

**PHILADELPHIA DISTRICT
NATIONAL LEVEE FOOT PRINT DATABASE SURVEYS
PROJECT REPORT**

CONTRACT No. W9133L-05-D-0003

Prepared for



**U.S. Army Corps of Engineers
Philadelphia, PA District**

Prepared by



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1.0 EXECUTIVE SUMMARY

As a result of recent Congressional action, the U.S. Army Corps of Engineers (USACE) has received the mandate and resources to design and build a National Levee Database (NLD). The NLD will play a role in a possible National Levee Safety Program, the Inspection of Completed Works (ICW) program, emergency response and coordination with FEMA's MapMod and Levee Certification programs.

PBS&J was contracted to survey approximately 14.31 miles of the Philadelphia District's project levees. The levees are distributed across 14 projects located in Pennsylvania, New York, New Jersey and Delaware. The project was broken into seven main areas of work: As-built preparation, survey control and field collection, survey processing, survey QC, data research and attribution, district review and final QC. The survey control and field data collection work was performed by PBS&J. The District provided the information for the data research and collection to PBS&J who then populated the database.

2.0 DESCRIPTION OF WORK

2.1 *Levee Data Collection Process*

PBS&J led the collection and development of a levee centerline and profiles (footprint) for federal levees within the District. The levee footprint includes the earthen levees, floodwalls, closures, and associated pump stations, drains, relief wells, piezometers, gravity drains, levee crossings, and other similar data. Surveyors also located encroachments within the right-of-way of the levees. Additionally, encroachment points can be collected at a lower accuracy using handheld GPS. The levee footprint consisted of horizontal and vertical measurements of the existing levee from the beginning point through the ending, with an elevation taken at approximately every 25 feet. Levee cross sections were obtained approximately every mile.

PBS&J utilized the processes from the previous districts to perform the current work for the Philadelphia District. The steps for this process became:

1. Research Data Collection
2. Survey Control and Field Data Collection
3. Survey Processing
4. Survey Data QC
5. Data Research and Database Compilation
6. District Review
7. Final QC

2.2.1 Research Data Collection

The initial work started with the District collecting their existing design and as-built drawings, operations manuals and other records. The as-builts and any other location maps were provided to

survey for their reference in the field. In addition to maps, local points of contacts for each levee project was provided by the District.

2.2.2 Survey Control and Field Data Collection

The survey control network was developed before field data collection work could begin. PBS&J performed the development of the control network across the District. The network consisted of a total of 104 points to be used as base stations and check points. Existing NGS and CORS/COOP control points were used when available. All of the control points were established or verified horizontally and vertically using differential Global Positioning System (GPS) surveying techniques. For additional detailed information on the control network and points see the attached Control Report.

Field surveys were performed by PBS&J, see Appendix A for the field collection methods. The District provided scanned copies of their as-builts, O&M manuals and reference shapefiles when available. Preparation of the data provided by the District for the survey was discussed in section 2.2.1. Most of this work was performed using Real Time Kinematic (RTK) GPS methods. RTK GPS allows for on the fly data collection tied into a base station that allows for in the field point correction. When GPS was not feasible, or when satellite coverage was blocked, survey using total stations were used to capture the positions of the required features. Prior to the commencement of data collection, the survey party will set their Base Station over a known point and proceed to a Control Point in order to check positions and calibrate equipment. The point will be collected and the ΔX , ΔY and ΔZ will be noted while collecting data. Survey parties will carefully observe data and radio quality on their survey controllers in order to assure that good satellite geometry and good signal solution is been used on the collected data. Work points are set throughout the course of the day and used for location checks and for cross-sections if needed.

When the RTK base needs to be moved due to radio limitations or safety concerns, then the initial check procedures shall be repeated for all work points utilized in the new setup by checking into main control. At the end of each work day, checks are to be performed on the control points and the ΔX , ΔY and ΔZ will be recorded.

Points will be checked randomly from one day to the next to provide overlap checks and improve the QA/QC standards.

Data for each specific feature were acquired as follows:

Feature	Data Collected
Piezometer	Top of pipe or side of feature if top of pipe is not accessible. Caps are not to be removed.
Relief Well	Top of pipe or structure take one point in the center of feature or side of feature if top is not accessible.

Pump Station	X, Y obtained at the door and finished floor obtained by Total Station or differential leveling. Underground pump stations are collected at the center of the top of the manhole or access structure. For unusual circumstances, then advice from local district should be requested as to where the elevation should be taken as there are pump stations that do not reside inside building.
Closure Structure Line	Take shot on top of both sides of this structure, which usually represents the level of protection, and one in the middle of the open structure that not only serves to show the height of the closure, but also represents a crossing point. Direction must be provided by the District on how to collect any unusual closure structures. Doorways through a floodwall are also to be captured as closure structures.
Cross Section Line	<p>Take shot at every break and one in the center up to 200 feet on the dried side or natural ground (after large grade changes are captured). Up to 200 feet on the wet side, natural ground or top of river bank. While all attempts should be taken to capture 200 feet on each side, there will be times when this is not possible due to high water, buildings, etc. If the cross-section cannot be acquired at its proposed location due to obstructions, then said location may be offset to an area within the same typical section that is similar to the original location. Floodwall cross-sections should have a shot at each base and two on top (one shot on top with the proper offset point is fine).</p> <p>Comments are to be added to each end point to indicate why the cross section was terminated.</p>
Floodwall Line	Shoot top of wall at 25 foot increments, any high or low points, and any breaks in the alignment. Collect the ends of the floodwall at the beginning and end. measure down to ground on the dried side every so often and at any changes of the natural ground greater than 3 feet. Also, measure down to the ground level at the point where the wall touches the natural ground if it is at a different elevation. (See appendix A page A-10 for details.) Doorways through a floodwall are to be captured as closure structures, so there may be a floodwall line on top of a closure structure line. (note thickness of wall and any changes in thickness)
Encroachment point	<p>Take one point in the center of the feature and make a note to identify the encroachment. When the encroachment is an area or line feature, such as a fence or parking lot, collect a single point where the feature encroaches upon the levee right of way and add a description to the comment. Linear features that run parallel to the levee direction for long distances can be collected with multiple points. Comments on starting and end points should be added.</p> <p>Encroachment points can be located with sub meter accuracy devices using Omni Star or any sub meter correction service providing proper calibration procedures are follow so the accuracy in wish it was located can be log properly.</p>
Gravity Drain Line	Collect inverts when possible. If obstructions such as high water prevents this, collect a point to define the alignment and make comments where the shot was taken, measure the inlet elevation (if not obscured), and outlet

	elevation (if not obscured), or make a note when either elevation is obscured. Record the pipe or culvert size and type.
Levee Crossing point	Collect one point where the feature crosses the line of protection (levee centerline) and describe path -over, under, through, on and note the type of crossing feature, width, and clearance -if path is 'over.' Gravity drain crossing points are not collected but developed when processing the data.
Levee centerline (profile)	Obtain elevations at the approximate center of levee at 25 foot intervals or where the elevation along the top of the levee noticeably changes between 25 foot shots. Additional shots may be needed on curves to properly represent the levee. High ground that splits a levee or floodwall is not captured.(unless requested) If a levee now has a highway on top of it, the profile is collected at the edge of the driving surface on wet side.
Failure points	Take one point in the center of feature.
Utilities points	Take a shot in the center or side, if center is not accessible.
Monuments/Benchmarks	Take one point in the center of feature.
Line of Protection (LOP)	The Line of Protection takes all the features at are collected along the levee line including levee centerline, floodwall centerline, closures, and high ground and combines them into a single continuous feature. This can be a useful when a single feature line is needed to show the complete system line of protection. This is compiled in the GIS
Misc. layers	Gate wells

Once this data had been collected, this field information is used in populating those items in the NLD Data Dictionary flagged "Field".

2.2.3 Survey Processing

Once the surveys were completed, the data needed to be processed. This included making sure that each feature is in the proper layer, creating line features from the point data, adding any of the field notes to each feature as necessary, creating the line of protection feature, and calculating the RMS error for the project. As a part of this processing, the data was compared with recent aerial imagery if current coverage was available.

The line of protection feature is not a feature that is defined in the NLD. This feature represents the entire line of protection for a given levee project. This is a combination of the levee centerline, floodwall line, closure structure line features, and high ground.

2.2.4 Survey QC

The surveyed data was then checked for completeness and converted to shapefiles using AutoCAD Civil 3D software. An example of the QC checklist is located in Appendix B and included checking to make sure that all of the levee and floodwall sections, cross sections, pump stations, and closure structures were collected, that the features were in 3-D, and that the proper field attributes were present. This also involved checking the topological structure of the data to ensure that the floodwall lines, levee centerlines, and closure structures snapped together if they are adjacent and also that the line of protection was coincident with these features. To perform these checks, these

features were loaded into a separate personal geodatabase. A list of any corrections that needed to be done was sent back to the surveyors.

2.2.5 Data Research and Database Compilation

The shapefiles that were created from the surveyed information were then loaded into the template geodatabase that was created for each segment and the remaining attributes were populated from data provided by The District. The source for each attribute is listed in Appendix C. Any additional information was placed in the comments field. The data was then checked to ensure that it was complete before being delivered to the District to review, the QC sheet is shown in Appendix D.

The as-built drawings or other plan sheets were then georeferenced to the best base data that was available. This was done to digitize those features that could not be collected in the field. This included the underground crossings that could not be seen in the field and any gravity drains that were obscured and not collected in the field. These images were also used in order to create the levee_station_point features once the surveyed centerline was available.

2.2.6 District Review

As each levee project was completed the database was provided to the District for review. The District provided comments that PBS&J then addressed.

2.2.7 Final QC

After the individual project databases were delivered to the District for review, the data was compiled into one master geodatabase. Final QC was performed on the master geodatabase. Queries were also written and performed on the data to check for duplicate id's, correctly populated attributes and that the tables were completed, these are shown in Appendix E.

The geodatabase was then sent to CRREL for validation. After the data was validated the final geodatabase was delivered to the District, along with the metadata, survey data and other deliverables.

PROJECT LEVEES

Allentown

Location

The Allentown Project is located in Lehigh County, Pennsylvania , on the right bank of the Lehigh River which is the primary flood source. The total length of flood protection is 0.85 miles long. This includes 0.79 (4,171 feet) of earthen levee, 0.05 miles (264 feet) of floodwall, and 1 closure structure. The protected area is roughly 77 acres.

Project Features

This levee was surveyed on 7/20/2010. The top elevation of the levee varies from 251.92 to 269.37 ft, with an average top width of 10 ft along the earthen levee sections. The features associated with the levee structure are listed below.

Boreholes:	None Collected
Encroachment Points:	1
Flood Fight Points:	None Collected
Crossing Points:	9
Failure Points:	None Collected
Relief Wells:	None Collected
Piezometers:	None Collected
Pump Stations:	None Collected
Sand Boils:	None Collected
Closure Structure Count:	None Collected
Cross Sections:	1
Floodwall Lines:	3
Gravity Drains:	2
Rehab Lines:	None Collected
Toe Drains:	None Collected



Survey Control / Data Collection

Vertical Datum: NAVD88

Horizontal Datum: NAD83

Station Name/PID	North	West	Elevation	Description	Stamping
KV1636	40 37 39.708090	75 29 00.808030	334.06	DISK IN CONCRETE	JORDAN 334.766 1960
KV1791	40 36 25.203536	75 22 41.814118	353.5	DISK IN CONCRETE	LEHIGH 1935
KV3367	40 35 27.702026	75 28 15.361960	371.01	BM AND ROD	M371 1979
KV3368	40 34 47.880810	75 28 48.462334	355.08	DISK AND REBAR	N371 1979

Allentown Jordan Creek

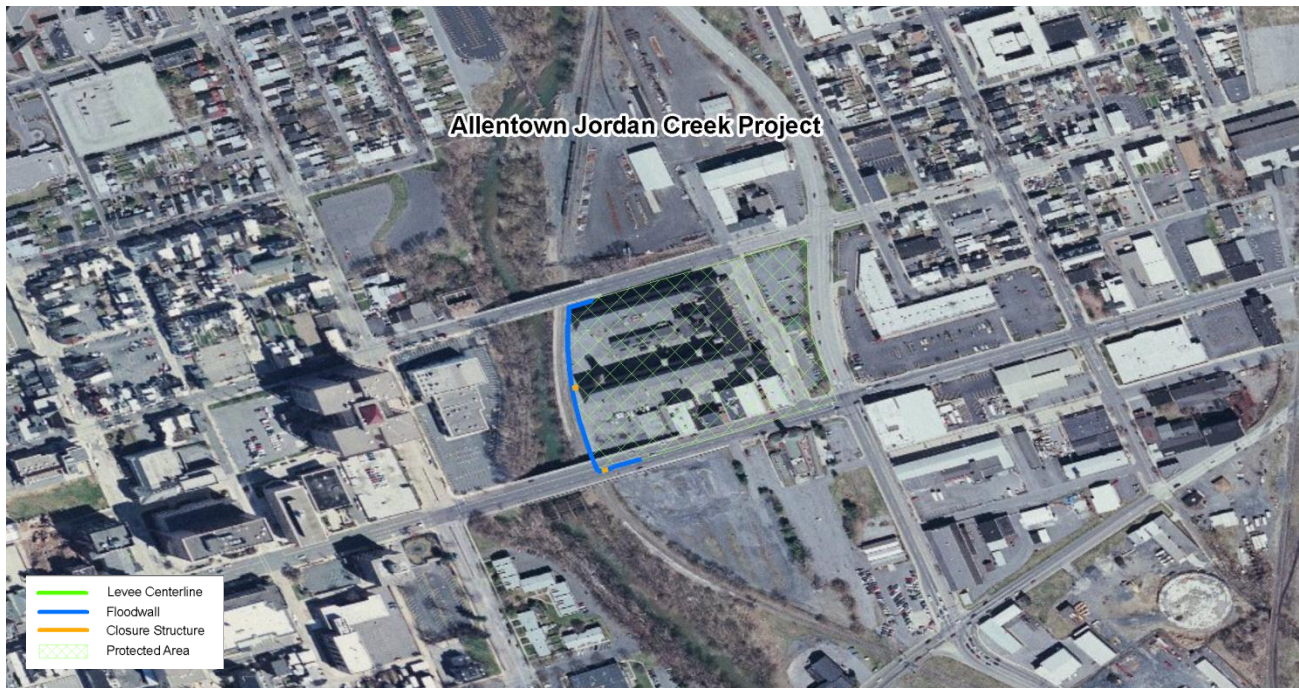
Location

The Allentown Jordan Creek Project is located in Lehigh County, Pennsylvania, on the left bank of Jordan Creek. The Jordan Creek is the primary flood source. The total length of flood protection is 0.13 miles long. This includes 0.13 miles (695 feet) of floodwall, and 2 closure structures. The protected area is roughly 7 acres.

