Brainerd Levee

OPERATION & MAINTENANCE MANUAL

Chattanooga, Tennessee

Cranston Engineering Group, P.C.

ENGINEERS - PLANNERS - SURVEYORS

March 1, 2012
Revised 12/31/15

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OPERATION & MAINTENANCE MANUAL

prepared for

Chattanooga Engineering Department
Chattanooga, Tennessee

prepared by

Cranston Engineering Group, P.C.
ENGINEERS - PLANNERS - SURVEYORS

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CHAPTER 1

INTRODUCTION

Operations and Maintenance Manual

Brainerd Levee

Chattanooga, Tennessee

Chapter 1 INTRODUCTION

1.1 Purpose

In 1980 the Tennessee Valley Authority (TVA) completed work on constructing the Brainerd Levee to provide increased protection against flooding for portions of Chattanooga. Upon completion of the work, the TVA developed and presented to the City of Chattanooga separate Operation and Maintenance Manuals to aid personnel charged with operational responsibilities by giving them instructions for operations, maintenance, and emergency situations. These original documents can be found electronically in Appendix C3.

The current December 2015 revisions are published to combine the two manuals into one and to update the manual to account for current practices. The purpose of the Manual remains to be one of providing a tool to assist Chattanooga personnel in their efforts to operate and maintain the Brainerd Levee so that it is in good working order at such time as it is needed for flood protection and to aid personnel during flood fighting.

1.2 General

The Brainerd Levee was built to protect portions of Chattanooga from floods on South Chickamauga Creek, West Chickamauga Creek and Spring Creek. How well the levee performs this function depends upon the components that make up the levee system and the personnel that maintain and operate the system. The components of the levee include the pump stations, gates, sandbags, and the levee itself. These parts depend on personnel: to grease the gate shafts, paint the metal, mow the grass, keep trees off the levee - MAINTENANCE; to check that the pump stations and gates work, make sure sandbags are on hand, look for signs of erosion, animal burrows and improper use - INSPECTION; to put the levee system into action when floods come - OPERATIONS; and to spot trouble on the levee and take action to keep the levee from failing during flood events - FLOOD FIGHT.

1.3 Applicability

1.3.1 *Function*

This manual has several functions. One is to give general information about the levee. Another is to provide a description of the components of the levee system and to show where they are. But the most important function is to provide a description of how to maintain and inspect the levee, how to operate the levee system during floods, and what to do in flood emergencies.

1.3.2 *User*

This manual has been written for the personnel who will do the maintenance, inspections, operations, and the flood fight. These are typically employees of the City of Chattanooga, but can also include contract workers and volunteers.

1.4 Outline of Manual

The order of information in the manual matches the order of the functions described above. The manual is divided into five chapters. The first is the introduction information which has the general information on the levee. This includes a history of the levee project, a brief description of the project, instructions for City officials, and a description of how high and how often the South Chickamauga Creek, West Chickamauga Creek and Spring Creek may flood at Chattanooga, Tennessee. The second chapter of the manual, "Description of Features," describes each of the levee components and what they are made of. The third chapter, "Routine Maintenance," lists those things that need to be done throughout the year to make sure everything will work when the floods come. The fourth chapter, "Periodic Inspections," details when to make inspections and what to look for. The fifth chapter, "Flood Fight," describes how to get ready for a flood, how and when to close the gates and crossings, and, during a flood, what trouble signs to look for and how to fight them. The manual also has four appendices. Appendix A contains the general layout of the levee and access routes. Appendix B contains reference guidelines for maintenance and inspection. Appendix C contains current (2015) levee plans and original TVA documents (electronic on disc). Appendix D contains sample maintenance and inspection forms and reporting documents.

1.5 General Description of Levee

The Brainerd Levee is located along the west side of South Chickamauga Creek, and then turns with Interstate 75 and Interstate 24 to run on the north side of West Chickamauga Creek and Spring Creek in Hamilton County, Tennessee. The levee and its rights-of-way are within the City limits of Chattanooga, Tennessee. The levee is about four and a half miles long (24,318 feet to be exact). It runs from the high ground at the intersection of Moore Road and Bonnieway Street to the high ground at North Terrace Road. The major parts of the levee are the levee itself (a large earthen dike and a shorter length of concrete flood wall), three pump stations with gates, two additional gate structures, and two monitoring stations. The levee system is impacted by various underground utilities. The primary features of the levee system are shown on Figure 1-1.

1.6 Construction History

The Brainerd Levee was designed and constructed by the Tennessee Valley Authority after which it was turned over to the City of Chattanooga for operation, maintenance and ownership. Construction was started in 1978 and completed in 1980. Table 1.1 shows its construction history.

In 2005 improvements were made to add a pedestrian / biking path along the crest of the levee from Shallowford Road to I-75. At this time, stairs were added on each side of Brainerd Road which extend down the creekside slope of the levee from the crest to the toe.

Improvement to the levee completed in 2014 involved raising the concrete floodwall about 3 feet to provide additional freeboard. This resulted in the west end of the wall being lengthened some 115 feet.

Improvements to the levee in 2015 involved raising the earthen embankment along I-24 at Pump Station No. 3. All trees and undesirable vegetation were removed and the crest was raised a maximum of four feet. This has created additional freeboard along this section of the levee. Construction was completed in the Fall of 2015.

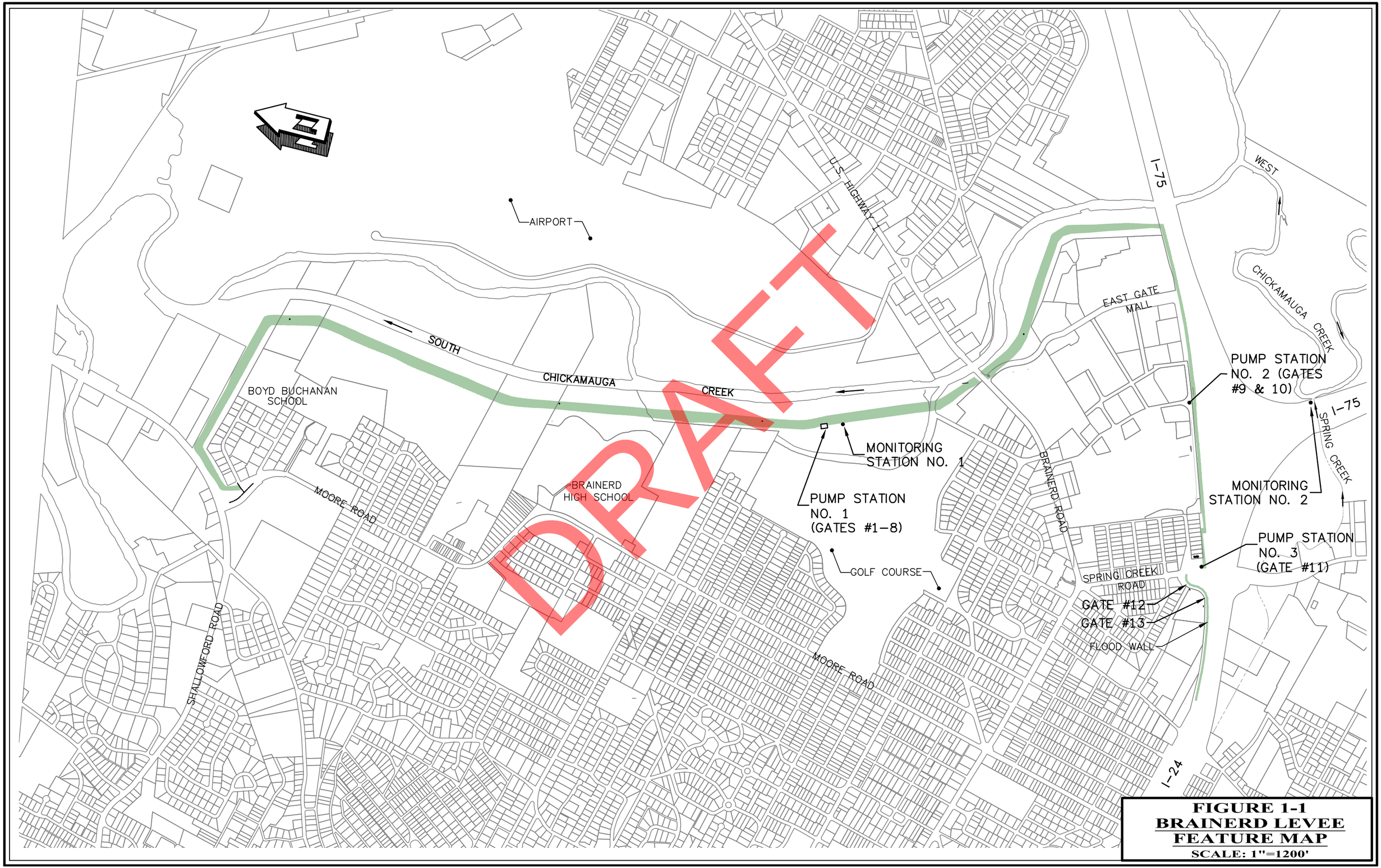


FIGURE 1-1
BRAINERD LEVEE FEATURE MAP
SCALE: 1"=1200'

Also, in early 2016 the reinforced concrete pipe which carries stormwater from the east side of Brainerd Road to the west side so that it can reach Pump Station No. 1 was lengthened by 100 feet. This allowed the landside slope to be flattened in this area which in turn allows the grass on the slope to be more easily maintained.

Table 1.1: Brainerd Levee Construction History

YEAR	ACTION
1978	Initiation of construction by TVA
1980	Construction completed & facility turned over to City
2005	Greenway constructed along crest of levee
2014	Concrete flood wall improvements along North Terrace Road
2015	Embankment improvements near Pump Station No. 3
2016	Improved drainage piping near Station 135+00

1.7 Operations and Maintenance Regulation

1.7.1 *General Requirements*

One important aspect of the Operation Manual and the Maintenance Manual prepared by TVA in 1980 is that they were written such that the City had to adopt these documents by signature of the Mayor, and in so doing, the City agreed to certain general stipulations concerning the overall operation and maintenance. While the TVA has recently notified the City that it will no longer provide general inspection, oversight and consulting services, there are a number of the items agreed to which are to be maintained. Briefly these include:

a. The levee will at all times be operated and maintained to provide the greatest degree of flood protection.
b. The City will operate the levee according to the Operation & Maintenance Manual, and will appoint a responsible person to do so. For the Brainerd Levee, this person is the Chattanooga City Engineer.
c. The necessary equipment and material to fight floods will always be on hand.
d. No temporary encroachments will be allowed on the levee system which will hamper the ability to fight floods.
e. No temporary encroachments, improvements or changes to the levee will be made unless explicitly approved prior to construction by the Chattanooga City Engineer (steps for obtaining this approval are described in the next section). Also, when the approved work is completed, as-built drawings will be provided to the Chattanooga City Engineer.
f. Any necessary repair or maintenance items found to be needed will be accomplished in a timely manner.
g. The City of Chattanooga shall see that the Chattanooga City Engineer has the power during flood fights to direct public and private groups which have property on or near the levee.

1.7.2 *United States Army Corps of Engineers Operation and Maintenance Guidelines*

The United States Army Corps of Engineers (USACE) has an extensive knowledge of levees resulting from a long history of construction, operating, and maintaining many levees throughout the country. Although the Brainerd Levee is not a USACE Levee,

guidance can still be obtained from their documents and regulations. Title 33, Code of Federal Regulations, Chapter 2, Part 208.10 has been attached in Appendix B1 to provide operation and maintenance guidelines to this manual.

1.8 Levee Encroachments

1.8.1 *General*

While all of the items in paragraph 1.7.1 are important, paragraphs 1.7.1(d) and 1.7.1(e) are very important, and need more explanation. These items cover obtaining approval of changes to the levee and encroachments. Encroachments, improvements, and changes cover everything imaginable; power poles and pipelines, roads, fences, openings, trees, houses, etc. The intent here is not to say no to anything on the levee, but to make sure anything proposed to be placed on, or in, the levee will not lessen the ability of the levee to protect portions of Chattanooga from floods. There are two types of concern. One is an action which may cause the levee to fail during a flood, such as erosion from an improperly placed pipeline. The second is an action which may slow down the movement of equipment during a flood emergency; such as a fence without a gate, or a lower power line blocking the path of a dragline crane.

