM Zone 15 (feet), NAD 83	No conversion necessary	NGVD 29 feet	No conversion necessary	4-foot contour interval	H&H model
Digital Orthorectified Color Imagery	Jun-2001						Feasibility Phase 2 Map Book
Hydrographic Survey by Napoleon Crew	1998 and 1999	UTM Zone 15 (feet), NAD 83	No conversion necessary	NGVD 29 feet	No conversion necessary		H&H model

Legend

NGVD 29  
NAVD 88

National Geodetic Vertical Datum of 1929  
National Geodetic Vertical Datum of 1988

EXHIBIT A-3.4  
 Conceptual Land Survey Loops