Project Features

This levee was surveyed on 7/20/2010. The top elevation of the floodwall varies from 255.96 to 256.94 ft, with an average floodwall width of 1 foot. The features associated with the levee structure are listed below.

Boreholes:	None Collected
Encroachment Points:	1
Flood Fight Points:	None Collected
Crossing Points:	5
Failure Points:	None Collected
Relief Wells:	None Collected
Piezometers:	None Collected
Pump Stations:	None Collected
Sand Boils:	None Collected
Closure Structure Count:	2
Cross Sections:	1
Floodwall Lines:	11
Gravity Drains:	3
Rehab Lines:	None Collected
Toe Drains:	None Collected



Survey Control / Data Collection

Vertical Datum: NAVD88

Horizontal Datum: NAD83

Station Name/PID	North	West	Elevation	Description	Stamping
KV1636	40 37 39.708090	75 29 00.808030	334.06	DISK IN CONCRETE	JORDAN 334.766 1960
KV1791	40 36 25.203536	75 22 41.814118	353.5	DISK IN CONCRETE	LEHIGH 1935
KV3367	40 35 27.702026	75 28 15.361960	371.01	BM AND ROD	M371 1979
KV3368	40 34 47.880810	75 28 48.462334	355.08	DISK AND REBAR	N371 1979

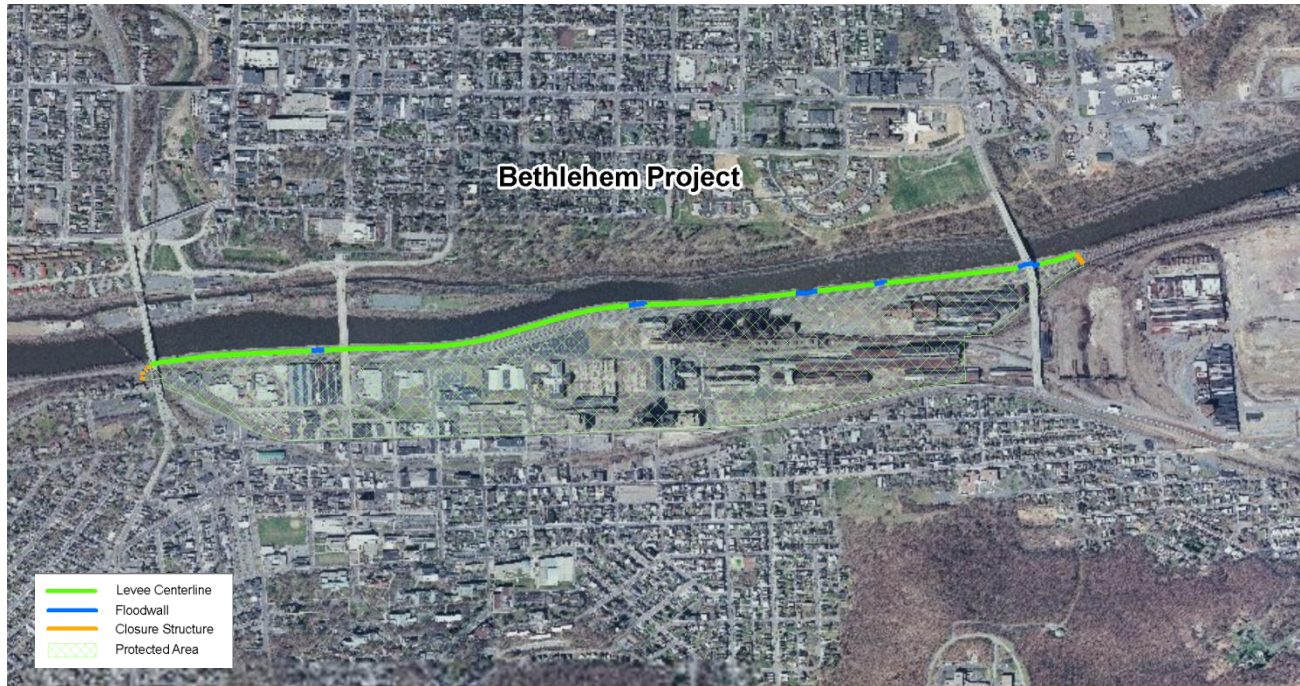
Bethlehem**Location**

The Bethlehem Project is located in Northampton County, Pennsylvania , on the right bank of the Lehigh River. The Lehigh River is the primary flood source. The total length of flood protection is 1.54 miles long. This includes 1.34 miles (7,098 feet) of earthen levee, 0.15 miles (796 feet) of floodwall, and 5 closure structures. The protected area is roughly 177 acres.

Project Features

This levee was surveyed on 7/20/2010. The top elevation of the levee varies from 231.7 to 241.19 ft, with an average top width of 6 ft along the earthen levee sections. The top elevation of the floodwall varies from 231.76 to 242.56 ft, with an average top width of 1.5 ft. The features associated with the levee structure are listed below.

Boreholes:	None Collected
Encroachment Points:	9
Flood Fight Points:	None Collected
Crossing Points:	36
Failure Points:	None Collected
Relief Wells:	None Collected
Piezometers:	None Collected
Pump Stations:	4
Sand Boils:	None Collected
Closure Structure Count:	5
Cross Sections:	2
Floodwall Lines:	14
Gravity Drains:	10
Rehab Lines:	None Collected
Toe Drains:	None Collected



Survey Control / Data Collection

Vertical Datum: NAVD88

Horizontal Datum: NAD83

Station Name/PID	North	West	Elevation	Description	Stamping
NAP08X	40 37 20.885020	75 23 02.807623	295.145	PK IN CONCRETE	NAP08X 2010
NAP09X	40 37 20.159019	75 23 59.755334	333.23	PK IN CONCRETE	NAP09X 2010
NAP10X	40 36 59.929615	75 22 57.873392	230.72	PK AND WASHER	NAP10X COE 2010
NAP11	40 36 53.083094	75 22 33.793109	237.05	PK IN CONCRETE	NAP11 2010

Cheltenham

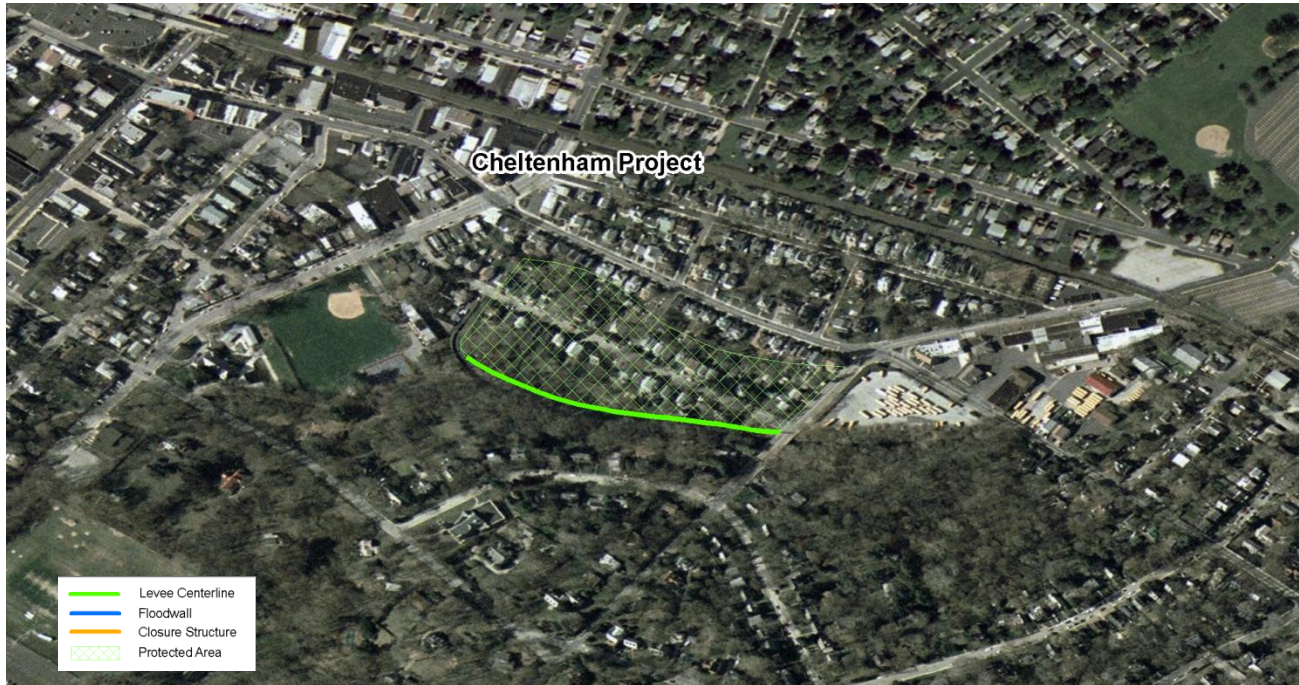
Location

The Cheltenham Project is located in Montgomery County, Pennsylvania , on the left bank of Tacony Creek, which is the primary flooding source. The total length of flood protection is .18 miles long (953 feet) of earthen levee. There are no floodwall or closure structures in this project. The protected area is roughly 8 acres.

Project Features

This levee was surveyed 7/19/2010. The top elevation of the levee varies from 223.81 to 226.14 ft, with an average top width of 10 ft along the earthen levee sections. The features associated with the levee structure are listed below.