1.8.2 *Purpose*

Proper levee maintenance and the control of levee encroachments are essential in maintaining levee stability and assuring maximum safety for protected areas. Urbanization, increased creek recreation use, economic considerations, and environmental construction restrictions on navigable waterways have created and will continue to create public pressure to construct utility lines, buildings, and other facilities on, across, adjacent to, and through existing levee embankments and rights-of-way. Uncontrolled levee encroachments weaken a levee system. Defined engineering standards and technical requirements for construction of encroachments are considered a necessity to establishing a well maintained, high performance levee system. The purpose of standards for obtaining encroachment on the levee is to assure that the integrity of the levee for fighting floods is maintained.

1.8.3 *Policy on Levee Encroachments*

The Brainerd Levee continues to perform the flood protection function for which it was originally designed and constructed.

1.8.3.1 *Levee Encroachment Policy*

The policy regarding levee encroachments will be to permit in the levee section only those installations that provide a flood control function during high river stages and heavy storm conditions.

1.8.3.2 *Policy Exceptions*

Exceptions to this policy will be allowed only in cases where the function of the encroachment is considered to be in the public interest and where adequate provisions can be made to maintain the integrity of the levee system.

1.8.3.3 *Applicant Submittals*

All applicants for levee encroachments shall submit through the Chattanooga Planning and Zoning Department prior to any approval consideration.

1.8.4 ***General Criteria for Submitted Proposals***

The basic requirement for consideration of any development or construction on, in, under, through, or in the vicinity of the levee shall be that no encroachment which will adversely affect the efficient operation or maintenance of the levee shall be permitted. Neither will any encroachment be allowed that adversely restricts access to the levee for purposes of flood fighting.

1.8.4.1 *Encroachments*

All proposals involving levee encroachment shall be submitted through the Planning and Zoning Department to the Chattanooga City Engineer. The Chattanooga City Engineer will review the proposed encroachment and determine whether or not he considers the encroachment to be in the public interest. The Chattanooga City Engineer will also determine if the design affects the levee integrity or impairs the City's ability to operate and maintain the levee and perform flood fights.

1.8.4.2 *Levee Modifications*

Designs for any proposed modifications of the levee, construction in the levee vicinity, or any other associated work which may alter the levee structure, should be accomplished in accordance with standard engineering practice by licensed professional engineers. It is suggested that engineers involved in this process have specialized training and demonstrated experience in the specific areas of design presented. For example, a design for any modification or alteration of the levee embankment should be performed by a licensed and experienced geotechnical or soils engineer with demonstrated experience in the design and construction of earthen water retaining structures. All submittals should contain appropriate drawings, computations, written descriptions, test data, and other materials consistent with the complexity of the encroachment and stage of design. Data should be in sufficient detail to allow necessary review by the Chattanooga City Engineer.

1.8.4.3 *Hydraulic Considerations*

The following hydraulic issues should be considered as applicable to the type of encroachment proposed:

1.8.4.3.1 Watershed Development

Since normal watershed development over time increases runoff volumes from a given storm occurrence any proposed development should be designed in accordance with current computed water surface elevations at the time of construction.

1.8.4.3.2 FEMA Certification

Future certification to Federal Emergency Management Agency (FEMA) should include the combined effects of existing and proposed development on the floodway. The effect of the total levee development is pertinent to the determination of impacts. FEMA is responsible for approving all construction in flood plains with respect to flood plain management ordinances required under the Flood Insurance Program.

1.8.4.3.3 Levee Modifications

Any modification should be designed to withstand rapid fluctuations of the creeks, the effects of drawdown after periods of flooding, and hydrostatic forces generated by high magnitude, long duration flooding.

1.8.4.3.4 Water Surface Elevations

Water surface elevation calculations should be computed using the back water computation procedures that normally accompany flood insurance studies. Most Architect-Engineering firms have access to these procedures.

1.8.4.4 *As-builts*

Completed "as-built" construction drawings of those features relative to the levee must be furnished to the Chattanooga City Engineer upon completion of an approved project.

1.9 Hydrology

Since the levee was built to protect portions of Chattanooga from flooding, knowledge of how often and how high floods can occur is important. By knowing this, the City can be better prepared to meet flood emergencies. Flood heights direct when the gates should be closed and pumping stations engaged.

1.9.1 ***System Design***

The portion of the levee along South Chickamauga Creek was designed to withstand a 350-year probability storm as evidenced by information shown on the original construction plans. However, this levee section was then tied into the existing "high ground" which is the I-75 /I-24 roadway embankment. The roadway embankment is nearly level along this stretch of highway and provides protection for only the 100-year flood on West Chickamauga Creek and Spring Creek when compared to published flood study data by the Federal Emergency Management Agency (FEMA). Thus, the entire levee system is considered to protect against a flood having a recurrence interval of 100 years. This does not mean such a flood will occur once every 100 years, but rather that the chance of the flood occurring is 1/100 (1%) every year.

1.9.2 ***Unregulated Peak Crests and Discharges***

South Chickamauga Creek has had a gaging station since 1929. Since completion of the Brainerd Levee in 1980 the station has been located on the levee approximately 350 feet south of Brainerd Road. West Chickamauga Creek has a gaging station located some 3.2 miles upstream of Fort Oglethorpe, Georgia which replaced an older station even farther upstream near Kensington, Georgia. Spring Creek has no known gaging stations.

Table 1.2 lists 13 floods on South Chickamauga Creek with unregulated crests of greater than 25 feet as measured at the gaging station. For several of these, a corresponding flow is published in the FEMA flood studies. Prior to the construction of the levee, it was universally agreed that the largest flood of record occurred in 1973 with a reported flow of 33,400 cubic feet per second (cfs) and a water surface elevation of 572.75 (28.20 feet gage). Since that time, two floods have resulted in higher recorded gage readings. These include the 2003 flood with a 29.29 feet gage reading and an unknown flow and the 1990 flood with a 28.72 feet gage reading and an estimated 19,500 cfs flow. It is likely that the

1973 flood would have resulted in higher stage maximum elevation had the Brainerd Levee and the levee at the airport on the east side of South Chickamauga Creek been in place at the time of the event.

Table 1.2: Floods at Chattanooga on South Chickamauga Creek from 1929 through 2010, With Unregulated Gage Crests of 25 Feet of More

MONTH	YEAR	BRAINERD GAGE[1] (FEET)	WATER SURFACE ELEVATION[2] (FEET)	PEAK DISCHARGE[3] (CFS)	TOP OF LEVEE ELEVATION[2] AT GAGE
May	2003	29.29	673.34	-	681.68
February	1990	28.72	672.77	19,500	681.68
March	1973	28.70	672.75	33,400	681.68
September	2009	28.54	672.59	-	681.68
March	1951	27.73	671.78	19,400	681.68
March	1994	27.54	671.59	-	681.68
November	1948	26.83	670.88	18,300	681.68
December	1961	25.70	669.75	-	681.68
December	1942	25.65	669.70	-	681.68
October	1995	25.60	669.65	-	681.68
February	1936	25.47	669.52	-	681.68
January	1947	25.35	669.40	-	681.68
September	2004	25.29	669.34	-	681.68

[1] All stages refer to the measurements at Brainerd Road Gage. Datum of Brainerd Road Gage is 0.0 = 644.12 (NGVD 1929).
[2] Water surface elevations and levee elevations adjusted to NAVD 1988.
[3] Peak discharges from Flood Insurance Study, Catoosa County, Georgia and Incorporated Areas by Federal Emergency Management Agency, effective September 11, 2009.

1.9.3 *Interior Drainage*

Internal drainage of stormwater trapped by the construction of the Brainerd Levee is handled at three pump stations constructed at the same time that the levee embankment was built. Normal flows pass through gates or piped systems at these pump stations by means of gravity flow to reach the adjacent creeks. Then, during times of flooding, gates on the gravity systems are closed to prevent water overflowing the creeks from backflowing to the interior area behind the levee, and the pumps are engaged to lift the interior stormwater over the levee to the creeks beyond. Ponding areas are located near each pump station to provide temporary water storage. After the flood waters have receded, the gates are opened to allow any remaining stored water to be discharged by gravity flow.

CHAPTER 2

DESCRIPTION OF FEATURES

Chapter 2 DESCRIPTION OF FEATURES

2.1 General

The Brainerd Levee is made up of five general types of features – the earthen levee and floodwall structures, gate structures, pump structures, monitoring stations, and ponding areas. Throughout the rest of the manual each item will be referred to by its specific name. The parts which make up the levee system are shown below. Their locations are shown in Appendix C1. Each item is described in this chapter.

2.2 Datum

This manual, having been updated from the previous (undated, circa 1980) Operation and Maintenance Manuals, contains information as well as various figures and images used in the previous manual. All elevation information used and presented here has been converted from National Geodetic Vertical Datum (NGVD) 1929 to North American Vertical Datum (NAVD) 1988. These adjustments used a standard conversion factor of minus (-)0.07 feet from NGVD 1929 to NAVD 1988. The reader should be aware that drawings from before approximately 1990, likely show information tied to the NGVD 1929 datum. Care should be exercised to assure that the datum is known when using any elevation information.

2.3 Features

The main parts of the levee system, sorted in order traveling upstream from the lower end are shown below in Table 2.1. Also shown in this table are the approximate levee stations, current top elevation (2015) and current 100-Year (base) flood elevation (2015).

Table 2.1: Levee Features

FEATURE	DESCRIPTION	APPROXIMATE LEVEE STATION	LEVEE TOP ELEVATION	APPROXIMATE 100-YR FLOOD ELEVATION	COMMENTS
Sections, Gates, Pump Stations and Monitoring Stations					
Earthen Levee from Moore Drive to I-75	Approximately 17,400 feet of earthen dike 20-35 feet high and having a 14 foot wide crest	6+48 -181+18	679.3-682.14	668.9 - 674.9	
Pump Station No. 1 Closure Gates (No.'s 1-8) & Pumps	8 electrically operated closure gates and 5 - 50,000 gpm pumps	118+00 -118+98	680.40-680.46	671.9	
Monitoring Station No. 1	Concrete structure with level sensors	124+25	681±	671.9	Located on bank of creek
Brainerd Road Crossing	Low spot where road crosses levee	141+65 - 142+25	679.3 - 679.4	671.9 - 672.9	
S. Chickamauga Creek Gaging Station	National Weather Service facility	146+00	681.68	672.8	
Earthen I-75 / I-24 Roadway Embankment	Approximately 4,250 feet of earthen roadway 50+ feet wide and 2-20 feet high	181+18 - 224+74	679.63-681.57	676.9 - 678.9	Needs closure during flood for freeboard

FEATURE	DESCRIPTION	APPROXIMATE LEVEE STATION	LEVEE TOP ELEVATION	APPROXIMATE 100-YR FLOOD ELEVATION	COMMENTS
Pump Station No. 2 Closure Gates (No. 9 & 10) & Pumps	2 electronically operated closure gates and 3 - 12,000 gpm pumps	204+00	680.82	676.9	
Monitoring Station No. 2	Concrete structure with level sensors	At confluence of W. Chickamauga Creek and Spring Creek	N/A	677	1,500' ± south of Pump Station No. 2
Earthen Levee from I-24 to Spring Creek Road	Approximately 565 feet of earthen dike 10-17 feet high with a 10 foot wide crest	300+00 - 305+65	684.59-685.43	678.9	
Pump Station No. 3 Closure Gate (No. 11) & Pumps	1 manually operated closure gate and 2 - 12,000 gpm pumps	304+90	681.22	678.9	
Floodwall Section	Concrete gravity-type flood wall 1-4 feet high	309+92 - 329+00	680.17-681.86	679.9	Needs closure during flood at Spring Creek Road
N. Terrace Gate No. 12	Concrete structure and 1 manually operated slide gate	311+00	681±	679.9	Opened during flood
N. Terrace Gate No. 13	Concrete structure and 1 manually operated slide gate	315+45	680.2	679.9	Closed during flood

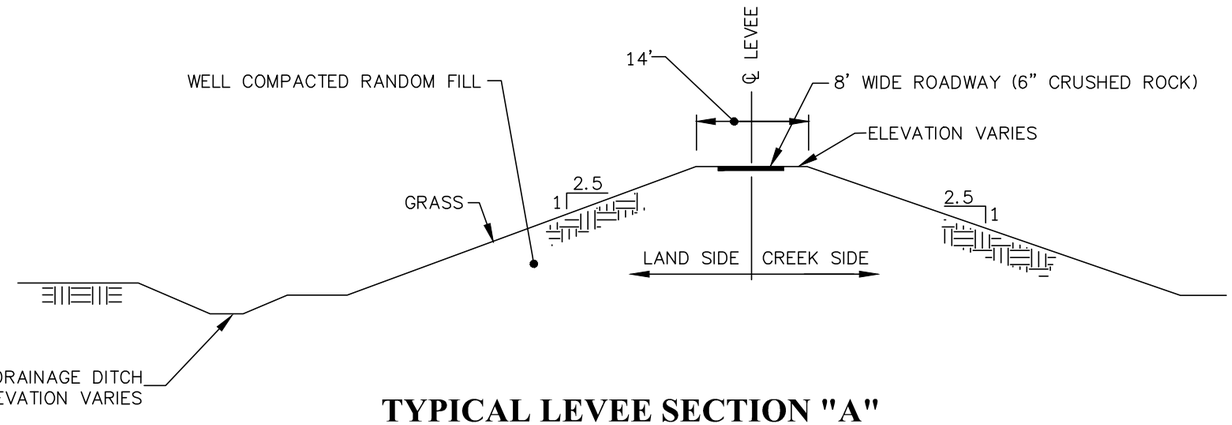
2.4 Descriptions

In describing the various levee parts it is easier to break them into six areas - the levee sections, special features, gates, pump stations, monitoring control stations, and ponding areas. Where available, plans of the levee features are provided in Appendix C (original TVA Documents). As these are the original plans, it needs to be noted that all elevations reference NGVD 1929.