Boreholes:	None Collected
Encroachment Points:	3
Flood Fight Points:	None Collected
Crossing Points:	4
Failure Points:	None Collected
Relief Wells:	None Collected
Piezometers:	None Collected
Pump Stations:	1
Sand Boils:	None Collected
Closure Structure Count:	None Collected
Cross Sections:	1
Floodwall Lines:	None Collected
Gravity Drains:	4
Rehab Lines:	None Collected
Toe Drains:	None Collected



Survey Control / Data Collection

Vertical Datum: NAVD88

Horizontal Datum: NAD83

Station Name/PID	North	West	Elevation	Description	Stamping
KV1876	40 7 19.622240	75 13 2.246160	185.587	DISK/ CONCRETE	Q 106 1935
KV1883	40 9 38.400335	75 4 27.815931	205.021	COPPER BOLT	NONE
NAP01X	40 05 54.666669	75 09 05.292741	229.838	DISK IN GRASS	NAP01X 2010

Chester

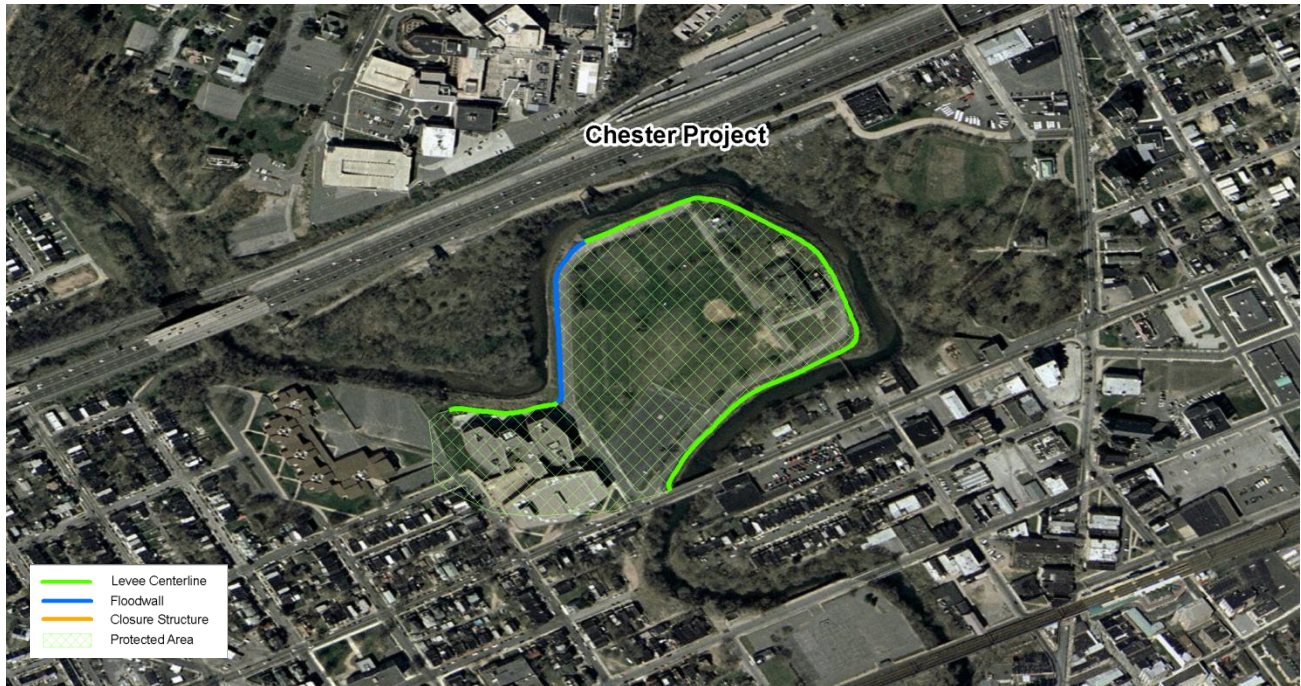
Location

The Chester Project is located in Delaware County, Pennsylvania , on the right bank of the Chester River. The Chester River is the primary flood source. The total length of flood protection is 0.65 miles long. This includes 0.51 miles (2,681 feet) of earthen levee, 0.14 miles (752 feet) of floodwall, and 0 closure structures. The protected area is roughly 26 acres.

Project Features

This levee was surveyed on 7/17/2010. The top elevation of the levee varies from 14.47 to 19.65 ft, with an average top width of 10 ft along the earthen levee sections. The top elevation of the floodwall varies from 18.01 to 19.18 ft, with an average top width of 1 ft. The features associated with the levee structure are listed below.

Boreholes:	None Collected
Encroachment Points:	13
Flood Fight Points:	None Collected
Crossing Points:	13
Failure Points:	None Collected
Relief Wells:	None Collected
Piezometers:	None Collected
Pump Stations:	None Collected
Sand Boils:	None Collected
Closure Structure Count:	None Collected
Cross Sections:	2
Floodwall Lines:	7
Gravity Drains:	7
Rehab Lines:	None Collected
Toe Drains:	None Collected



Survey Control / Data Collection

Vertical Datum: NAVD88

Horizontal Datum: NAD83

Station Name/PID	North	West	Elevation	Description	Stamping
AI4363	39 49 45.500039	75 17 05.931951	4.78	DISK/ CONCRETE	8 K 1 1999
JU0774	39 50 51.797659	75 21 51.969423	37.992	DISK/ CONCRETE	S 208 1963
JU2216	39 52 1.979853	75 18 1.586251	16.952	ROD/ SLEEVE	X 369 1979

Deposit

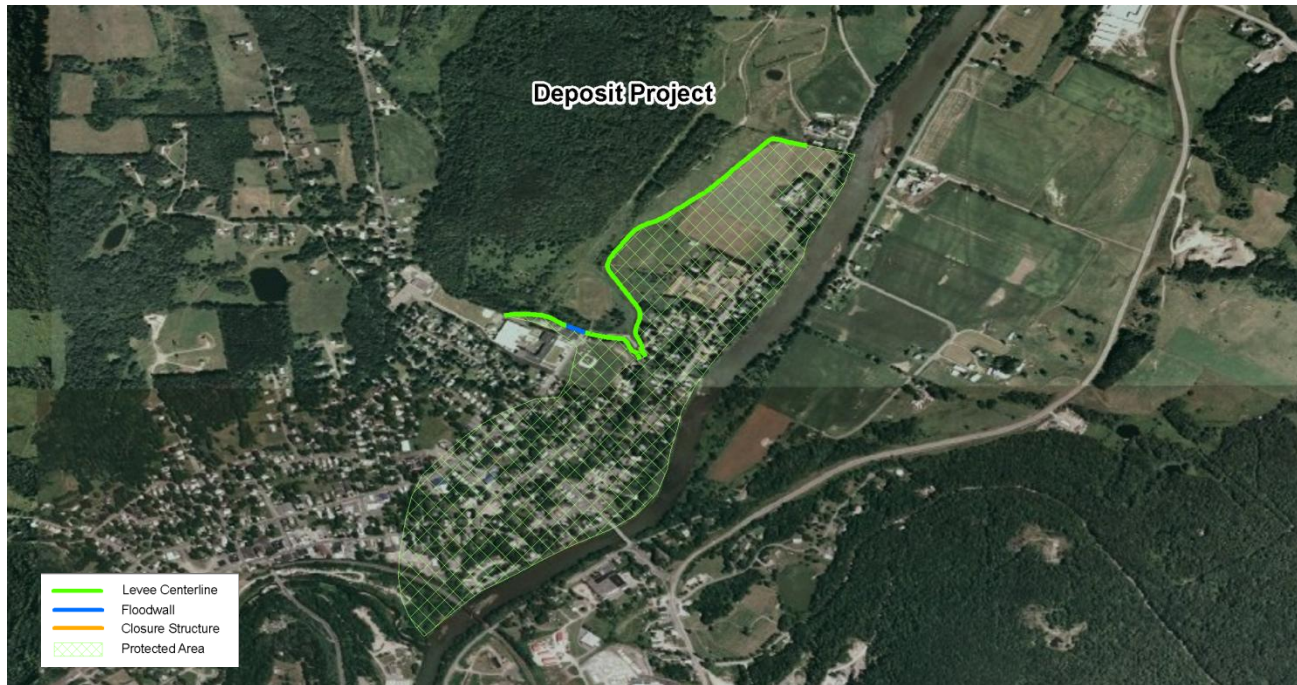
Location

The Deposit Project is located in Delaware County, New York , on the left and right banks of the Butler Brook. The total length of flood protection is 0.85 miles long. This includes 0.82 miles (4,335 feet) of earthen levee, 0.03 miles (167 feet) of floodwall, and 0 closure structures. The protected area is roughly 146 acres.

Project Features

This levee was surveyed on 7/29/2010. The top elevation of the levee varies from 995.78 to 1029.06 ft, with an average top width of 10 ft along the earthen levee sections. The top elevation of the floodwall varies from 1003.47 to 1004.87 ft, with an average top width of .67 ft. The features associated with the levee structure are listed below.

Boreholes:	33
Encroachment Points:	39
Flood Fight Points:	None Collected
Crossing Points:	16
Failure Points:	None Collected
Relief Wells:	None Collected
Piezometers:	None Collected
Pump Stations:	None Collected
Sand Boils:	None Collected
Closure Structure Count:	None Collected
Cross Sections:	1
Floodwall Lines:	7
Gravity Drains:	None Collected
Rehab Lines:	None Collected
Toe Drains:	None Collected



Survey Control / Data Collection

Vertical Datum: NAVD88

Horizontal Datum: NAD83

Station Name/PID	North	West	Elevation	Description	Stamping
NA1901	42 04 25.952290	75 24 34.127396	1047.42	STEEL ROD IN GRASS	C451 1982
NA1902	42 04 49.627958	75 24 08.628333	1020.17	ROD TO REFUSAL	D451 1982
NAP15	42 04 07.43799	75 25 02.18082	1003.465	CAP AND REBAR	NAP15 2010
NAP16X	42 05 48.82670	75 23 33.73883	1059.94	PK NAIL / WASHER	NAP16X 2010

East Branch

Location

The East Branch Project is located in Delaware County, New York , on the left bank of the East Branch Delaware River, which is the primary flood source. The total length of flood protection is 0.98 (5,172 feet) of earthen levee. There are no floodwall or closure structures in this project. The protected area is roughly 80 acres.

Project Features

This levee was surveyed on 7/29/2010. The top elevation of the levee varies from 1007.21 to 1014.77 ft, with an average top width of 12 ft along the earthen levee sections. The features associated with the levee structure are listed below.

Boreholes:	21
Encroachment Points:	25
Flood Fight Points:	None Collected
Crossing Points:	9
Failure Points:	None Collected
Relief Wells:	None Collected
Piezometers:	None Collected
Pump Stations:	None Collected
Sand Boils:	None Collected
Closure Structure Count:	None Collected
Cross Sections:	2
Floodwall Lines:	None Collected
Gravity Drains:	1
Rehab Lines:	None Collected
Toe Drains:	None Collected



Survey Control / Data Collection

Vertical Datum: NAVD88

Horizontal Datum: NAD83

Station Name/PID	North	West	Elevation	Description	Stamping
LY2382	41 55 15.384145	75 11 41.925489	1698.05	ROD IN CONCRETE	B456 1982
LY2384	41 55 01.717501	75 12 39.515639	1496.37	ROD IN CONCRETE	D456 1982
NAP13X	41 59 21.75380	75 07 52.11835	1012.06	CAP AND REBAR	NAP13X 2010 COE
NAP14	41 59 23.71323	75 08 24.89725	1007.62	CAP AND REBAR	NAP14 2010 C Of E

East Stroudsburg

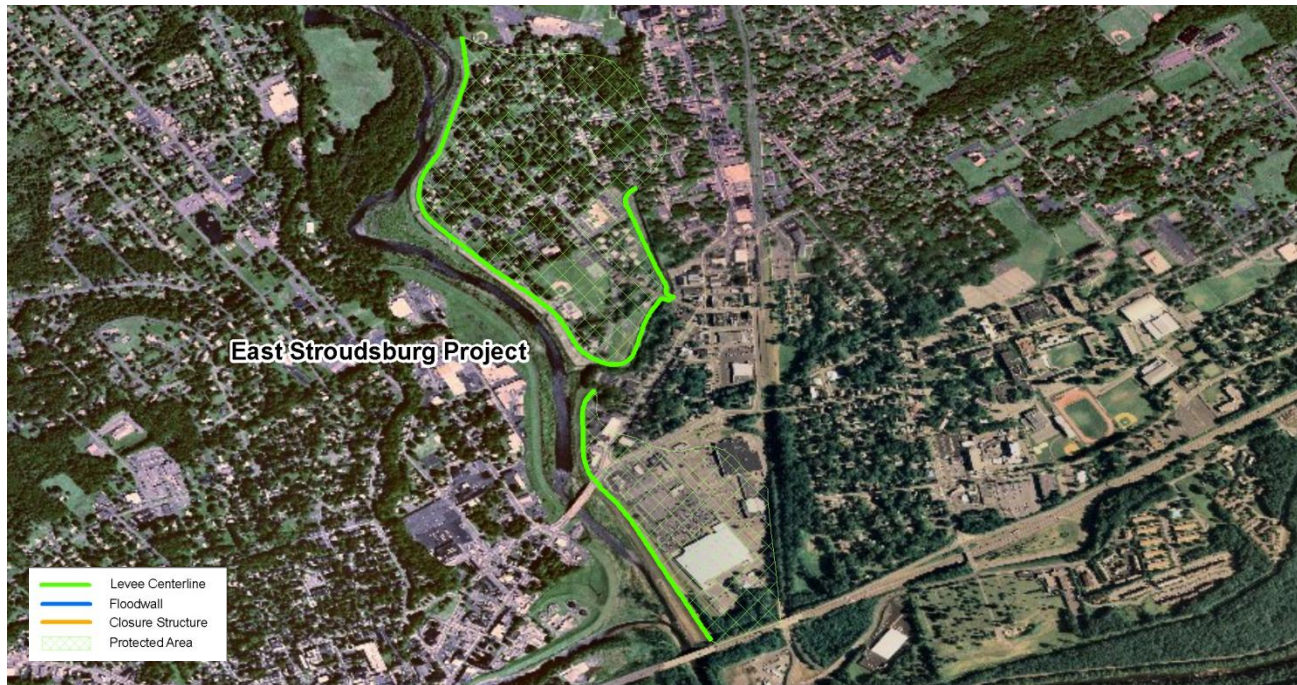
Location

The Irving Levee Project is located in Monroe County, Pennsylvania , on the left bank of Brodhead Creek. The Trinity River is the primary flood source. The total length of flood protection is 1.76 miles (9,313 feet) of earthen levee. There is no floodwall or closure structures in this project. The protected area is roughly 147 acres.