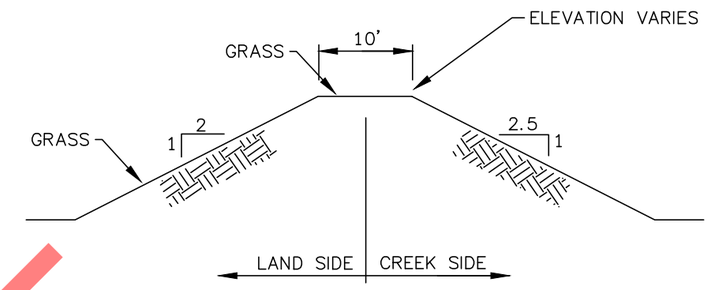
2.4.1 *Levee Sections*

The levee is mainly a large earthen dike except for a section of concrete floodwall at its western end. The typical design shapes are shown in Figure 2-1. The top of the levee has a width of 10 to 14 feet, except as indicated below. The top generally has a gravel surface course road. Each side slope is grassed and slopes away from the top, generally having 1 foot of drop for every 2 to 2 1/2 feet of horizontal distance from the top of the levee.

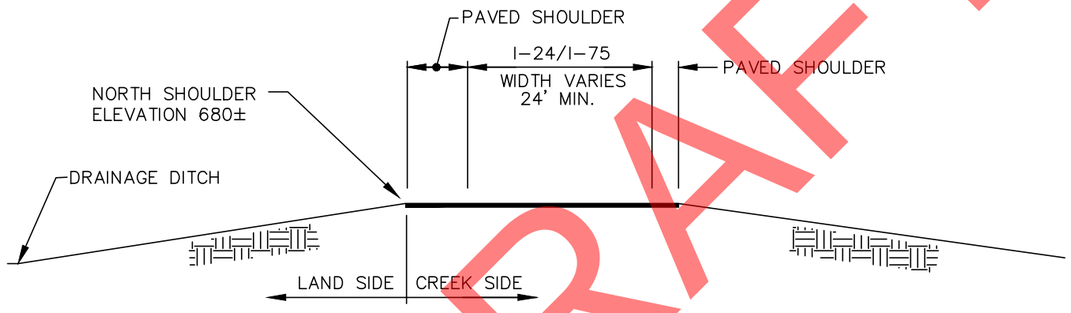
The levee along its length divides into sections defined by their location and/or the type of cross-section. The levee sections and their cross sections, access points, and any special features are listed in Table 2.2 and are described in more detail below.



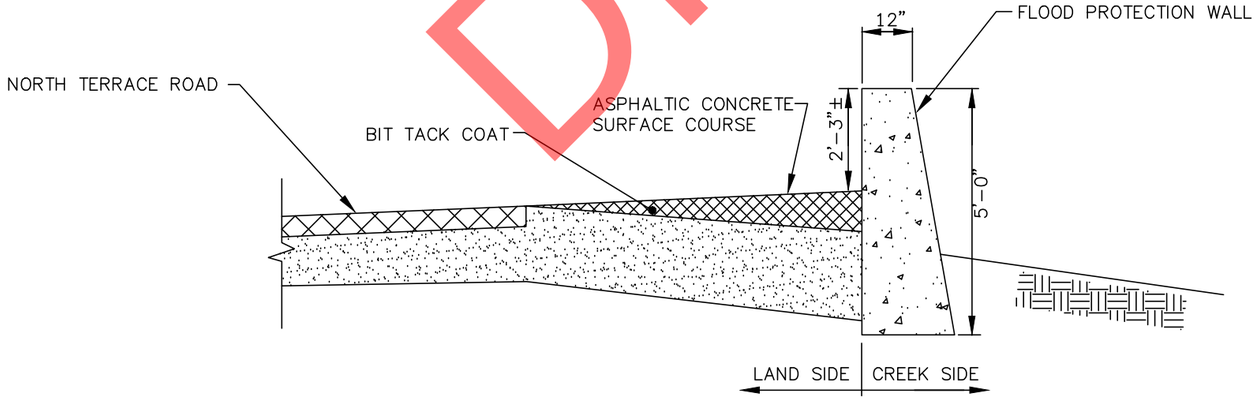
TYPICAL LEVEE SECTION "A"



TYPICAL LEVEE SECTION "B"



TYPICAL LEVEE SECTION "C"



TYPICAL LEVEE SECTION "D"

Cranston Engineering Group, P.C.
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BRAINERD LEVEE
COMPLIANCE DETERMINATION

TYPICAL CROSS-SECTIONS

JOB No.	SCALE	DATE
2010-0315	NONE	APRIL 30, 2012

FIGURE NUMBER
2-1

Table 2.2: Levee Sections

LEVEE SECTION	CROSS SECTION TYPE [1]	ACCESS ROUTES [2]	SPECIAL FEATURES
South Chickamauga - Moore Drive to I-75 Roadway	A	Ramp at Bonnieway Street; gravel road and ramp behind Brainerd High School; Brainerd Road; gated drive off Cornelison Road	Power line crossings; water line crossings; sewer line crossings; Pump Station No. 1
I-75 / I-24 - Road shoulder from near bridge over S. Chickamauga Creek to within 565 feet of Spring Creek Road overpass	B	I-75 northbound & I-24 westbound; Cornelison Road at East Gate Mall; East Gate Loop	Fiber optics line parallels interstate; traffic sign poles; adjacent to mall and residential area; Pump Station No. 2
Pump Station No. 3 - I-24 to Spring Creek Road overpass	C	I-24 westbound; Miller Road	Protects Pump Station No. 3 and houses
Floodwall	D	North Terrace Road; Spring Creek Road	Two gate closures associated with the wall section

[1] See Figure 2-1.
[2] Dry levee access routes; for high water access see Appendix A and Table 5.8

2.4.1.1 *South Chickamauga Section*

This section of the levee extends from Moore Road to I-75 for a distance of 17,379 linear feet. The embankment cross section has a maximum height of approximately 35 feet, a crest width of 14 feet and 2.5:1 slopes on both faces of the dike. The crest has a gravel pedestrian walkway / bikeway along nearly its entire length and grass cover elsewhere. The exception to the above cross section is a small plug of embankment used in the drainage ditch at I-75. Here the crest is still about 14 feet wide, but the slopes are 5 or 6:1. A typical view of the South Chickamauga Section is shown in Figure 2-2.

Figure 2-2

2.4.1.2 *Interstate Section*

This section of the levee system extends from about 200 feet west of South Chickamauga Creek to near the Spring Creek Road overpass for a distance of 4,356 linear feet. The interstate highway was existing when the embankment levee sections were constructed and the interstate roadway embankment was by necessity incorporated into the levee system. The interstate roadway at this location is constructed of compacted fill over existing natural terrain. The shoulder point on the north side of the interstate embankment has been used as the reference and field staked baseline. The interior embankment slope for this section has a 3.5 to 4:1

inclination. The minimum crest width is where there are only two travel lanes with paved shoulders adjoined by grassed shoulders for a total crest width of some 50+ feet. The height of the interior shoulder point above natural grade varies from 2 to 20 feet. A typical view of the section is shown in Figure 2-3.

Figure 2-3

2.4.1.3 *Pump Station No. 3 Section*

A short, 570 foot long section of levee embankment was constructed between Pump Station No. 3 and Interstate 24. This section leaves the interstate embankment and then turns parallel to the interstate until it terminates at the Spring Creek Road overpass embankment near Pump Station No. 3. This section of levee has a 10 foot crest width with 2:1 inclination on the interior slope and creekside slope. The maximum height of this embankment is 21 feet and the entire surface is grass covered. A typical view of this section is shown in Figure 2-4.

Figure 2-4

2.4.1.4 *Floodwall*

The floodwall section of the levee begins on the west side of Spring Creek Road and extends some 2018 feet along the southern road shoulder of North Terrace Road. This gravity-type concrete wall is generally some two to four above road grade. Typical views of the floodwall section are shown in Figures 2-5 and 2-6.

Figure 2-5

Figure 2-6

2.4.2 ***Special Features***

2.4.2.1 *Bank Protection*

In addition to the grass vegetation covering the levee slopes, riprap bank protection is provided at one location along the levee. The creekside slope on both sides of the Brainerd Road bridge together with the slope under the bridge have been provided with extra riprap. Granite riprap has been placed from the toe of slope to the crest of slope and extends approximately 200 feet on either side of the bridge. A view of the stone riprap is shown in Figure 2-7.

Figure 2-7

2.4.2.2 *Greenway*

In 2008, the City of Chattanooga opened access to the crest of a portion of the levee to the public as part of the South Chickamauga Greenway. The greenway provides a walking/bike path that runs for a number of miles along the creek.

The 3.3 miles of the levee between Moore Drive and I-75 have been made a part of the greenway. This has resulted in an 8 foot wide asphalt surface treatment path being installed on the crest of the levee. Access steps and a handicapped ramp have been provided near the Moore Drive end. Benches have been placed periodically along the route and mile marker posts have been installed to inform users of distances traveled. Views of the greenway features are shown in Figures 2-8 and 2-9.

Figure 2-8

Figure 2-9

2.4.3 ***Gates***

2.4.3.1 *Pump Station No. 1 Gates (Station 118+25)*

Three 7' x 7' slide gates are built into the building structure for Pump Station No. 1. Normal gravity flow of internal drainage passes through these gate openings and on to South Chickamauga Creek. During times of flooding, these gates are closed using motor operated mechanisms and the pump station is activated. These gates are identified as Gates #1, #2 and #3 in TVA drawings. Drawings 101-19E225-1 through

101-19E230-2 in Appendix C3 show the construction details of these gates. Views of the gates are shown in Figures 2-10 and 2-11.

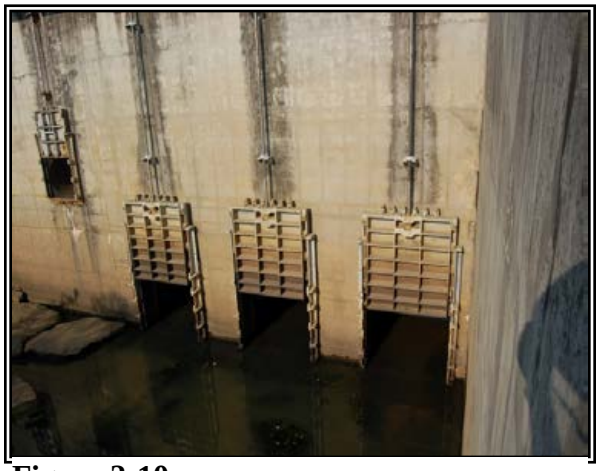


Figure 2-10

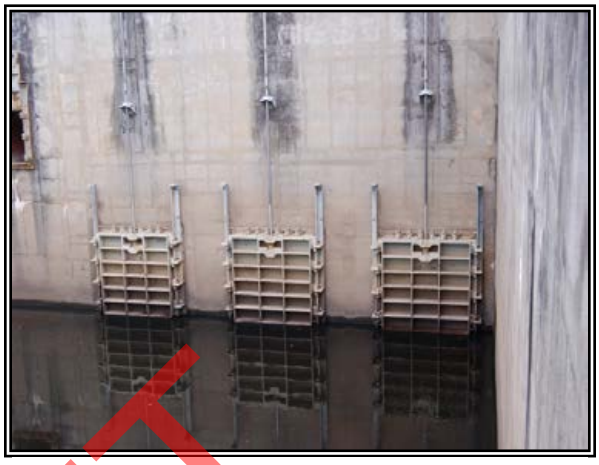


Figure 2-11

Five smaller 4’ x 4’ slide gates are also located at this pump station. These gates are located at the discharge of the five pumps and are normally always open. During a very high flood they can be closed to prevent backflow into the pump station. These gates are identified as Gates #4, #5, #6, #7 and #8 in the TVA drawings. Drawings 101-19E225-1 thru 101-19E230-2 in Appendix C3 show the construction details of these gates. A view of the gates is shown in Figure 2-12.