Project Features

This levee was surveyed on 7/22/2010. The top elevation of the levee varies from 406.94 to 421.08 ft, with an average top width of 10 ft along the earthen levee sections. The features associated with the levee structure are listed below.

Boreholes:	None Collected
Encroachment Points:	7
Flood Fight Points:	None Collected
Crossing Points:	27
Failure Points:	None Collected
Relief Wells:	None Collected
Piezometers:	1
Pump Stations:	None Collected
Sand Boils:	None Collected
Closure Structure Count:	None Collected
Cross Sections:	3
Floodwall Lines:	None Collected
Gravity Drains:	14
Rehab Lines:	None Collected
Toe Drains:	None Collected



Survey Control / Data Collection

Vertical Datum: NAVD88

Horizontal Datum: NAD83

Station Name/PID	North	West	Elevation	Description	Stamping
KV1416	40 59 11.186035	75 11 40.973516	429.67	DISK IN CONCRETE	C71 1921
LY1101	41 00 30.907886	75 11 04.649544	458.31	DISK IN CONCRETE	Y10 1932 458-877
NAP06	40 59 49.10580	75 11 15.28007	407.904	CONCRETE STRUCTURE	NAP06 2010

Gibbstown

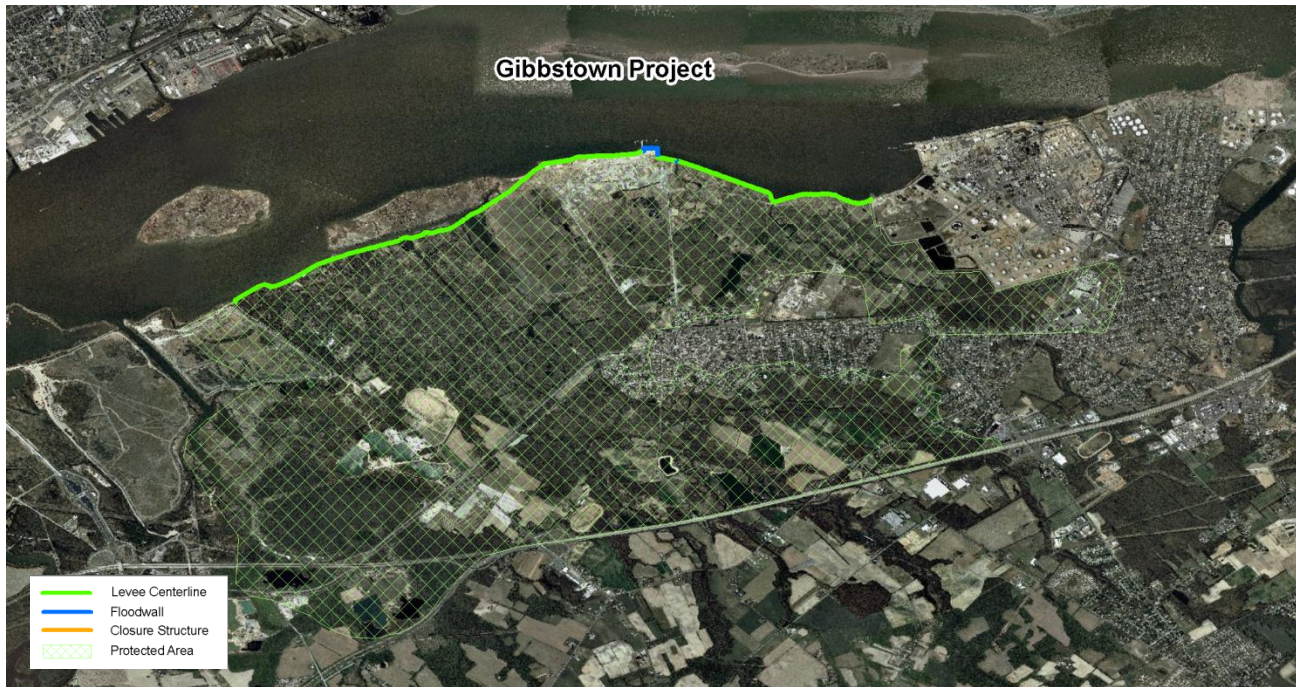
Location

The Gibbstown Project is located in Gloucester County, New Jersey , on the left bank of the Delaware River, which is the primary flood source. The total length of flood protection is 3.96 miles long. This includes 3.79 miles (20,014 feet) of earthen levee, 0.16 miles (866 feet) of floodwall, and 1 closure structure. The protected area is roughly 5548 acres.

Project Features

This levee was surveyed on 7/16/2010. The top elevation of the levee varies from 6.22 to 11.4 ft, with an average top width of 17.6 ft along the earthen levee sections. The features associated with the levee structure are listed below.

Boreholes:	None Collected
Encroachment Points:	13
Flood Fight Points:	None Collected
Crossing Points:	36
Failure Points:	None Collected
Relief Wells:	None Collected
Piezometers:	2
Pump Stations:	None Collected
Sand Boils:	None Collected
Closure Structure Count:	1
Cross Sections:	4
Floodwall Lines:	3
Gravity Drains:	6
Rehab Lines:	None Collected
Toe Drains:	None Collected



Survey Control / Data Collection

Vertical Datum: NAVD88

Horizontal Datum: NAD83

Station Name/PID	North	West	Elevation	Description	Stamping
AI4363	39 49 45.500039	75 17 05.931951	4.78	DISK/ CONCRETE	8 K 1 1999
JU0774	39 50 51.797659	75 21 51.969423	37.992	DISK/ CONCRETE	S 208 1963
JU2216	39 52 1.979853	75 18 1.586251	16.952	ROD/ SLEEVE	X 369 1979

Hawley**Location**

The Hawley Project is located in Wayne County, Pennsylvania , on the right bank of the Lackawaxen River. The Lackawaxen River is the primary flood source. The total length of flood protection is 0.88 miles long. This includes 0.81 miles (4,280 feet) of earthen levee, 0.06 miles (332 feet) of floodwall, and 2 closure structures. The protected area is roughly 48 acres.

Project Features

This levee was surveyed on 7/22/2010. The top elevation of the levee varies from 890.99 to 901.23 ft, with an average top width of 8 ft along the earthen levee sections. The features associated with the levee structure are listed below.

Boreholes:	None Collected
Encroachment Points:	2
Flood Fight Points:	None Collected
Crossing Points:	11
Failure Points:	None Collected
Relief Wells:	None Collected
Piezometers:	None Collected
Pump Stations:	None Collected
Sand Boils:	None Collected
Closure Structure Count:	2
Cross Sections:	1
Floodwall Lines:	5
Gravity Drains:	4
Rehab Lines:	None Collected
Toe Drains:	None Collected



Survey Control / Data Collection

Vertical Datum: NAVD88

Horizontal Datum: NAD83

Station Name/PID	North	West	Elevation	Description	Stamping
NAP01	41 28 42.44008	75 10 50.96876	897.315	DISK/REBAR IN LEVEE	NAP01 2010
NAP02	41 28 33.62788	75 10 22.87273	892.868	DISK IN CONCRETE	NAP02 2010
NAP03X	41 27 53.73894	75 07 38.32548	847.962	DISK/REBAR IN LEVEE	NAP03X 2010
NAP04X	41 25 47.03750	75 08 19.31352	1299.825	PK IN CONCRETE	NAP04X 2010 COE
NAP05X	41 22 20.65832	75 07 40.58555	1397.55	DISK/REBAR	NAP05X 2010

Morrisville

Location

The Morrisville Project is located in Bucks County, Pennsylvania, on the right bank of the Delaware River. The Delaware River is the primary flood source. The total length of flood protection is 0.74 miles (3,899 feet) of earthen levee. There are no floodwall or closure structures in this project. The protected area is roughly 80 acres.

Project Features

This levee was surveyed on 7/19/2010. The top elevation of the levee varies from 30.08 to 31.86 ft, with an average top width of 6 ft along the earthen levee sections. The features associated with the levee structure are listed below.

Boreholes:	None Collected
Encroachment Points:	5
Flood Fight Points:	None Collected
Crossing Points:	12
Failure Points:	None Collected
Relief Wells:	None Collected
Piezometers:	None Collected
Pump Stations:	None Collected
Sand Boils:	None Collected
Closure Structure Count:	None Collected
Cross Sections:	1
Floodwall Lines:	None Collected
Gravity Drains:	3
Rehab Lines:	None Collected
Toe Drains:	None Collected



Survey Control / Data Collection

Vertical Datum: NAVD88

Horizontal Datum: NAD83

Station Name/PID	North	West	Elevation	Description	Stamping
DE9792	40 11 40.590776	74 45 07.109082	41.453	DISK/ CONCRETE	11 D 4 2001
KV1032	40 12 12.666600	74 46 24.747464	44.6	DISK/ CONCRETE	W 106 1935
KV6033	40 12 51.476968	74 46 4.341212	32.334	DISK/ CONCRETE	11 C 1 1988

New Castle

Location

The New Castle Project is located in New Castle County, Delaware , on the right bank of the Delaware River. The Delaware River is the primary flood source. The total length of flood protection is 0.25 miles (1,304 feet) of earthen levee. There are no floodwall or closure structures in this project. The protected area is roughly 302 acres.

Project Features

This levee was surveyed on 7/18/2010. The top elevation of the levee varies from 5.22 to 9.58 ft, with an average top width of 10 ft along the earthen levee sections. The features associated with the levee structure are listed below.

Boreholes:	None Collected
Encroachment Points:	9
Flood Fight Points:	None Collected
Crossing Points:	6
Failure Points:	None Collected
Relief Wells:	None Collected
Piezometers:	None Collected
Pump Stations:	None Collected
Sand Boils:	None Collected
Closure Structure Count:	None Collected
Cross Sections:	1
Floodwall Lines:	None Collected
Gravity Drains:	3
Rehab Lines:	None Collected
Toe Drains:	None Collected



Survey Control / Data Collection

Vertical Datum: NAVD88

Horizontal Datum: NAD83

Station Name/PID	North	West	Elevation	Description	Stamping
JU1890	39 41 36.446834	75 34 41.247220	68.423	DISK/ CONCRETE	R 22 1959
JU1892	39 40 24.170159	75 35 50.310579	70.875	DISK/ CONCRETE	HARE 2 1941 1956 1958
JU1903	39 39 27.673360	75 33 47.589909	7.077	DISK/ CONCRETE	NO 1 1953

Stroudsburg

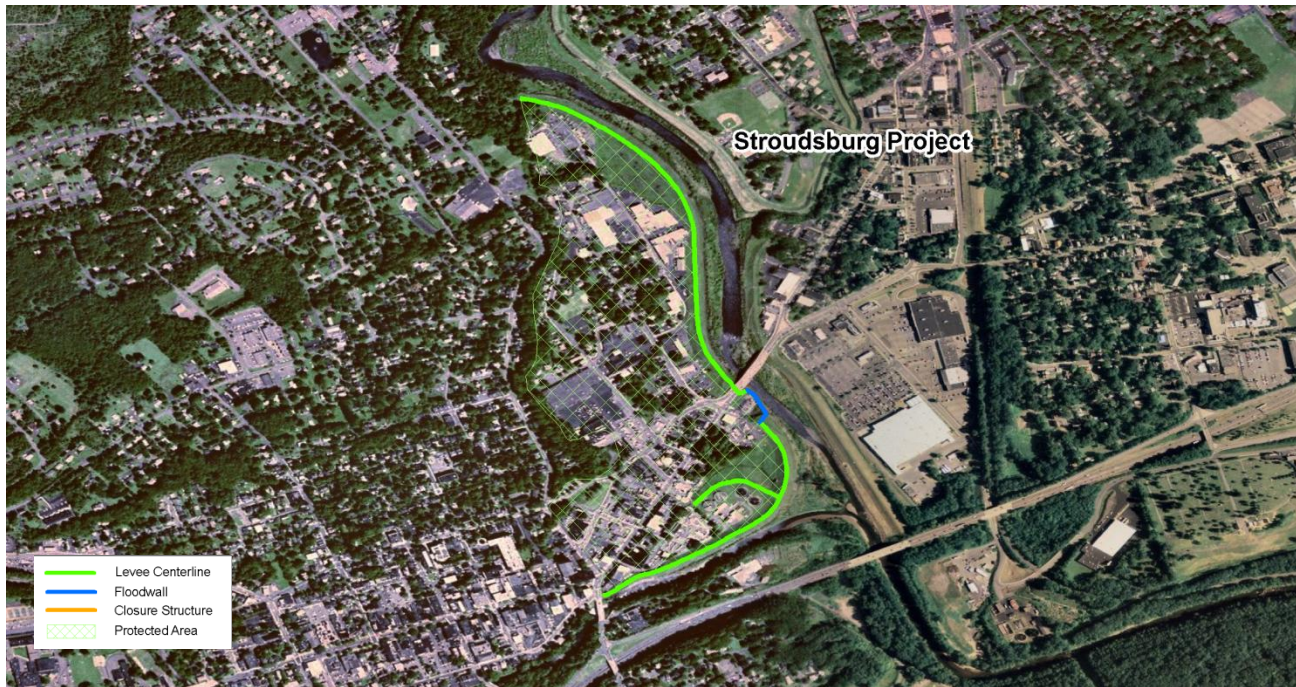
Location

The Stroudsburg Project is located in Monroe County, Pennsylvania , on the right bank of Brodhead Creek. The total length of flood protection is 4.08 miles long. This includes 1.2 miles (6,309 feet) of earthen levee, 0.07 miles (358 feet) of floodwall, and 0 closure structures. The protected area is roughly 102 acres.