Figure 2-12

2.4.3.2 *Pump Station No. 2 Gates (Station 204+50)*

Pump Station No. 2 has a 48 inch diameter gravity discharge pipe which is tied to a 5' x 40' discharge chamber. On each end of the chamber are 3' x 3' motor operated slide gates. Normal flows are routed by gravity through these open gates and on to West Chickamauga Creek. During times of flooding these gates are closed and the pump station is activated. These gates are identified as Gates #9 and #10 in TVA drawings. Drawings 101-19E235-1 through 101-19E235-5, 101-19E245-1, and 101-19E245-2

in Appendix C3 show the construction details of these gates. Views of the gates are shown in Figures 2-13 and 2-14.

Figure 2-13

Figure 2-14

2.4.3.3 *Pump Station No. 3 Gate (Station 304+90)*

A single, 3' x 3' manually operated gate is built into the discharge chamber at Pump Station No. 3. Normal flow is routed by gravity through this gate and on to Spring Creek. During times of flooding this gate is closed and the pump station is activated. This gate is identified as Gate #11 in the TVA documentation. Drawings 101-19E240-1 through 101-19E240-4 and 101-19E246 in Appendix C3 show the construction details of this gate.

2.4.3.4 *North Terrace Road Gate #12 (Station 311+00)*

A single, 3' x 3' manually operated slide gate is mounted on the end of the inlet wing wall of a 36 inch gravity pipe passing under North Terrace Road and the floodwall section of Brainerd Levee. This gate is normally closed and any flow reaching it continues on to Gate #13 described below. In times of flooding, Gate #12 is opened so that runoff water in this area passes into the pipe and is routed to the inlet side of Pump Station No. 3. This gate is designated as Gate #12 in TVA documentation. Drawings 101-19E212-1, 101-19E212-2 and 101-19H260-1 in Appendix C3 show the construction details of this gate. Views of the gate are shown in Figures 2-15 and 2-16.

Figure 2-15

Figure 2-16

2.4.3.5 *North Terrace Road Gate #13 (Station 315+45)*

A single, 4' x 4' manually operated slide gate is located in a concrete structure built on the inlet end of a 48 inch diameter gravity pipe which passes under North Terrace Road and the Brainerd Levee floodwall. During times of normal flow stormwater reaches this open gate and passes on to Spring Creek. When flooding situations occur, this gate is closed which forces the water to Gate #12 as described above. After flooding conditions recede, the gate is re-opened to drain the area. This gate is designated as Gate #13 in TVA documentation. Drawings 101-19E212-1, 101-19E212-2 and 101-19H260-1 in Appendix C3 show the construction details of this gate. Views of the gate are shown in Figures 2-17 and 2-18.

Figure 2-17

Figure 2-18

Drawings 104-19E200-1 through 104-19E265-2 in Appendix C3 show slide gate arrangement and details for each type of gate.

2.4.4 *Pump Stations*

There are three pump stations which transfer stormwater runoff from the interior of the levee system to the creekside during times of flooding. Each has an associated storage basin which holds excess water in preparation for pumping.

2.4.4.1 *Pump Station No. 1 (Station 118+50)*

Pump Station No. 1 is located some 2,200 feet north of Brainerd Road and is constructed into the levee embankment. This station is equipped with three gated concrete channels for normal gravity flow and five low head centrifugal stormwater pumps. The five pump discharge pipes are also fitted with closure gates. Each pump is driven by a 350 HP motor and can transport water at a rate of 50,000 gpm. A 13 feet deep concrete pump suction basin is built into the landside of the structure.

When water rises out of the banks of South Chickamauga Creek and the floodwaters reach a pre-set level, the gravity flow gates are closed and pumps placed in automatic operation. Float switches monitoring water level on the landside of this structure control when the first pump is turned on. If the water keeps rising the second, third, fourth and fifth pumps are turned on sequentially. As the floodwater recedes at the end of the storm event, the pumps are turned off in order and then the gravity gates are re-opened.

In the event that greater than the design flood occurs and the floodwater level reaches near the top of levee, the pumps are turned off, the five pump discharge gates closed, and the station is shut down.

Drawings 101-19E225-1 through 101-19E230-2 in Appendix C3 show the construction details of this pump station. Views of Pump Station No. 1 are shown in Figures 2-19 through 2-22.

Figure 2-19

Figure 2-20

Figure 2-21

Figure 2-22

2.4.4.2 *Pump Station No. 2 (Station 204+75)*

Pump Station No. 2 is located on the south side of East Gate Mall near the intersection of Cornelison Road and Eastgate Loop. The structure is located just to the landside of the toe of the interstate roadway which forms this section of levee. It was constructed at this location because there was already a 48 inch concrete storm pipe in place to carry gravity stormwater flow. This station is equipped with two slide gates to control gravity flow and three low head centrifugal stormwater pumps. Each pump is driven by a 50 HP motor and can transport water at a rate of 12,000 gpm. The station has an underground pump suction basin and a gravity drainage control basin.

Upon the rise of water out of the banks of West Chickamauga Creek and Spring Creek and the rising of water above a pre-set level, the gates in the gravity drainage control basin are closed and the pumps are placed in automatic operation. Electrodes monitoring water level in the suction basin turn on the first pump when water reaches a pre-set level. The second and third pumps are sequentially turned on if the water keeps rising. As the floodwater recedes the pumps are turned off in order and then the gates to the gravity drainage structure are re-opened. Views of Pump Station No. 2 are shown in Figures 2-23 and 2-24.

Drawings 101-19E235-1 through 101-19E235-5 in Appendix C3 show the construction details of this pump station.

Figure 2-23

Figure 2-24

2.4.4.3 *Pump Station No. 3 (Station 305+00)*

Pump Station No. 3 is located on the landside of the short levee embankment section just east of Spring Creek Road. It is located to the landside of the toe of slope. The structure was constructed at this location because there was already a 36 inch concrete storm pipe in place to carry gravity stormwater flow. This station is equipped with one slide gate to control gravity flow and two low head centrifugal stormwater pumps. Each pump is driven by a 50 HP motor and can transport water at a rate of 12,000 gpm. The station has an underground pump suction basin and a gravity drainage control basin.

Upon the rise of water out of the banks of West Chickamauga Creek and Spring Creek and the rising of water above a pre-set level, the gate in the gravity drainage control basin is closed and the pumps are placed in automatic operation. Electrodes monitoring water level in the suction basin turn on the first pump when water reaches a pre-set level. The second is turned on if the water keeps rising. As the floodwater recedes the pumps are turned off in order and then the gate to the gravity drainage structure is re-opened. Views of Pump Station No. 3 are shown in Figures 2-25 and 2-26.

Drawings 101-19E240-1 through 101-19E240-4 in Appendix C3 show the construction details of this pump station.

Figure 2-25

Figure 2-26

2.4.5 ***Monitoring Control Stations***

The levee system is provided with two identical remote monitoring stations for the purpose of determining when rising floodwaters have reached a level to trigger closing of gravity flow control gates and placing the stormwater pumps in automatic control position. These structures are hollow square columns built on spread footings. A top chamber holds an electrode unit which hangs into the hollow column. The columns have small, 3" square holes on each of the sides which allow water to enter the inside of the column and seek the same level as the flood waters flowing by. The smallness of the holes helps to create a "stilling" basin where the electrodes hang so that waves or currents do not cause erroneous measurements. An aluminum hatch on the top chamber gives access to the electrodes and electrical hookup. Drawing 101-19E220 in Appendix C3 shows the construction details of these monitoring stations. Views of the stations are shown in Figures 2-27 and 2-28.

Figure 2-27

Figure 2-28

2.4.5.1 *South Chickamauga Monitoring Station*

Also identified as Monitoring Station No. 1 on TVA drawings, this structure is located at the top of bank on the west side of South Chickamauga Creek. It is positioned at levee Station 124+25 and 265 feet to the east. Control to the station appears to be underground and likely connects directly to Pump Station No. 1. However, the route of such underground wires is unknown. This monitoring station is utilized in the operation of Pump Station No. 1 only.

2.4.5.2 *West Chickamauga Creek Monitoring Station*

Located at the confluence of Spring Creek and West Chickamauga Creek, this structure is also referred to as Monitoring Station No. 2 in TVA drawings. The station is sited on the top of bank of West Chickamauga Creek some 1,500' east of Pump Station No. 2. Control is via overhead telephone lines which report to the Moccasin Bend Wastewater Plant. Access to the structure is only from the I-75 road

shoulder by foot. This monitoring station is used to control both Pump Station No. 2 and Pump Station No. 3.

2.4.6 ***Ponding Areas***

Ponding areas are temporary holding basins which were provided at each pump station to maintain a buffer to account for the fact that storm inflow and pumping rates are not always the same. The ponding areas vary in size depending upon the pumping rate of the particular station. An overview of these areas is shown in Figure 2-29.

2.4.6.1 *Ponding Area No. 1*

This ponding area is associated with Pump Station No. 1. It is actually a series of areas connected by ditches and piping, and it extends from the Boyd Buchanan School (Station 38+00) to the south side of Brainerd Road (Station 156+00). It was constructed primarily in the old meander loops of South Chickamauga Creek after the creek was straightened. Ponding Area No. 1 has a surface area of approximately 155 acres and a depth of some five to seven feet. Thus, the available storage is about 591 acre-feet. All of the ponding area is on City property.

2.4.6.2 *Ponding Area No. 2*

Associated with Pump Station No. 2, this ponding area includes the ditches parallel to the interstate on both sides of the structure. It also includes water storage of less than one foot of depth in the streets adjacent to the pump station. The area of ponding is approximately 21 acres (at various depths) and the storage is estimated at 30 acre-feet. Some of the ponding is off City property.

2.4.6.3 *Ponding Area No. 3*

This ponding area serves Pump Station No. 3. It includes the ditches and swales draining to the pump station as well as the yard outside of the structure, several adjoining yards and the nearby streets. Ponding in streets is less than one foot in depth. The area of ponding is approximately 23 acres (at various depths), and the storage is estimated at 16 acre-feet. Some of the ponding is off City property.