Project Features

This levee was surveyed on 7/22/2010. The top elevation of the levee varies from 393.9 to 412.97 ft, with an average top width of 10 ft along the earthen levee sections. The features associated with the levee structure are listed below.

Boreholes:	None Collected
Encroachment Points:	25
Flood Fight Points:	None Collected
Crossing Points:	23
Failure Points:	None Collected
Relief Wells:	None Collected
Piezometers:	13
Pump Stations:	1
Sand Boils:	None Collected
Closure Structure Count:	None Collected
Cross Sections:	2
Floodwall Lines:	6
Gravity Drains:	10
Rehab Lines:	None Collected
Toe Drains:	None Collected



Survey Control / Data Collection

Vertical Datum: NAVD88

Horizontal Datum: NAD83

Station Name/PID	North	West	Elevation	Description	Stamping
KV1416	40 59 11.186035	75 11 40.973516	429.67	DISK IN CONCRETE	C71 1921
KV1417	40 59 45.538486	75 10 52.088561	421.61	DISK IN CONCRETE	A11 1932
LY1101	41 00 30.907886	75 11 04.649544	458.31	DISK IN CONCRETE	Y10 1932 458-877
NAP06	40 59 49.10580	75 11 15.28007	407.904	CONCRETE STRUCTURE	NAP06 2010

Weissport

Location

The Weissport Project is located in Carbon County, Pennsylvania , on the left bank of the Lehigh River. The Lehigh River is the primary flood source. The total length of flood protection is 0.89 miles (4,750 feet) of earthen levee. There are no floodwall or closure structures in this project. The protected area is roughly 62 acres.

Project Features

This levee was surveyed on 7/21/2010. The top elevation of the levee varies from 459.85 to 474.97 ft, with an average top width of 10 ft along the earthen levee sections. The features associated with the levee structure are listed below.

Boreholes:	None Collected
Encroachment Points:	7
Flood Fight Points:	None Collected
Crossing Points:	16
Failure Points:	None Collected
Relief Wells:	None Collected
Piezometers:	None Collected
Pump Stations:	None Collected
Sand Boils:	None Collected
Closure Structure Count:	None Collected
Cross Sections:	3
Floodwall Lines:	None Collected
Gravity Drains:	4
Rehab Lines:	None Collected
Toe Drains:	None Collected



Survey Control / Data Collection

Vertical Datum: NAVD88

Horizontal Datum: NAD83

Station Name/PID	North	West	Elevation	Description	Stamping
KV2801	40 50 20.737702	75 40 05.202300	486.13	DISK IN CONCRETE	U361 PADH
KV2802	40 50 18.599074	75 40 25.652088	500.15	DISK IN CONCRETE	K361 PADH
KV2807	40 50 19.455158	75 42 29.409224	476.23	DISK IN CONCRETE	T361 1969
NAP07	40 49 43.66919	75 42 13.23637	465.682	RDISK/REBAR IN LEVEE	NAP07 2010

APPENDIX A

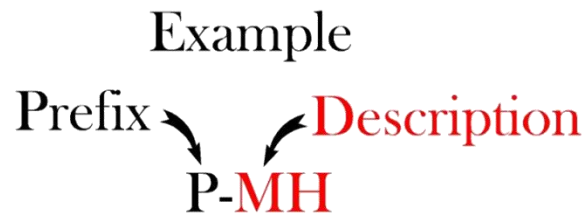
FIELD DATA COLLECTION METHODS



This appendix describes the general process for gathering levee inventory information for inclusion in the National Levee Database (NLD).

Field data collection will use standardized codes for each feature to be collected as part of the levee inventory. The following are the codes to be used.

Field Description



Prefix

L-line
E-Encroachment
X-Cross Section
P-Point Feature

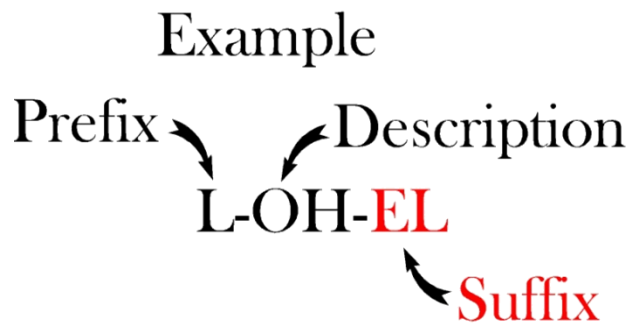
Description

*-TW	TOP OF WALL
*-EP	EDGE OF PAVEMENT
*-BFW	BOTTOM OF FLOOD WALL
*-NG	NATURAL GROUND
*-TOP	TOP OF SLOPE/ BANK
*-TOE	TOE OF SLOPE/BANK
*-GS	GROUND ELEVATION SHOT
*-FW	FLOOD WALL
*-W	WATER
*-WELL	WELL
*-LP	LIGHT POLE
*-PS	PUMP STATION
*-FF	FINISHED FLOOR
*-GW	GUY WIRE
*-PP	POWER POLE
*-OH	OVERHEAD
*-LV	LEVEE
*-HG	HIGH GROUND
*-MH	MANHOLE
*-HW	HEADWALL
*-WV	WATER VALVE

*-SW	SIDEWALK
*-RW	RELIEF WELL
*-GTW	GATE WELL
*-PZ	PIEZOMETER
*-CF	CHAIN LINK FENCE
*-BW	BARBED WIRE FENCE
*-RR	RAILROAD
*-CB	CATCH BASIN
*-GAS	UTILITY GAS
*-RD	ROAD

(*) Prefix

Additional description may be added to list



Suffix

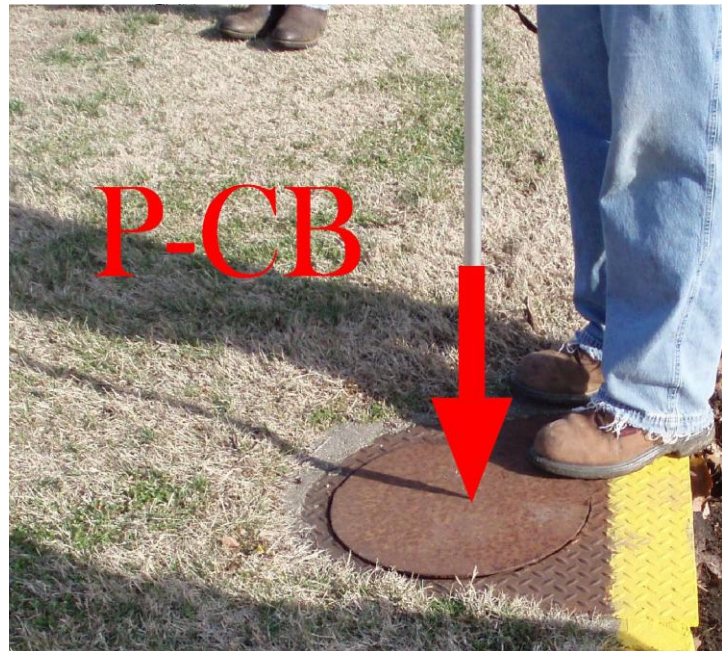
*-**-CONC.	CONCRETE
*-**-EL	ELECTRIC
*-**-FO	FIBER OPTIC
*-**-AP	ASPHALT PAVEMENT
*-**-TP	TELEPHONE
*-**-CL	CLOSURE
*-**-B	BEGIN
*-**-E	END

(*) Prefix

() Description**

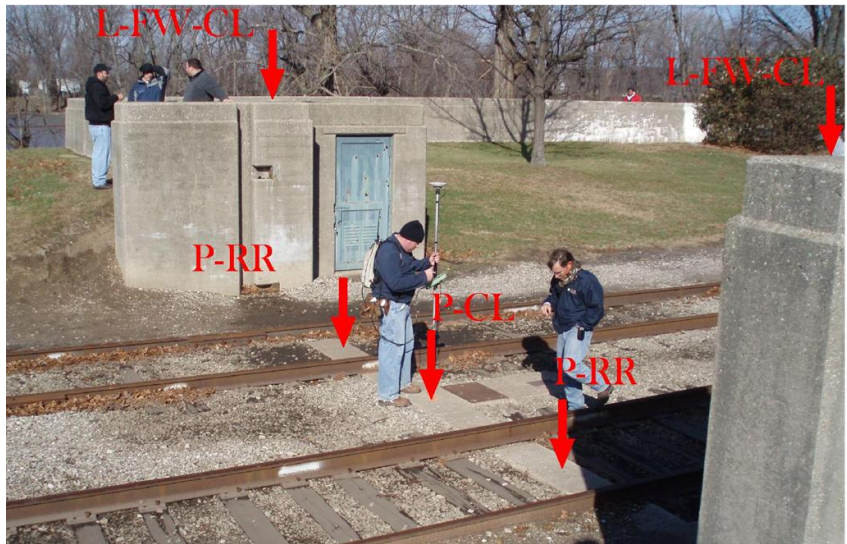
Additional description may be added to list

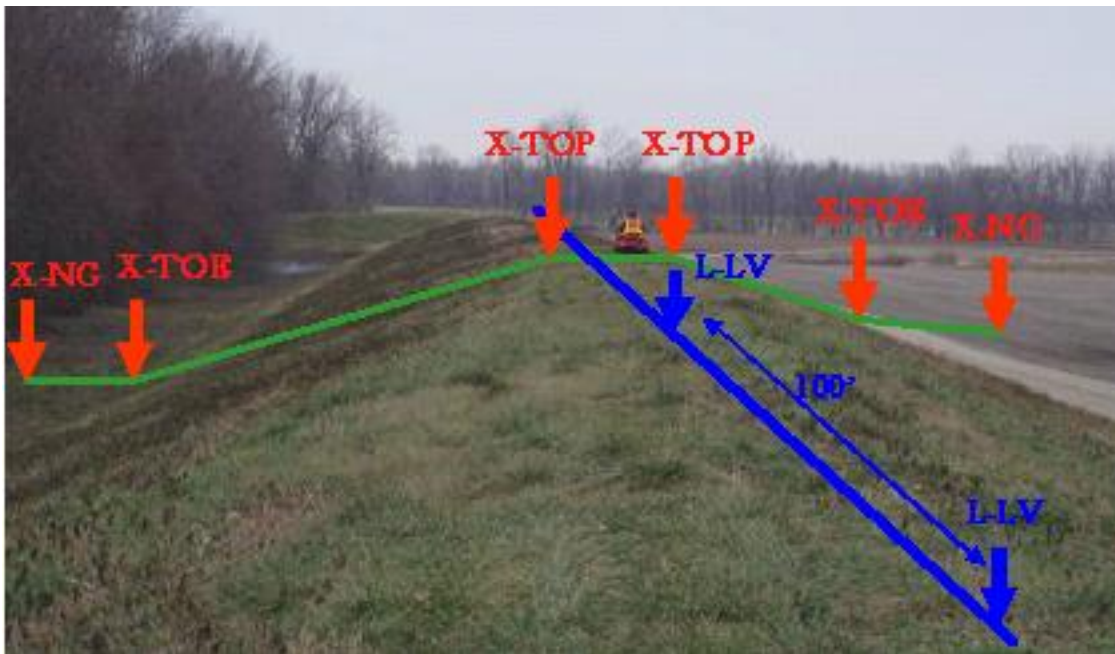
The following are typical data collection methods to be used to collect the levee features. **Piezometers** and **relief well** will be collected with a point located on the top of the item. It must be noted if the relief wells are raised above or flush with the ground.



This is an example of a **piezometer**. Visual appearance may differ from one presented.