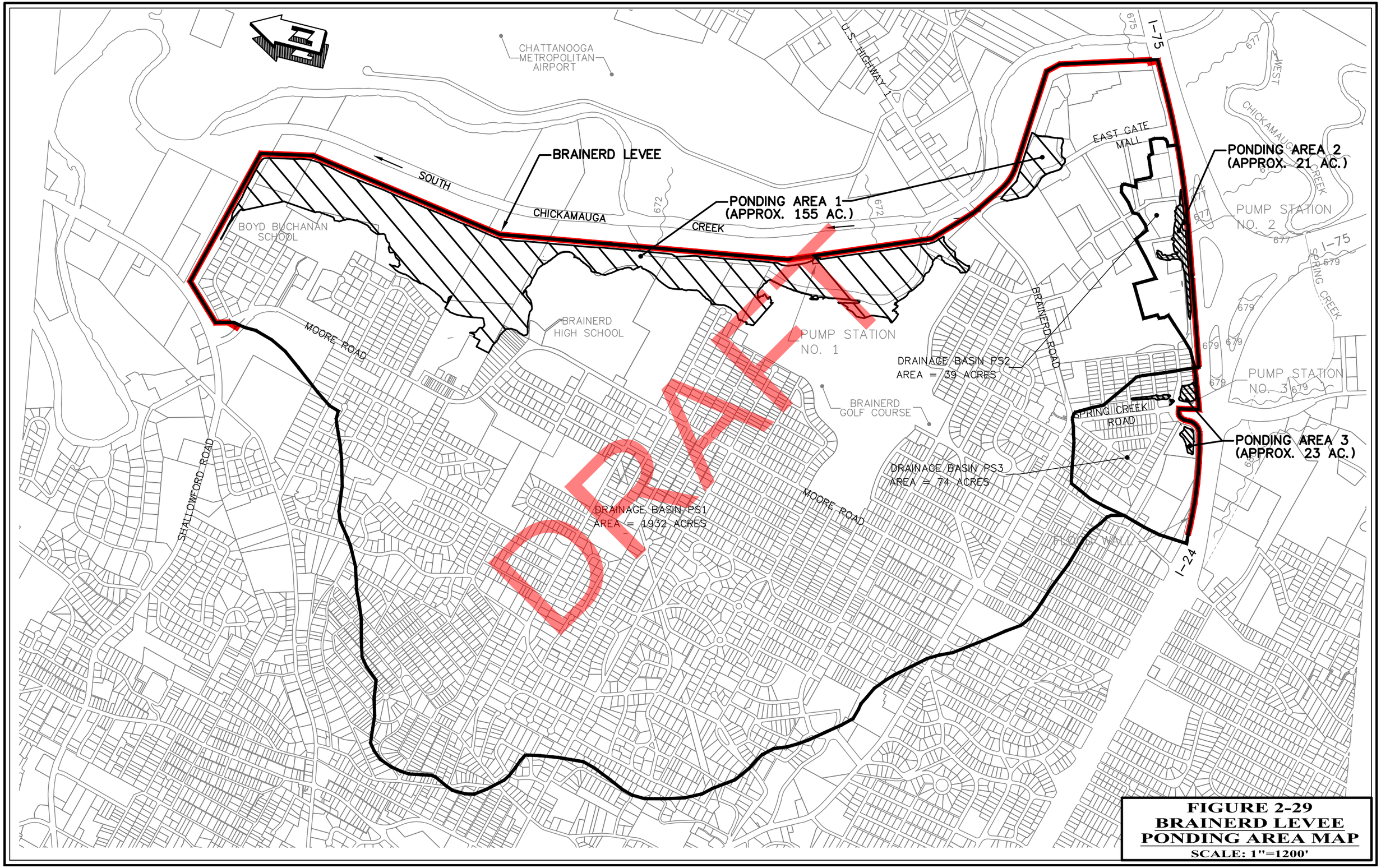


FIGURE 2-29
BRAINERD LEVEE
PONDING AREA MAP
SCALE: 1"=1200'

CHAPTER 5

FLOOD FIGHT

5.3.3.7 *Prepare to set up Emergency Operations Center:*

5.3.3.7.1 Prepare for round-the-clock operation for as much as 5-1/2 days.

5.3.3.7.2 Have list of contacts (Table 5.4, above).

5.3.3.7.3 Arrange telephone/radio communications between center and operating crews.

5.3.3.8 *Arrange for temporary, emergency lighting for night time operations on levee.*

5.3.3.9 *Make provisions for removal of drift at bridges crossing the river.*

5.4 Flood Operations

5.4.1 *General*

Having completed the PRE-FLOOD instructions, the next step in the flood fight is to close the gate structures and crossings. The expected size of the coming flood dictates which parts are to be closed. For any flood which is predicted to have a crest at elevation 653.45 or higher at Monitoring Station No. 1 or 667.97 (NAVD 1988) or higher at Monitoring Station #2, all pump stations will be in automatic flood control mode. Only on the prediction of an extremely high flood will it be necessary to completely close the levee.

5.4.2 *Closings*

Table 5.5 lists the order of closings based on the predicted gage reading at the Gaging Station. Table 5.5 also references detailed closing instructions for each gate and crossing. Operating instructions are shown in Section 5.4.4

Table 5.5: Order of Closing and Pumping Operations

PUMP[2] /GATE[3] /CROSSING	GAGES (EL., NAVD 1988)		REFERENCE INSTRUCTION SECTION[1] /REMARKS
	Monitoring Station #1	Monitoring Station #2	
All sluice gates are fully **OPEN**, except #12, which is **CLOSED**; All pumps set to **MANUAL** mode	<653.43	<667.43	Section 5.4.4.2; Normal operating condition, below flood stage
Pump Station 1 (PS-1): Switch all pumps to **AUTOMATIC** mode **CLOSE** Sluice Gates # 1, 2, 3	653.43	N/A	Section 5.4.4.3.1; Signal is sent to Alarm Moccasin Bend Sewage Treatment Plant to dispatch personnel to PS-1
Pump 1 **ON** (PS-1)	653.93	N/A	Section 5.4.4.3.1c
Pump 2 **ON** (PS-1)	654.43	N/A	Section 5.4.4.3.1c
Pump 3 **ON** (PS-1)	654.93	N/A	Section 5.4.4.3.1c
Pump 4 **ON** (PS-1)	655.43	N/A	Section 5.4.4.3.1c
Pump 5 **ON** (PS-1)	655.93	N/A	Section 5.4.4.3.1c
Pump Station 2 (PS-2) & 3 (PS-3): Switch all pumps to **AUTOMATIC** mode **CLOSE** Sluice Gates # 9, 10 Pump Station 3 (PS-3): **CLOSE** Sluice Gates # 11 **OPEN** Sluice Gate #12 at Spring Creek Road	N/A	667.43	Section 5.4.4.3.3; Signal is sent to Alarm Moccasin Bend Sewage Treatment Plant to dispatch personnel to PS-2 and PS-3

CLOSE Sluice Gate #13 under North Terrace Road **CLOSE** Flap Gate in concrete wall at North Terrace Road			
Pump 6 **ON** (PS-2)	N/A	668.93	Section 5.4.4.3.3c
Pump 7 **ON** (PS-2)	N/A	669.43	Section 5.4.4.3.3c
Pump 8 **ON** (PS-2)	N/A	669.93	Section 5.4.4.3.3c
Pump 9 **ON** (PS-3)	N/A	668.93	Section 5.4.4.3.3d
Pump 10 **ON** (PS-3)	N/A	669.43	Section 5.4.4.3.3d
(For any flood crest predicted to exceed elevation of 680± ft and flood waters begin to flow over I-24/I-75 interchange: all sluice gates shall be **OPENED** (except 4-8 and 12, they shall be **CLOSED**), and pump stations **SHUT-OFF** and electrical power source disconnected. See section 5.4.4.4			

[1] Reference: See section 5.4.4, herein, for flood relief operation instructions as originally determined by the Tennessee Valley Authority, 1980. Also, see Appendix B2 for detailed electrical operating instructions for the pumping stations.

[2] Pump: Pump numbering is based on the original TVA operations manual, 1980, and is also reflected in Plan/Profile Maps in Appendix C1.

[3] Gate: In the event that interior flooding causes the detention basin (landside) at PS-1 to rise above elevation 659.93 and the South Chickamauga Creek (SCC) is below the top of the sluice gates (El 655.93), the gates should be toggled open to the interior water to drain out. This should be closely monitored for the event that the SCC rises again and the gates need be closed. See section 5.4.4.3.1d for further explanation and details.

N/A – Not Applicable

5.4.3 *Pre-operation Instructions*

Prior to initiating the closures, the Chattanooga City Engineer should:

a. Determine the predicted flood crest and when it will occur.
b. Based on this information and Table 5.5, decide which closings need to be made.
c. Based on closings necessary, determine how to best deploy the crews and equipment. The closing by sandbag to add freeboard requires more people, equipment, and lead time. Thus depending on the size of the predicted flood, it may be advisable to dispatch one or more crews to start sandbag closures, while directing one or more crews to start the gate closings.
d. The Chattanooga City Engineer will designate a specific time of closure of each crossing and notify affected parties of that time.
e. In closing the gates and roadway, the Chattanooga City Engineer should note that the times given in the manual to close each are calculations based on ideal assumptions of:
   1. People, materials and equipment are on hand.
   2. People, materials and equipment are immediately mobilized.
   3. Personnel closing the crossing are familiar with what they are doing.
f. Because of this, it is strongly suggested that the Chattanooga City Engineer undertake a program of trial closings to directly determine the capabilities of his personnel and equipment and to check closure times based on field results and revise accordingly.

5.4.4 *Operating Instructions for Brainerd Levee Flood Relief Plan*

5.4.4.1 *General*

a. Water surface in relocated channel is monitored at monitoring station No. 1 and water surface in West Chickamauga Creek and Spring Creek is monitored at monitoring station No. 2. The monitoring stations are connected to alarms in the Moccasin Bend Sewage Treatment Plant. An NWS Gaging

station is also on South Chickamauga Creek and can be referred to via the internet at http://water.weather.gov/ahps2/hydrograph.php?gage=chkt1&wfo=mrx

b. For location of numbered sluice gates on pumping stations and culverts, see Appendix C1.

c. All qualified personnel responsible for operating flood control gates and pumping stations shall have in their possession keys to access all appropriate pumping buildings and gate locks.

5.4.4.2 *Normal Condition*

a. Water surface in South Chickamauga Creek below elevation 653.43.

b. Water surface in West Chickamauga Creek and Spring Creek below elevation 667.43.

c. All sluice gates fully opened with the exception of No. 12 which is completely closed.

d. Pumps in all pumping stations set on NORMAL operating mode. Automatic pump control set on MANUAL operating mode.

5.4.4.3 *Operation Mode During Flooding*

5.4.4.3.1 When water surface in South Chickamauga Creek (SCC) rises to elevation 653.43:

a. Monitoring Station No. 1 sends signal to Moccasin Bend Sewage Treatment Plant causing alarm to sound.

b. Qualified city personnel go to Pumping Station No. 1 (PS-1) and check sluice gates 4, 5, 6, 7, and 8 to verify that they are fully open. City personnel switch all pumps to automatic operating mode and electrically close Sluice Gate Nos. 1, 2, and 3.

c. The first pump in PS-1 starts automatically when water surface in pumping station sump reaches elevation 653.93. Remaining four pumps start automatically and sequentially with increase of water surface in sump in 0.5-foot increments. All pumps cut off automatically and simultaneously when water surface in sump drops to elevation 653.43.

d. Water surface at PS-1 will be monitored continuously during SCC flooding. In the rare event that a local storm causes the water surface in the detention basin to rise to elevation 659.93 and the water surface in SCC is below elevation 655.93 (top of Sluice Gates 1, 2, and 3), city personnel will electrically open Sluice Gates 1, 2, and 3 and leave the pumps in automatic operating mode. Sluice Gates 1, 2, and 3 will remain open as long as the water surface in the detention basin is at a higher elevation than the water surface in SCC and the water surface in SCC remains below elevation 655.93. If the elevation of the water surface in the

detention basin drops below the elevation of the water surface in SCC or the water surface elevation of SCC rises above elevation 655.93, city personnel will electrically close sluice gates 1, 2, and 3 and leave the pumps in automatic operating mode.

e. If contact with Monitoring Station No. 1 is lost, the NWS Gaging Station elevations can be used by City personnel (See Table 5.5).

5.4.4.3.2 When water surface in SCC recedes below elevation 653.43:

a. If forecast is for continuing recession of SCC, then qualified city personnel will:

1. Electrically open sluice gates 1, 2, and 3.

2. Switch all pumps in PS-1 to MANUAL operating mode. This returns installation to normal condition.

5.4.4.3.3 When water surface in West Chickamauga Creek and Spring Creek rises to elevation 667.43.

a. Monitoring Station No. 2 sends signal to Moccasin Bend Sewage Treatment Plant causing alarm to sound.

b. Qualified city personnel go to pumping station Nos. 2 and 3 (PS-2 and PS-3) and will:

1. Switch all pumps at PS-2 and PS-3 to automatic operating mode.

2. Manually close sluice gate Nos. 9 and 10 at PS-2 and sluice gate No. 11 at PS-3

3. Manually open sluice gate No. 12 at entrance to 36-inch-diameter culvert under Spring Creek Road.

4. Manually close sluice gate No. 13 at entrance to 48-inch-diameter culvert under North Terrace Road.

c. The first pump in PS-2 starts automatically when water surface in pumping station sump reaches elevation 668.93. Remaining pumps start automatically and sequentially with increase of water surface in sump in 0.5-foot increments.

d. The first pump in PS-3 starts automatically when water surface in pumping station sump reaches elevation 668.93, and the second pump starts automatically when water surface in the sump rises to elevation 669.43.

e. All pumps at PS-2 and PS-3 stop automatically and simultaneously when water surface in sump drops to elevation 667.93.

f. Water surface at PS-2 and PS-3 will be monitored continuously during West Chickamauga Creek and Spring Creek flooding.

g. If contact with Monitoring Station No. 2 is lost, the NWS Gaging Station elevations can be used by city personnel to approximate conditions upstream (See Table 5.5)

5.4.4.3.4 When water surface in West Chickamauga Creek and Spring Creek recedes below elevation 667.43:

a. If forecast is for continuing recession of West Chickamauga Creek and Spring Creek then qualified city personnel will:

1. Manually open sluice gate Nos. 9 and 10 at PS-2 and sluice gate No. 11 at PS-3.

2. Switch all pumps at PS-2 and PS-3 to MANUAL operating mode.

3. Manually open sluice gate No. 13 at entrance to 48-inch-diameter culvert under North Terrace Road.

4. Manually close sluice gate No. 12 at entrance to 36-inch-diameter culvert under Spring Creek Road. This returns installation to normal condition.