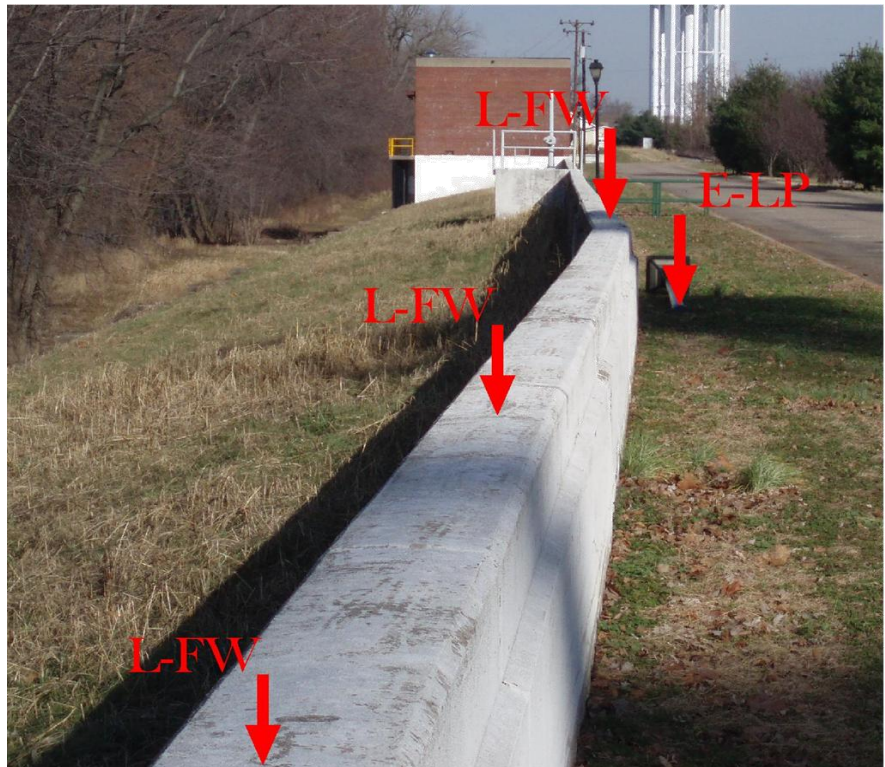
Typical **closure structures** for roads, railroads, and other at grade crossing will be collected by taking 3 points. Take one elevation at each end of the closure at the top of the structure and one in center of the closure at the grade. In the example above you will also collect two crossing points for the railroad tracks. Below is a typical road closure with encroachment point.

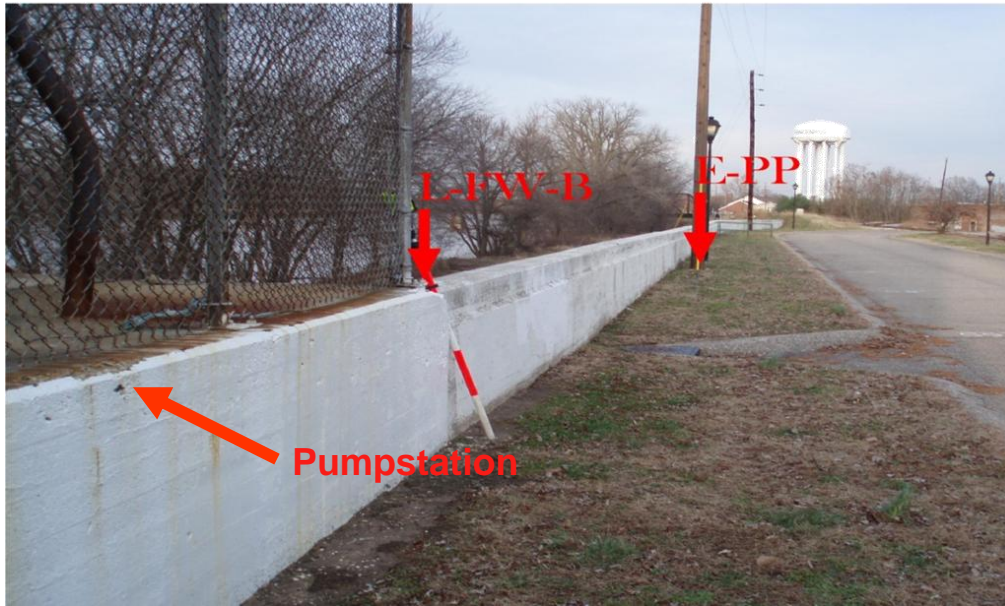




Levee centerlines are to be collected approximately every 25'. Low or high points in between 25' shot are also to be collected. **Cross sections** are going to be collected approximately 1 per mile and will extend 200' from toe of levee or natural ground on land side, top of bank, natural ground (if river is more than 200') or 200' whichever comes first on the water side. Additional shots may be required to pickup other items such as setback levees, drainage ditches parallel to the levee or other notable changes in topography.

Typical **Floodwall centerline** points are collected every 25' as is earth levee centerlines. The encroachment point (Light Pole) is also noted in this picture.

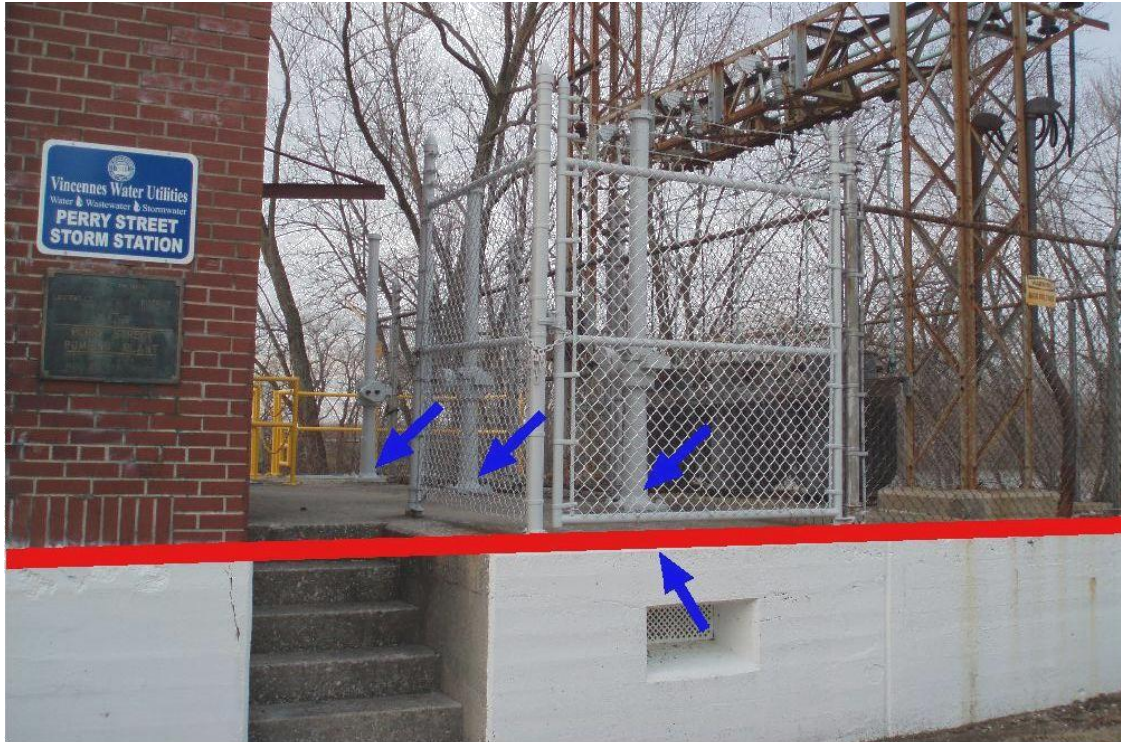




In these situations, definitions must be acquired to indicate the transition line between **flood wall** and **pump station**.

Once again the transition line that must be defined it is still part of the flood wall line feature, but it will contain a note explaining that it is a pump station.





On the point feature **pump station**, attributes like these 3 sluice gates must be annotated.

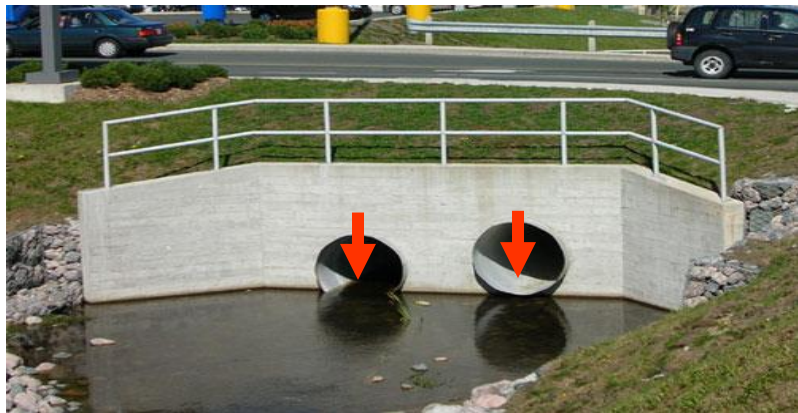


Pump stations are collected as point features in the data. The point of record is the center of the entrance to the building. The elevation should be the entrance sill or finished floor elevation. The pump station does not have to be open, taking the point as close to this location as possible. Make a note about the location if other than the entrance. If no building exists take a point that is easily identifiable and note the location. Underground pump stations will be located with a point at the entrance manhole or cover.

These are 2 examples of **gate wells**. Elevations for these features must be on top of the structures. Notice the image on the bottom has a sluice gate on top. This must be labeled as a note in the field book and as an attribute on the electronic file.



There are also **gravity lines** connecting utility fixtures from one side of the levee to the gate wells and from the gate wells to outfall pipes. The outfall pipe may not always be visible, but when apparent, the invert elevation, type, and size must be obtained.



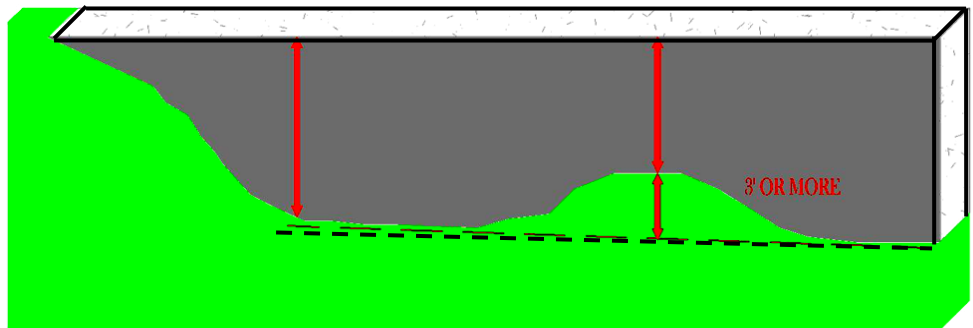
Gravity drains (drainage structures that pass through or under the levee) will be collected as line feature based on the two invert points. If pipe is underwater a point on its apparent location must be obtained for determining alignment and line feature connectivity. Inverts will be taken from the as-built plans when the inverts are not obtainable in the field.





Levee crossings are captured as point features and designate whether they are overhead, on, through or below the levee. Note the width of the crossing and the crossing path (above, over, below and through). The type of crossing is also captured (road, electrical, pipeline, telephone, etc.)

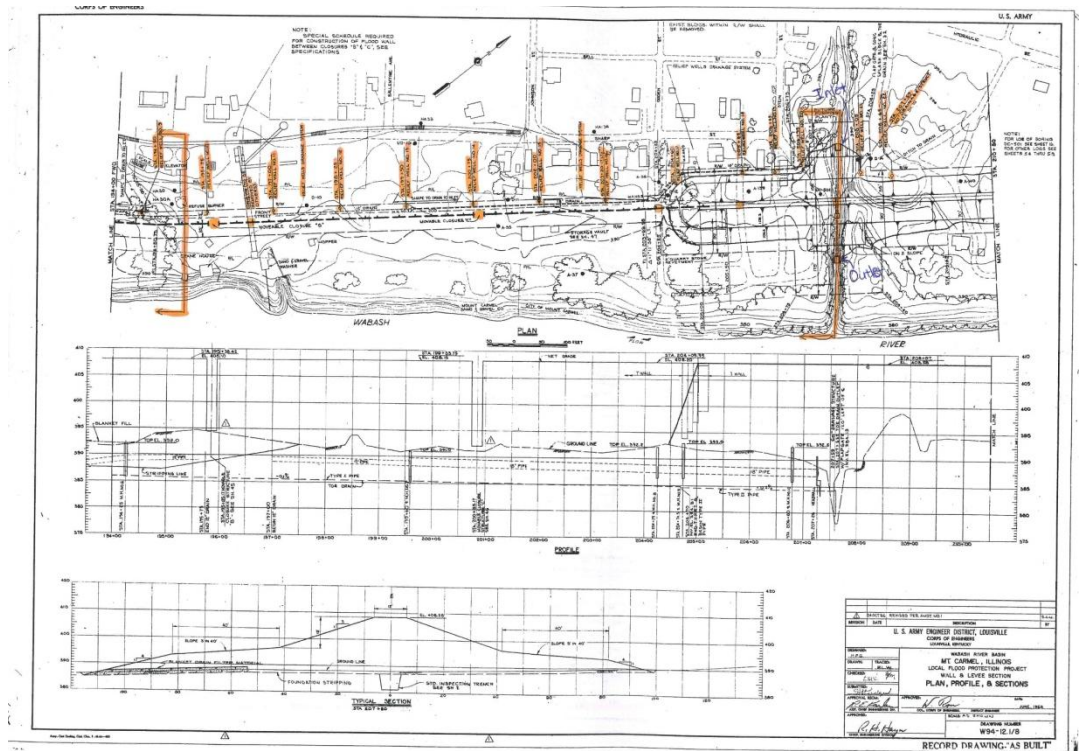
While acquiring flood wall feature special notice must be taken on ground contour. A sudden rise or decrease on the ground may indicate a strong or weak point on the wall. These changes are to be acquired only on dried side if they exceed 3' or more.