5.4.4.4 . *Emergency Operating Condition*

5.4.4.4.1 In the event that the water surface in South Chickamauga Creek, West Chickamauga Creek, and Spring Creek rises above elevation 680 and starts flowing across Interstate Highways 24 and 75 causing flooding of the protected area.

a. Qualified city personnel go to pumping station No. 1 (PS-1) and will:

1. Electrically open sluice gate Nos. 1, 2, and 3.

2. Switch all pumps off.

3. Switch all control panels and all other electrical equipment off.

4. Disconnect outside electrical power source from PS-1

b. Qualified city personnel go to pumping station Nos. 2 and 3 (PS-2 and PS-3) and will:

1. Manually open sluice gate No. 9 and 10 at PS-2 and sluice gate No. 11 at PS-3.

2. Manually open sluice gate No. 13 at entrance to 48-inch diameter culvert under North Terrace Road.

3. Switch all pumps off at PS-2 and PS-3.

4. Switch all control panels and all other electrical equipment off at PS-2 and PS-3.

5. Disconnect outside electrical power source from PS-2 and PS-3.

5.4.4.4.2 When water surface in South Chickamauga Creek, West Chickamauga Creek, and Spring Creek recedes into the natural channels, then qualified city personnel will:

a. Restore electrical power to all pumping stations.

b. Energize all control panels, pumps, and all other electrical equipment in PS-1, PS-2, and PS-3.

c. Perform necessary tests to insure that all electrical and mechanical equipment in PS-1, PS-2, and PS-3 is functioning properly.

d. Return all pumps and sluice gates in PS-1, PS-2, and PS-3 to settings listed under NORMAL CONDITION. Return all sluice gates, on gated structures at entrance to culverts, to settings listed under NORMAL CONDITION.

5.5 Flood Watch

5.5.1 *General*

The main item of FLOOD WATCH is continuous patrol. Once high water is against the levee there are many things which could happen which would place the Levee System in danger. Table 5.6 contains a list of potential trouble signs to look for on patrol, and Table 5.7 contains areas of interest which should be closely monitored. Paragraph 5.6, Emergency Operations, contains ways to combat trouble signs if and when observed.

Table 5.6: High Water Trouble Signs

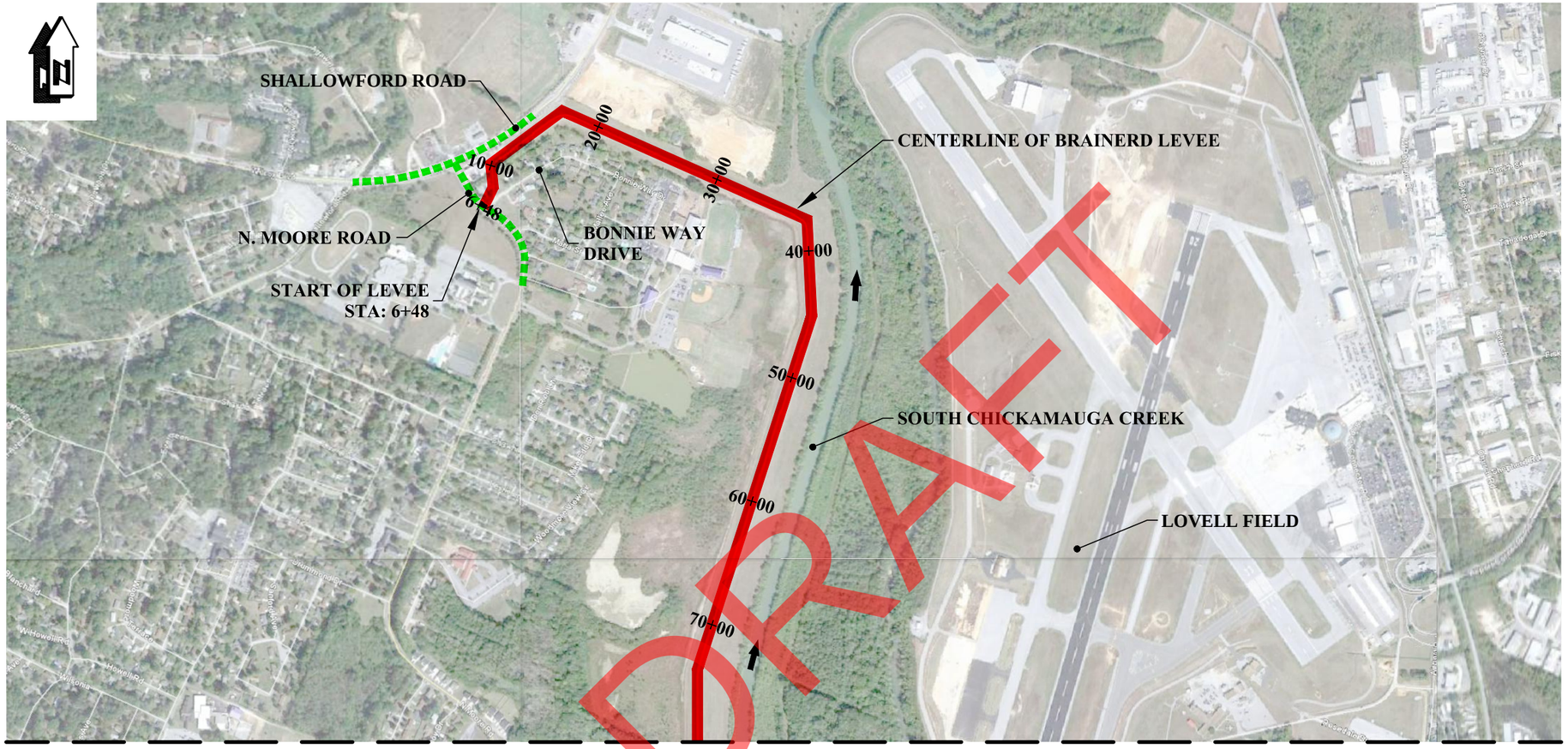
Location	Watch For	Action
Earth levee:		
Land side	saturated (wet) areas	monitor[2], drain[1], blanket[1]
	sand boils	monitor[2], sandbag ring[1]
	slides/sloughs	monitor[2], drain[1], blanket[1]
	settlement	monitor[2]
Creek side	low sections that may be over-topped	emergency topping[1]
	wave action/scour	emergency protection[1]
	drift, debris	remove
Wall sections	saturation, boils at base	monitor[2], drain[1], sandbag ring[1]
	leakage/seepage through wall	monitor[2], drain[1]
Gates	seepage along tie-in to levee	monitor[2], drain[1]
	leakage at gates	monitor[2]

[1] Instructions covered in Section 5.6 - Emergency Operations.

[2] When trouble sign is spotted, location should be marked on crest road with stake and flag to aid in relocation.

Appendix A

Levee Features and Access Routes



MATCHLINE - FIGURE A2

LEGEND

- LEVEE ROAD
- ACCESS
- LIMITED TO NO ACCESSIBILITY AT HIGH WATER (100 YEAR STORM EVENT)

* PHOTOGRAPHY OCTOBER 8, 2010

500 250 0 500 1000
SCALE IN FEET

Cranston Engineering Group, P.C.
452 ELLIS STREET, AUGUSTA, GEORGIA 30901
POST OFFICE BOX 2546, AUGUSTA, GEORGIA 30903
TELEPHONE 706-722-1588
FACSIMILE 706-722-8379
mail@cranstonengineering.com

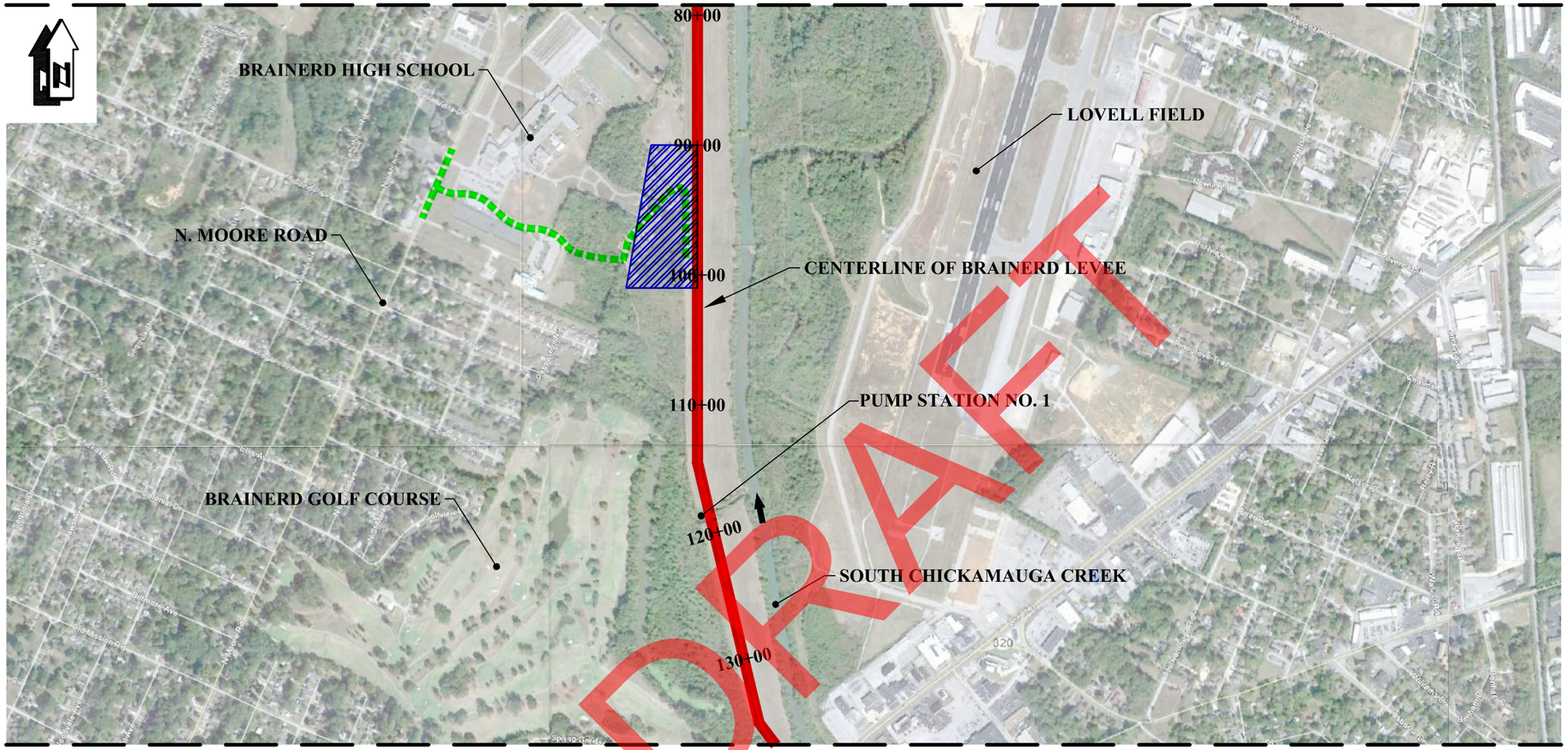
BRAINERD LEVEE
OPERATIONS AND MAINTENANCE MANUAL - APPENDIX A

LEVEE FEATURES AND ACCESS ROUTES

JOB No. 2010-0315
SCALE AS SHOWN
DATE APRIL 30, 2012

FIGURE NUMBER
A1

MATCHLINE - FIGURE A1



MATCHLINE - FIGURE A3

LEGEND

- LEVEE ROAD
- ACCESS
- LIMITED TO NO ACCESSIBILITY AT HIGH WATER (100 YEAR STORM EVENT)