This is an example of the data attributes that will be loaded on data collectors. Similar attributes lists will be created for the variety software on the market. It's recommended to use an attributes list when collecting data on the field to minimize field book data entry and speed up office processing.

<ul style="list-style-type: none"> [-] Pump_Station <ul style="list-style-type: none"> [-] Feature_Name [-] Comments [-] Gravity_Drain_line <ul style="list-style-type: none"> [-] Drain_Diameter [-] Comments [-] Encroachment_point <ul style="list-style-type: none"> [-] Comments [-] levee_failure_point <ul style="list-style-type: none"> [-] Failure length [-] failure depth [-] Comments [-] Piezometer_point <ul style="list-style-type: none"> [-] comments [-] Levee_Relief_well <ul style="list-style-type: none"> [-] Comments [-] Sand_boil_point <ul style="list-style-type: none"> [-] Comments [-] Utility <ul style="list-style-type: none"> [-] Comments [-] Position <ul style="list-style-type: none"> [-] None [-] Flush [-] Raised 	<ul style="list-style-type: none"> [-] levee_centerline <ul style="list-style-type: none"> [-] Comments [-] Floodwall_line <ul style="list-style-type: none"> [-] wall_height [-] wall_width [-] Primary_Material <ul style="list-style-type: none"> [-] None [-] Concrete [-] Aluminum [-] Brick [-] Cinderblock [-] Earthen [-] Logs [-] Sheet Metal [-] Wood [-] Closure_Structure <ul style="list-style-type: none"> [-] Height [-] Width [-] Levee_Crossing_Point <ul style="list-style-type: none"> [-] Crossing Type <ul style="list-style-type: none"> [-] None [-] Road [-] Railroad [-] Pipeline [-] Utility [-] Other [-] Width/Diameter [-] Clearance
--	---

This is an example of the plan sheets that were provided by the District. They will be marked with features that need to be located. If these features are not visible or appear to be disturbed in the field, you will note in the survey field book the stationing and reason it can't be located or surveyed at the time.



ACCURACY DETERMINATION

To determine if the features position meets the stipulated accuracy of ± 8 cm, a Root-Mean Square (RMS) of the Master Control observation differences is calculated. The RMS is used instead of standard deviation, since the RMS calculation is not biased by assuming the mean equals zero as is assumed in the standard deviation calculation. The RMS is simply calculated by:

$$RMS = \sqrt{\frac{\sum X^2}{N}}$$

where: X = coordinate differences

N = number of comparisons made.

This computation was made as taken from a number of observed benchmarks to show the accuracy of the RTK procedure.

APPENDIX B

PROCESSED SURVEY DATA QC LIST

The following table is for checking the survey data submitted for development of the database.

Levee	Levee A		Levee B	
	Date	Initial	Date	Initial
Receive Survey Data				
Is Data in 3D?				
Any anomalies or outliers?				
Topology Check (line features snapped, line of protection on top of centerline, floodwall, closure)				
Closure Structure				
Height				
Width				
Closure Type				
Horizontal Accuracy				
Vertical Accuracy				
Missing Closures				
General Comments				
Cross Section Line				
Survey Date				
Coordinate Capture Method				
Horizontal Accuracy				
Vertical Accuracy				
Comment on why cross section ended				
Missing Cross Sections				
General Comments				
Floodwall Line				
Height				
Material				
Coordinate Capture Method				
Horizontal Accuracy				
Vertical Accuracy				
Missing Floodwall				
General Comments				
Encroachment Point				
Encroachment Type				
Horizontal Accuracy				
Vertical Accuracy				
General Comments				
Gravity Drain				
Inlet Invert Elevation				
Outlet Invert Elevation				
Size, Type				
Horizontal Accuracy				
Vertical Accuracy				

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Correct Elevations for obscured pipes				
General Comments				
Levee Centerline				
Coordinate Capture Method				
Horizontal Accuracy				
Vertical Accuracy				
Missing Levee Centerline				
General Comments				
Levee Crossing Point				
Path				
Type				
Width				
Clearance				
Horizontal Accuracy				
Vertical Accuracy				
General Comments				
Pump Station Point				
Horizontal Accuracy				
Vertical Accuracy				
Missing Pump Station				
General Comments				
Relief Well				
Top Elevation				
Name/Number				
Horizontal Accuracy				
Vertical Accuracy				
General Comments				
Piezometer				
Top Elevation				
Name/Number				
Horizontal Accuracy				
Vertical Accuracy				
General Comments				
Levee Failure				
Length				
Depth				
Horizontal Accuracy				
Vertical Accuracy				
General Comments				
Utility/ Misc Points				
Comments				
Overall Comments				

APPENDIX C
PROJECT GDB QC LIST

Levee	_____		
Date	_____		
Attributed By	_____		
Reviewed By	_____		
Borehole Point		Levee Relief Well Point	
Points Digitized	_____	Points Attributed	_____
Points Attributed	_____		
Verify 10%	_____	Points Digitized if needed	_____
		Verify 10%	_____
Closure Structure Line		Levee Station Point	
Lines Attributed	_____	Points Match As-builts	_____
Verify 10%	_____	Points Attributed	_____
Verify Line Direction	_____		
Cross Section Line		Piezometer Point	
Lines Attributed	_____	Points Attributed	_____
Verify Line Direction	_____		
Encroachment Point		Points Digitized if needed	_____
Points Attributed	_____	Verify 10%	_____
Permitted set to No	_____		
Flood Fight Point		Protected Area	
Points Attributed	_____	Polygon Attributed	_____
Verify 10%	_____	Note added	_____
Floodwall Line		Pump Station Point	
Lines Attributed	_____	Points Attributed	_____
Verify 10%	_____		
Verify Line Direction	_____	Points Digitized if needed	_____
		Verify 10%	_____
Gravity Drain Line		Sand Boil Point	
Lines Attributed	_____	Points Attributed	_____
Verify 10%	_____	Verify 10%	_____
Verify Line Direction	_____		
Levee Centerline		Toe Drain Line	
Lines Attributed	_____	Lines Digitized	_____
Verify 10%	_____	Lines Attributed	_____
Verify Line Direction	_____	Verify 10%	_____
Levee Crossing Point		FC_SEGMENT	_____
Points Attributed	_____	FC_PROJECT	_____
Verify points were digitized from as-builts and for gravity drains	_____	FC_SYSTEM	_____
		ORGANIZATION	_____
Levee Failure Point		POINT_OF_CONTACT	_____
Points Attributed	_____	ADDRESS	_____
Verify 10%	_____		

APPENDIX D

DATA SOURCES

Data sources that are used for the population of the database are tracked as part of the effort. In general these will be similar for most of the districts. This is not detailed description but rather a general listing of source material.

Feature	Source
levee_centerline	
Levee_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Up_River_Mile	DRG, AS-BUILT OVERVIEW MAP
Down_River_Mile	DRG, AS-BUILT OVERVIEW MAP
Feature_Name	DISTRICT LIST -Usually Appendix A of SOW
Feature_Length	CALC FROM FEATURE IN MILES
Gage_Code	GAGE FOUND IN O&M, CODE FROM USGS STREAM GAGE SHAPEFILE
Gage_Owner	STREAM GAGE SHAPEFILE/USGS WEBSITE
Slope_Landside	SURVEY PROVIDES
Slope_Waterside	SURVEY PROVIDES
Bank_d	AS-BUILT OVERVIEW MAP
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION
Cutoff_Type_d	LEVEE TYPICAL SECTION (AS-BUILTS)
Levee_Type_d	LEVEE TYPICAL SECTION (AS-BUILTS)
Primary_Material_d	SURVEY, TYPICAL SECTION (AS-BUILTS)
Crest_Width	SURVEY PROVIDES
Crest_Access	ADD NOTE "See Levee Crossing Points"
Flood_Source	O&M PROJECT DESCRIPTION
River_Basin	O&M PROJECT DESCRIPTION
Horiz_Accuracy	SURVEY PROVIDES RMS ERROR
Vert_Accuracy	SURVEY PROVIDES RMS ERROR
Comments	
floodwall_line	
Floodwall_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Up_River_Mile	DRG, AS-BUILT OVERVIEW MAP
Down_River_Mile	DRG, AS-BUILT OVERVIEW MAP
Feature_Name	DISTRICT LIST -Usually Appendix A of SOW
Feature_Length	CALC FROM FEATURE IN MILES - DATA MUST BE PROJECTED TO DO THIS
Gage_Code	GAGE FOUND IN O&M, CODE FROM USGS STREAM GAGE SHAPEFILE
Wall_Height	SURVEYORS CAPTURE IN FIELD
Foundation_Width	MONOLITH DETAILS (AS-BUILTS)

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Wall_Width	SURVEY OR MONOLITH DETAILS (AS-BUILTS)
Wall_Depth	SURVEY HEIGHT - TOTAL HEIGHT SHOWN ON MONOLITH DETAILS
Primary_Material_d	SURVEY OR MONOLITH DETAILS
Bank_d	AS-BUILT OVERVIEW MAP
Cutoff_Type_d	MONOLITH DETAILS (AS-BUILTS)
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION
Wall_Type_d	MONOLITH DETAILS (AS-BUILTS)
Flood_Source	O&M PROJECT DESCRIPTION
River_Basin	O&M PROJECT DESCRIPTION
Horiz_Accuracy	SURVEY PROVIDES RMS ERROR
Vert_Accuracy	SURVEY PROVIDES RMS ERROR
Comments	
closure_structure_line	
Closure_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Levee_Station_Code	CLOSURE STRUCTURE DETAILS (AS-BUILTS)
Feature_Name	CLOSURE STRUCTURE DETAILS (AS-BUILTS)
Closure_Use	O&M
Closure_Height	SURVEY DATA
Closure_Width	SURVEY DATA
River_Mile	DRG, AS-BUILT OVERVIEW MAP
Gate_Type_d	SURVEY OR CLOSURE STRUCTURE DETAILS (AS-BUILTS)
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION
Comments	
levee_station_point	
Levee_Station_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
River_Mile	DRG, AS-BUILT OVERVIEW MAP
Levee_Station_Code	AS-BUILT
Levee_Mile	MEASURE FROM LINE OF PROTECTION REFERENCE POINT FEATURECLASS
Landside_Toe_Elevation	DO NOT POPULATE
Station_Elevation	GENERATE BY PULLING DATA FROM SURVEYED LEVEE CENTERLINE OR FLOODWALL LINE FEATURECLASS
Water_Surface_Elevation	DO NOT POPULATE
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION
Comments	
pump_station_point	<i>POINT SURVEY COLLECTED, ALL ATTRIBUTES ARE RESEARCH</i>
Pumpstation_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE

Philadelphia District National Levee Inventory Database

Levee_Station_Code	PUMP STATION DETAILS (AS-BUILTS)
River_Mile	DRG, AS-BUILT OVERVIEW MAP
Date_Built	O&M PUMP STATION DESCRIPTIONS
Number_Pumps	O&M PUMP STATION DESCRIPTIONS
Pump_Elevation	PUMP STATION DETAILS (AS-BUILTS)
Invert_Elevation	PUMP STATION DETAILS (AS-BUILTS)
Max_Design_Head	O&M PUMP STATION DESCRIPTIONS
Capacity	O&M PUMP STATION DESCRIPTIONS
Feature_Name	O&M PUMP STATION DESCRIPTIONS OR PUMP STATION DETAILS (AS-BUILTS)
Interior_Drain	O&M PUMP STATION DESCRIPTIONS
Pump_Age	O&M PUMP STATION DESCRIPTIONS
Pump_Type_d	O&M PUMP STATION DESCRIPTIONS
Pump_Config_d	O&M PUMP STATION DESCRIPTIONS
Pump_Drive_d	O&M PUMP STATION DESCRIPTIONS
Backup_Power_d	O&M PUMP STATION DESCRIPTIONS
Flood_Source	O&M PUMP STATION DESCRIPTIONS
River_Basin	O&M PUMP STATION DESCRIPTIONS
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION IF SURVEYED
Comments	
levee_crossing_point	<i>FROM SURVEY DATA FOR ABOVE GROUND CROSSINGS, DIGITIZED FROM AS-BUILTS FOR BELOW GROUND</i>
Crossing_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Levee_Station_Code	AS-BUILT OR MEASURE FROM LEVEE_STATION_POINTS
Date_Built	PERMIT INFORMATION
Crossing_Type_d	SURVEY OR AS-BUILT
Crossing_Path_d	SURVEY OR AS-BUILT
Width	SURVEY OR AS-BUILT
Clearance	SURVEY OR AS-BUILT
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION IF SURVEYED
Comments	
protected_area	
Protect_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_System_ID	FC_SYSTEM TABLE
Feature_Name	ADDED "PROTECTED AREA" AFTER THE SEGMENT NAME PER DISTRICT GUIDANCE
Warn_d	O&M PROJECT DESCRIPTION
Protected_Area_Source	DRG TOPO
Min_Protect_Level	O&M PROJECT DESCRIPTION
Egress_Number	O&M PROJECT DESCRIPTION