* PHOTOGRAPHY OCTOBER 8, 2010

500 250 0 500 1000

SCALE IN FEET

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BRAINERD LEVEE
OPERATIONS AND MAINTENANCE
MANUAL - APPENDIX A

LEVEE FEATURES AND ACCESS ROUTES

JOB No. 2010-0315
SCALE AS SHOWN
DATE APRIL 30, 2012

FIGURE NUMBER
A2

MATCHLINE - FIGURE A2

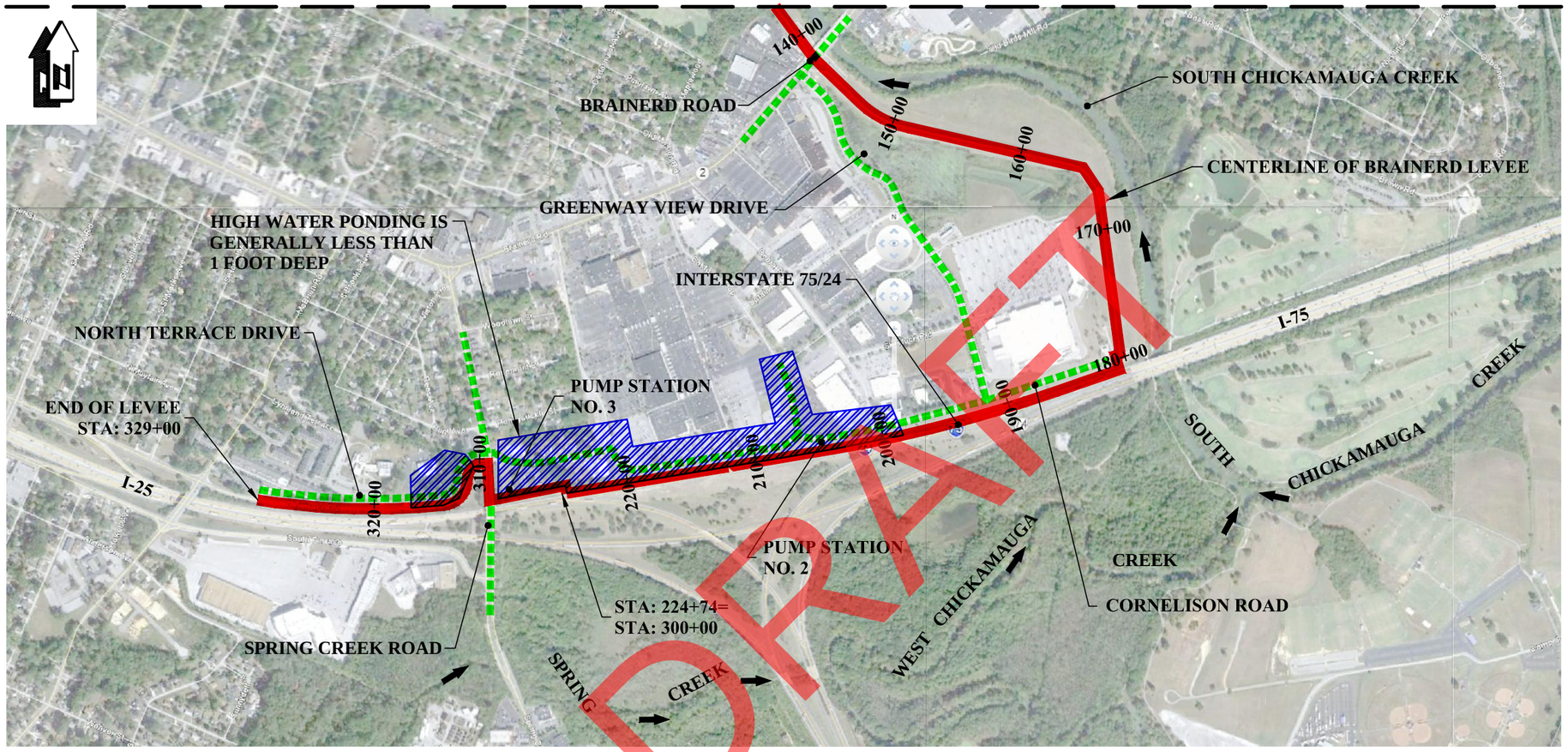

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FIGURE NUMBER
A3

Appendix B1

Operations and Maintenance Guidelines From: Title 33, Code of Federal Regulations, Chapter 2, Part 208.10, Flood Control Regulations (33 CFR 208.10)

AUTHORITY: Sec. 7, 58 Stat. 890; 33 U.S.C. 709.

§ 208.10 Local flood protection works; maintenance and operation of structures and facilities.

(a) *General.* (1) The structures and facilities constructed by the United States for local flood protection shall be continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain the maximum benefits.

(2) The State, political subdivision thereof, or other responsible local agency, which furnished assurance that it will maintain and operate flood control works in accordance with regulations prescribed by the Secretary of the Army, as required by law, shall appoint a permanent committee consisting of or headed by an official hereinafter called the ''Superintendent,'' who shall be responsible for the development and maintenance of, and directly in charge of, an organization responsible for the efficient operation and maintenance of all of the structures and facilities during flood periods and for continuous inspection and maintenance of the project works during periods of low water, all without cost to the United States.

(3) A reserve supply of materials needed during a flood emergency shall be kept on hand at all times.

(4) No encroachment or trespass which will adversely affect the efficient operation or maintenance of the project works shall be permitted upon the rights-of-way for the protective facilities.

(5) No improvement shall be passed over, under, or through the walls, levees, improved channels or floodways, nor shall any excavation or construction be permitted within the limits of the project right-of-way, nor shall any change be made in any feature of the works without prior determination by the District Engineer of the Department of the Army or his authorized representative that such improvement, excavation, construction, or alteration will not adversely affect the functioning of the protective facilities. Such improvements or alterations as may be found to be desirable and permissible under the above determination shall be constructed in accordance with standard engineering practice. Advice regarding the effect of proposed improvements or alterations on the functioning of the project and information concerning methods of construction acceptable under standard engineering practice shall be obtained from the District Engineer or, if otherwise obtained, shall be submitted for his approval. Drawings or prints showing such improvements or alterations as finally constructed shall be furnished the District Engineer after completion of the work.

(6) It shall be the duty of the superintendent to submit a semiannual report to the District Engineer covering inspection, maintenance, and operation of the protective works.

(7) The District Engineer or his authorized representatives shall have access at all times to all portions of the protective works.

(8) Maintenance measures or repairs which the District Engineer deems necessary shall be promptly taken or made.

(9) Appropriate measures shall be taken by local authorities to insure that the activities of all local organizations operating public or private facilities connected with the protective works are coordinated with those of the Superintendent's organization during flood periods.

(10) The Department of the Army will furnish local interests with an Operation and Maintenance Manual for each completed project, or separate useful part thereof, to assist them in

carrying out their obligations under this part.

(b) *Levees*—(1) *Maintenance.* The Superintendent shall provide at all times such maintenance as may be required to insure serviceability of the structures in time of flood. Measures shall be taken to promote the growth of sod, exterminate burrowing animals, and to provide for routine mowing of the grass and weeds, removal of wild growth and drift deposits, and repair of damage caused by erosion or other forces. Where practicable, measures shall be taken to retard bank erosion by planting of willows or other suitable growth on areas riverward of the levees. Periodic inspections shall be made by the Superintendent to insure that the above maintenance measures are being effectively carried out and, further, to be certain that:

(i) No unusual settlement, sloughing, or material loss of grade or levee cross section has taken place;

(ii) No caving has occurred on either the land side or the river side of the levee which might affect the stability of the levee section;

(iii) No seepage, saturated areas, or sand boils are occurring;

(iv) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged;

(v) Drains through the levees and gates on said drains are in good working condition;

(vi) No revetment work or riprap has been displaced, washed out, or removed;

(vii) No action is being taken, such as burning grass and weeds during inappropriate seasons, which will retard or destroy the growth of sod;

(viii) Access roads to and on the levee are being properly maintained;

(ix) Cattle guards and gates are in good condition;

(x) Crown of levee is shaped so as to drain readily, and roadway thereon, if any, is well shaped and maintained;

(xi) There is no unauthorized grazing or vehicular traffic on the levees;

(xii) Encroachments are not being made on the levee right-of-way which might endanger the structure or hinder its proper and efficient functioning during times of emergency.

Such inspections shall be made immediately prior to the beginning of the flood season; immediately following each major high water period, and otherwise at intervals not exceeding 90 days, and such intermediate times as may be necessary to insure the best possible care of the levee. Immediate steps will be taken to correct dangerous conditions disclosed by such inspections. Regular maintenance repair measures shall be accomplished during the appropriate season as scheduled by the Superintendent.

(2) *Operation.* During flood periods the levee shall be patrolled continuously to locate possible sand boils or unusual wetness of the landward slope and to be certain that:

(i) There are no indications of slides or sloughs developing;

(ii) Wave wash or scouring action is not occurring;

(iii) No low reaches of leave exist which may be overtopped;

(iv) No other conditions exist which might endanger the structure.

Appropriate advance measures will be taken to insure the availability of adequate labor and materials to meet all contingencies. Immediate steps will be taken to control any condition which endangers the levee and to repair the damaged section.

(c) *Flood walls*—(1) *Maintenance.* Periodic inspections shall be made by the Superintendent to be certain that:

(i) No seepage, saturated areas, or sand boils are occurring;

(ii) No undue settlement has occurred which affects the stability of the wall or its water tightness;

(iii) No trees exist, the roots of which might extend under the wall and offer accelerated seepage paths;

(iv) The concrete has not undergone cracking, chipping, or breaking to an extent which might affect the stability of the wall or its water tightness;

(v) There are no encroachments upon the right-of-way which might endanger the structure or hinder its functioning in time of flood;

(vi) Care is being exercised to prevent accumulation of trash and debris adjacent to walls, and to insure that no fires are being built near them;

(vii) No bank caving conditions exist riverward of the wall which might endanger its stability;

(viii) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged.

Such inspections shall be made immediately prior to the beginning of the flood season, immediately following each major high water period, and otherwise at intervals not exceeding 90 days. Measures to eliminate encroachments and effect repairs found necessary by such inspections shall be undertaken immediately. All repairs shall be accomplished by methods acceptable in standard engineering practice.

(2) *Operation.* Continuous patrol of the wall shall be maintained during flood periods to locate possible leakage at monolith joints or seepage underneath the wall. Floating plant or boats will not be allowed to lie against or tie up to the wall. Should it become necessary during a flood emergency to pass anchor cables over the wall, adequate measures shall be taken to protect the concrete and construction joints. Immediate steps shall be taken to correct any condition which endangers the stability of the wall.

(d) *Drainage structures*—(1) *Maintenance.* Adequate measures shall be taken to insure that inlet and outlet channels are kept open and that trash, drift, or debris is not allowed to accumulate near drainage structures. Flap gates and manually operated gates and valves on drainage structures shall be examined, oiled, and trial operated at least once every 90 days. Where drainage structures are provided with stop log or other emergency closures, the condition of the equipment and its housing shall be inspected regularly and a trial installation of the emergency closure shall be made at least once each year. Periodic inspections shall be made by the Superintendent to be certain that:

(i) Pipes, gates, operating mechanism, riprap, and headwalls are in good condition;

(ii) Inlet and outlet channels are open;

(iii) Care is being exercised to prevent the accumulation of trash and debris near the structures and that no fires are being built near bituminous coated pipes;

(iv) Erosion is not occurring adjacent to the structure which might endanger its water tightness or stability.

Immediate steps will be taken to repair damage, replace missing or broken parts, or remedy adverse conditions disclosed by such inspections.

(2) *Operation.* Whenever high water conditions impend, all gates will be inspected a short time before water reaches the invert of the pipe and any object which might prevent closure of the gate shall be removed. Automatic gates shall be closely observed until it has been ascertained that they are securely closed. Manually operated gates and valves shall be closed as necessary to prevent inflow of flood water. All drainage structures in levees shall be inspected frequently during floods to ascertain whether seepage is taking place along the lines of their contact with the embankment. Immediate steps shall be taken to correct any adverse condition.

(e) *Closure structures*—(1) *Maintenance.* Closure structures for traffic openings shall be inspected by the Superintendent every 90 days to be certain that:

(i) No parts are missing;

(ii) Metal parts are adequately covered with paint;

(iii) All movable parts are in satisfactory working order;

(iv) Proper closure can be made promptly when necessary;

(v) Sufficient materials are on hand for the erection of sand bag closures and that the location of such materials will be readily accessible in times of emergency.

Tools and parts shall not be removed for other use. Trial erections of one or more closure structures shall be made once each year, alternating the structures chosen so that each gate will be erected at least once in each 3-year period. Trial erection of all closure structures shall be made whenever a change is made in key operating personnel. Where railroad operation makes trial erection of a closure structure infeasible, rigorous inspection and drill of operating personnel may be substituted

therefor. Trial erection of sand bag closures is not required. Closure materials will be carefully checked prior to and following flood periods, and damaged or missing parts shall be repaired or replaced immediately.