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Horiz_Accuracy	N/A BECAUSE FEATURE IS DIGITIZED FROM DRG
Vert_Accuracy	N/A BECAUSE FEATURE IS DIGITIZED FROM DRG
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION IF SURVEYED
Comments	
gravity_drain_line	
Drain_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Levee_Station_Code	DRAINAGE STRUCTURE DETAILS OR MEASURE FROM LEVEE_STATION_POINT
Feature_Name	
Drain_Diameter	SURVEY OR DRAINAGE STRUCTURE DETAILS (AS-BUILT)
Design_Length	DRAINAGE STRUCTURE DETAILS
Capacity	N/A
Material_Type_d	SURVEY OR DRAINAGE STRUCTURE DETAILS (AS-BUILT)
Inlet_Elevation	SURVEY
Outlet_Elevation	SURVEY
Gate_Type_d	O&M DRAINAGE STRUCTURE LIST OR DRAINAGE STRUCTURE DETAILS (AS-BUILT)
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION IF SURVEYED
Comments	
borehole_point	
Borehole_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Levee_Station_Code	AS-BUILT
Start_Date	BORING LOGS
Completion_Date	BORING LOGS
Reference_Pt_Elevation	BORING LOGS
Reference_Pt_Description	"Elevation at bottom of borehole"
Ground_Surf_Elevation	BORING LOGS
Total_Depth	AS BUILT DETAIL
Feature_Desc	AS-BUILT
Boring_Method	BORING LOGS
Borehole_Type	BORING LOGS
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION IF SURVEYED
Comments	
cross_section_line	
Cross_Sec_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Levee_Station_Code	MEASURE FROM LEVEE STATION POINT FEATURE
River_Mile	DRG OR AS-BUILT OVERVIEW MAP

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Survey_Date	SURVEY
Coordinate_Method_d	SURVEY
Horiz_Accuracy	SURVEY PROVIDES RMS ERROR
Vert_Accuracy	SURVEY PROVIDES RMS ERROR
Comments	PROVIDED BY SURVEYORS TO EXPLAIN WHY CROSS SECTION ENDED ON EACH SIDE
encroachment_point	<i>FROM SURVEY DATA FOR ABOVE GROUND ENCROACHMENTS, DIGITIZED FROM AS-BUILTS FOR BELOW GROUND PERMITTED ENCROACHMENTS</i>
Enchr_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Levee_Station_ID	N/A
Reported_Date	PERMIT INFORMATION PROVIDED BY THE DISTRICT
Resolutuion_Date	PERMIT INFORMATION PROVIDED BY THE DISTRICT
Permitted	DEFAULT "NO" UNLESS INFO PROVIDED BY DISTRICT
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION IF SURVEYED
Comments	
levee_failure_point	<i>NOT COLLECTED FOR THIS DISTRICT</i>
Failure_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Levee_Station_ID	LEVEE FAILURE DETAILS OR MEASURE FROM LEVEE_STATION_POINT
River_Mile	
Failure_Length	
Failure_Depth	
Failure_Date	
Levee_Failure_Name	
Repair_Date	
Failure_Type_d	SURVEYORS PROVIDE THIS INFORMATION IF SURVEYED
Faultline_d	
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION IF SURVEYED
Comments	
levee_relief_well_point	
Relief_Well_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Levee_Station_ID	RELIEF WELL DETAILS (AS-BUILT) OR O&M RELIEF WELL LIST OR MEASURE FROM LEVEE_STATION_POINT
Feature_Name	
Top_Elevation	SURVEY
Well_Depth	RELIEF WELL DETAILS (AS-BUILT)
Date_Built	RELIEF WELL DETAILS (AS-BUILT) OR O&M RELIEF WELL LIST
Flow_Capacity	RELIEF WELL DETAILS (AS-BUILT)

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Control_Elevation	RELIEF WELL DETAILS (AS-BUILT)
Well_Diameter	RELIEF WELL DETAILS (AS-BUILT)
Well_Rehab_Date	RELIEF WELL DETAILS (AS-BUILT)
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION IF SURVEYED
Comments	
flood_fight_point	<i>NOT COLLECTED FOR THIS DISTRICT</i>
Flood_Fight_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Levee_Station_ID	FLOOD FIGHT DETAILS (AS-BUILT) OR MEASURE FROM LEVEE STATION POINT
Built_Date	
River_Mile	DRG OR AS-BUILT OVERVIEW MAP
FF_Measure_Length	
Remove_Date	
FF_Measure_Type_d	
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION IF SURVEYED
Comments	
piezometer_point	
Piezom_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Levee_Station_ID	PIEZOMETER DETAILS (AS-BUILT) OR MEASURE FROM LEVEE STATION POINT
Feature_Name	
Installation_Date	PIEZOMETER DETAILS (AS-BUILT)
Top_Elevation	SURVEY -STORED IN GEOMETRY OF FEATURE
Tip_Elevation	PIEZOMETER DETAILS (AS-BUILT)
Location_Offset	MEASURE FROM LEVEE CENTERLINE OR FLOODWALL LINE
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION IF SURVEYED
Comments	
sand_boil_point	<i>NOT COLLECTED FOR THIS DISTRICT</i>
Boil_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Levee_Station_ID	SAND BOIL POINT DETAILS OR MEASURE FROM LEVEE STATION POINT
River_Mile	DRG OR AS-BUILT OVERVIEW MAP
Location_Offset	MEASURE FROM LEVEE CENTERLINE OR FLOODWALL LINE
Cone_Diameter	
Discovery_Date	
Feature_Name	
River_Stage	
River_Gage	

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Flow_Status_d	
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION IF SURVEYED
Comments	
rehabilitation_line	<i>NOT COLLECTED FOR THIS PROJECT</i>
Rehab_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Rehab_Date	
Rehab_Cost_d	
Rehab_Desc	
From_Measure	
To_Measure	
Horiz_Accuracy	SURVEY PROVIDES RMS ERROR OR BLANK FOR DIGITIZED POINTS
Vert_Accuracy	SURVEY PROVIDES RMS ERROR OR BLANK FOR DIGITIZED POINTS
Comments	
toe_drain_line	
Toe_Drain_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
FC_Segment_ID	FC_SEGMENT TABLE
Feature_Name	
Trench_Depth	AS-BUILT
Date_Built	O&M
Flow_Capacity	DO NOT POPULATE
Outfall_Elevation	AS-BUILT PROFILE
Pipe_Diameter	AS-BUILT PROFILE
Drain_Length	AS-BUILT PROFILE OR CALC IN FEET
Drain_Condition	N/A
Coordinate_Method_d	SURVEYORS PROVIDE THIS INFORMATION IF SURVEYED
Comments	
line_of_protection_reference_points	<i>DIGITIZED EVERY 0.1 MILE ALONG THE LINE OF PROTECTION</i>
LOP_Point_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
DIST_MILES	MEASURED ALONG THE LINE OF PROTECTION FEATURECLASS
Elevation	CALCULATED FROM THE GEOMETRY OF THE LINE OF PROTECTION FEATURECLASS
Comments	
line_of_protection_reference_line	<i>COMBINATION OF LEVEE CENTERLINE, FLOODWALL LINE, CLOSURE STRUCTURES, AND HIGH GROUND</i>
LOP_line_ID	PER USACE PRIMARY KEY GENERATION DOCUMENT
Comments	

APPENDIX E

Final QC

The following scripts are used for the final overall review of the NLD database:

Address:

Address_Type_d vs Domain
Address_Country_d vs Domain
Address_State_d vs Domain
Address_Unmatched_Org_ID
Find duplicates for Address

Borehole_point:

Borehole_Boring_Method_d vs Domain
Borehole_Unmatched_FC_Segment_ID
Find duplicates for borehole_point

Closure_structure_line:

Closure_Struct_Clos_Type_d vs Domain
Closure_Struct_Unmatched_FC_Segment_ID
Find duplicates for closure_structure_line

Cross_section_line:

Cross_Section_Coordinate_Method_d vs Domain
Cross_Section_Unmatched_FC_Segment_ID
Find duplicates for cross_section_line

Encroachment_point:

Encroachment_Permitted vs Domain
Encroachment_Unmatched_FC_Segment_ID
Find duplicates for encroachment_point

FC_Project:

FC_Project_Project_Type_d vs Domain
Find duplicates for FC_Project

FC_Segment:

FC_Segment_District_d vs Domain
FC_Segment_FIRM_Protection_Provided_d vs Domain
FC_Segment_Potential_Haz_Class_d vs Domain
FC_Segment_RIP_Status_d vs Domain
FC_Segment_Segment_Certification_d vs Domain

FC_Segment Unmatched FC_System_ID

FC_Segment Unmatched Org_ID

FC_Segment Unmatched PAL_Status

Find duplicates for FC_Segment

FC_System:

FC_System ID values not in Protected_Area

Find duplicates for FC_System

Flood_fight_point:

Flood_Fight_Pt FF_Measure_Type_d vs Domain

Flood_Fight_Pt Unmatched FC_Segment_ID

Find duplicates for flood_fight_point

Floodwall_line:

Floodwall Bank_d vs Domain

Floodwall Coordinate_Method_d vs Domain

Floodwall Cutoff_Type_d vs Domain

Floodwall Primary_Material_d vs Domain

Floodwall Unmatched FC_Segment_ID

Floodwall Wall_Type_d vs Domain

Find duplicates for floodwall_line

Gravity_drain_line:

Gravity_Drain Gate_Type_d vs Domain

Gravity_Drain Material_Type_d vs Domain

Gravity_Drain Unmatched FC_Segment_ID

Find duplicates for gravity_drain_line

Levee_centerline:

Levee_Centerline Bank_d vs Domain

Levee_Centerline Coordinate_Method_d vs Domain

Levee_Centerline Cutoff_Type_d vs Domain

Levee_Centerline Levee_Type_d vs Domain

Levee_Centerline Primary_Material_d vs Domain

Levee_Centerline Unmatched FC_Segment_ID

Find duplicates for levee_centerline

Levee_crossing_point:

Levee_Crossing_Pt Crossing_Path_d vs Domain
Levee_Crossing_Pt Crossing_Type_d vs Domain
Levee_Crossing_Pt Unmatched FC_Segment_ID
Find duplicates for levee_crossing_point

Levee_failure_point:

Levee_Failure_Pt Failure_Type_d vs Domain
Levee_Failure_Pt Faultline_d vs Domain
Levee_Failure_Pt Unmatched FC_Segment_ID
Find duplicates for levee_failure_point

Levee_relief_well_point:

Levee_Relief_Well Unmatched FC_Segment_ID
Find duplicates for levee_relief_well_point

Levee_station_point:

Levee_Station_Pt Capture_Station_Elevation_d vs Domain
Levee_Station_Pt Unmatched FC_Segment_ID
Find duplicates for levee_station_point

Media:

Media Content_Classification_d vs Domain
Find duplicates for Media

Organization:

Organization Org_Type_d vs Domain
Find duplicates for Organization

PAL_Status:

PAL_STATUS IN_PAL_Process_d vs Domain
PAL_STATUS PAL_Scenario_d vs Domain
PAL_STATUS PAL_Status_d vs Domain
Find duplicates for PAL_Status

Piezometer_point:

Piezometer Unmatched FC_Segment_ID

Find duplicates for piezometer_point

Point_of_contact:

Point_of_Contact Unmatched Address_ID

Point_of_Contact Unmatched Org_ID

Find duplicates for Point_Of_Contact

Protected_area:

Protected_Area Unmatched FC_System_ID

Protected_Area Warn_d vs Domain

Find duplicates for protected_area

Pump_station_point:

Pump_Station Backup_Power_d vs Domain

Pump_Station Pump_Config_d vs Domain

Pump_Station Pump_Drive_d vs Domain

Pump_Station Pump_Type_d vs Domain

Pump_Station Unmatched FC_Segment_ID

Find duplicates for pump_station_point

Rehabilitation_line:

Rehabilitation_Line Rehab_Cost_d vs Domain

Rehabilitation_Line Unmatched FC_Segment_ID

Find duplicates for rehabilitation_line

Sand_boil_point:

Sand_Boil Flow_Status_d vs Domain

Sand_Boil Unmatched FC_Segment_ID

Find duplicates for sand_boil_point

Toe_drain_line:

Find duplicates for toe_drain_line

ToeDrain Unmatched FC_Segment_ID