(2) *Operation.* Erection of each movable closure shall be started in sufficient time to permit completion before flood waters reach the top of the structure sill. Information regarding the proper method of erecting each individual closure structure, together with an estimate of the time required by an experienced crew to complete its erection will be given in the Operation and Maintenance Manual which will be furnished local interests upon completion of the project. Closure structures will be inspected frequently during flood periods to ascertain that no undue leakage is occurring and that drains provided to care for ordinary leakage are functioning properly. Boats or floating plant shall not be allowed to tie up to closure structures or to discharge passengers or cargo over them.

(f) *Pumping plants*—(1) *Maintenance.* Pumping plants shall be inspected by the Superintendent at intervals not to exceed 30 days during flood seasons and 90 days during off-flood seasons to insure that all equipment is in order for instant use. At regular intervals, proper measures shall be taken to provide for cleaning plant, buildings, and equipment, repainting as necessary, and lubricating all machinery. Adequate supplies of lubricants for all types of machines, fuel for gasoline or diesel powered equipment, and flash lights or lanterns for emergency lighting shall be kept on hand at all times. Telephone service shall be maintained at pumping plants. All equipment, including switch gear, transformers, motors, pumps, valves, and gates shall be trial operated and checked at least once every 90 days. Megger tests of all insulation shall be made whenever wiring has been subjected to undue dampness and otherwise at intervals not to exceed one year. A record shall be kept showing the results of such tests. Wiring disclosed to be in an unsatisfactory condition by such tests shall be brought to a satisfactory condition or shall be promptly replaced. Diesel and gasoline engines shall be started at such intervals and allowed to run for such length of time as may be necessary to insure their serviceability in times of emergency. Only skilled electricians and mechanics shall be employed on tests and repairs. Operating personnel for the plant shall be present during tests. Any equipment removed from the station for repair or replacement shall be returned or replaced as soon as practicable and shall be trial operated after reinstallation. Repairs requiring removal of equipment from the plant shall be made during off-flood seasons insofar as practicable.

(2) *Operation.* Competent operators shall be on duty at pumping plants whenever it appears that necessity for pump operation is imminent. The operator shall thoroughly inspect, trial operate, and place in readiness all plant equipment. The operator shall be familiar with the equipment manufacturers' instructions and drawings and with the ''Operating Instructions'' for each station. The equipment shall be operated in accordance with the above-mentioned ''Operating Instructions'' and care shall be exercised that proper lubrication is being supplied all equipment, and that no overheating, undue vibration or noise is occurring. Immediately upon final recession of flood waters, the pumping station shall be thoroughly cleaned, pump house sumps flushed, and equipment thoroughly inspected, oiled and greased. A record or log of pumping plant operation shall be kept for each station, a copy of which shall be furnished the District Engineer following each flood.

(g) *Channels and floodways*—(1) *Maintenance.* Periodic inspections of improved channels and floodways shall be made by the Superintendent to be certain that:

(i) The channel or floodway is clear of debris, weeds, and wild growth;

(ii) The channel or floodway is not being restricted by the depositing of waste materials, building of unauthorized structures or other encroachments;

(iii) The capacity of the channel or floodway is not being reduced by the formation of shoals;

(iv) Banks are not being damaged by rain or wave wash, and that no sloughing of banks has occurred;

(v) Riprap sections and deflection dikes and walls are in good condition;

(vi) Approach and egress channels adjacent to the improved channel or floodway are sufficiently clear of obstructions and debris to permit proper functioning of the project works.

Such inspections shall be made prior to the beginning of the flood season and otherwise at intervals not to exceed 90 days. Immediate steps will be taken to remedy any adverse conditions disclosed by such inspections. Measures will be taken by the Superintendent to promote the growth of grass on bank slopes and earth deflection dikes. The Superintendent shall provide for periodic repair and cleaning of debris basins, check dams, and related structures as may be necessary.

(2) *Operation.* Both banks of the channel shall be patrolled during periods of high water, and measures shall be taken to protect those reaches being attacked by the current or by wave wash. Appropriate measures shall be taken to prevent the formation of jams of ice or debris. Large objects which become lodged against the bank shall be removed. The improved channel or floodway shall be thoroughly inspected immediately following each major high water period. As soon as practicable thereafter, all snags and other debris shall be removed and all damage to banks, riprap, deflection dikes and walls, drainage outlets, or other flood control structures repaired.

(h) *Miscellaneous facilities*—(1) *Maintenance.* Miscellaneous structures and facilities constructed as a part of the protective works and other structures and facilities which function as a part of, or affect the efficient functioning of the protective works, shall be periodically inspected by the Superintendent and appropriate maintenance measures taken. Damaged or unserviceable parts shall be repaired or replaced without delay. Areas used for ponding in connection with pumping plants or for temporary storage of interior run-off during flood periods shall not be allowed to become filled with silt, debris, or dumped material. The Superintendent shall take proper steps to prevent restriction of bridge openings and, where practicable, shall provide for temporary raising during floods of bridges which restrict channel capacities during high flows.

(2) *Operation.* Miscellaneous facilities shall be operated to prevent or reduce flooding during periods of high water. Those facilities constructed as a part of the protective works shall not be used for purposes other than flood protection without approval of the District Engineer unless designed therefor.

(Sec. 3, 49 Stat. 1571, as amended; 33 U.S.C. 701c)

[9 FR 9999, Aug. 17, 1944; 9 FR 10203, Aug. 22, 1944]

§ 208.11 Regulations for use of storage allocated for flood control or navigation and/or project operation at reservoirs subject to prescription of rules and regulations by the Secretary of the Army in the interest of flood control and navigation.

(a) *Purpose.* This regulation prescribes the responsibilities and general procedures for regulating reservoir projects capable of regulation for flood control or navigation and the use of storage allocated for such purposes and provided on the basis of flood control and navigation, except projects owned and operated by the Corps of Engineers; the International Boundary and Water Commission, United States and Mexico; and those under the jurisdiction of the International Joint Commission, United States, and Canada, and the Columbia River Treaty. The intent of this regulation is to establish an understanding between project owners, operating agencies, and the Corps of Engineers.

(b) *Responsibilities.* The basic responsibilities of the Corps of Engineers regarding project operation are set out in the cited authority and described in the following paragraphs:

(1) Section 7 of the Flood Control Act of 1944 (58 Stat. 890, 33 U.S.C. 709) directs the Secretary of the Army to prescribe regulations for flood control and navigation in the following manner:

Hereafter, it shall be the duty of the Secretary of War to prescribe regulations for the use of storage allocated for flood control or navigation at all reservoirs constructed wholly or in part with Federal funds provided on the basis of such purposes, and the operation of any such project shall be in accordance with such regulations: *Provided,*

Appendix B2

Electrical Operating Instructions for Brainerd Levee Pumping stations South Chickamauga Creek Chattanooga, Tennessee

ELECTRICAL OPERATING INSTRUCTIONS FOR BRAINERD LEVEE PUMPING STATIONS SOUTH CHICKAMAUGA CREEK CHATTANOOGA, TENNESSEE

GENERAL OPERATION

During standby periods, all three pumping stations are unmanned. At the three pumping stations the individual pump control switches are left in NORMAL position. Additionally, the common pump control switches are left in MANUAL and the gravity flow sluice gate selector switch (at pumping station No. 1) is placed in OFF position. However, when high water alarms are received at the sewage plant (as displayed on the local annunciator), city personnel must place the appropriate pumping stations in automatic control by the following process:

1. At the switchboards, place the gravity flow sluice gate (GFSG) selector switch in MANUAL (at pumping station No. 1 only).
2. Close the GFSG via the local control station at the pumping station deck (at pumping station No. 1 only).
3. Verify that the individual pump control switches are in NORMAL
4. At the switchboard, place the common control switch in AUTO. The pumping stations are now in fully automatic control. To return the pumping stations to a standby condition the procedure must be reversed.

DETAILED OPERATION OF PUMPING STATION 1

1. Pump motor circuits

When the station is under automatic control, the first pump will start 10 seconds after the water level reaches elevation 653.93. The second pump starts, if needed 20 seconds after the water reaches elevation 654.43. Likewise, if needed, the third, fourth, and fifth pumps start 30, 40, and 50 seconds after the water reaches elevations 654.93, 655.43 and 655.93, respectively. All pumps in operation stop simultaneously at elevation 653.43 with falling water level. The following explanation is for pump No. 1, other pumps are similar. (Reference TVA drawings 105-19E511-l and 105-19E511-2). The sump water level auxiliary relay contacts LlX through L5X will close on increasing water level; however, sequencing relay (10) has only one contact closed forcing the pump control circuit to start for only one water elevation. The pump can also be manually started by placing the control switch in ON. Relay P1 will be energized whenever the pump is running and drops out 2 seconds after the pump stops. If the pump should continue to operate with the sump at elevation 652.43 or less, the emergency stop relay 63-lE will open the pump breaker via shunt trip action. Whenever the pump is running the lubrication solenoid is energized, and the pump motor heater is shut off. Relay 27-1 monitors abnormal pump conditions (pump trip-out, loss of voltage, blown fuse, and breaker trip). If the pump is out of service, the pump control switch should be placed in OFF and the pump breaker tripped. The pump discharge slide gate electrically interlocks the pump preventing operation if the gate is not fully open.

2. Sequencing and Level Control

Water levels in the sump are monitored by level relays 63-1 through 63-5. These relays are set to operate at levels 653.93 through 655.93 in 1/2-foot increments and reset simultaneously at elevation 653.43. When level 653.93 is reached with rising water level timer LIT is energized. After 10 seconds water level auxiliary relay LlX picks up. When level 654.43 is reached, timer L2T is energized. After 20 seconds L2T energizes water level auxiliary relay L2X and simultaneously sends a redundant signal to energize relay LlX. This pattern is continued for levels 654.93 through 655.93 (with timing increased between steps by 10 seconds and each level sending a redundant signal to the previous circuit). Relays LlX through L5X will start the pumps selectively as determined by sequence relay(10).The sequencing circuit will start the pumps in the order 1-2-3-4-5, 2-3-4-5-1, through 5-1-2-3-4. After a pumping cycle, relay 10 will step to a new position (example: if sequence 3-4-5-1-2 is selected and pumps 3 and 4 operate only, the future sequence will be 5-1-2-3-4). Stepping is done immediately after the pumps stop. In the example given, when pumps 3 and 4 stop, relays P3 and P4 in the individual pump control circuits are deenergized but on time-delay drop out. For relay 10's stepping circuit this results in a circuit through LlX, L2X, L3X, L4X, L5T, the parallel combination of 27-1 through 27-5, P3 and relay 10's preclosed contact 1-28. Relay 10 steps to position 4 closing contact 10-29. Since P4 is still closed, relay 10 steps to position 5 closing 10-30. However, since pump 5 was not on, contact PS is open. Therefore relay 10 stops. Then, with the stepping circuit deenergized, pump No. 5 will only have sequencing relay contact 10-25 closed--ensuring that pump 5 will start via LlX only. Therefore, pump 5 will be the first to start on the next pumping cycle. The sequencing circuit is arranged so that if all pumps operate on a given pumping cycle, relay 10 will not step at all. Additionally, if any pump should trip out during pumping or be out of service the sequencing circuit will step through that pump. However, if the stepping circuit fails to operate altogether, the next pumping operation will not be affected other than not having the preferred sequence.

3. Gravity Flow Service Gates

The gates are raised or lowered from the pumping station deck. If raised the gates will rise until the raise limit switch is reached; similarly for lowering. If desired, the stop push button must be operated to stop the gate at any intermediate position. To prevent mechanical damage to the gate caused by an obstruction of movement the torque switches are arranged to shunt trip the GFSG breaker.

DETAILED OPERATION OF PUMPING STATION 2

Pumping station No. 2 is similar in operation to pumping station No, 1, except on a smaller scale. The major differences are:

1. Only three pumps available for operation versus 5.
2. Gravity flow sluice gates are manually operated,
3. Reference TVA drawing 105-19E512.

DETAILED OPERATION OF PUMPING STATION 3

Pumping station is similar in operation to pumping station No, 2 except on a smaller scale. The major differences are:

1. Only two pumps available for operation versus 3.
2. Pump sequencing is accomplished via a dual pump alternator versus a sequencing relay.
3. Reference TVA drawing 105-19E513.

ALARMS AND INDICATION

The sewage treatment plant receives five alarms:

1. South Chickamauga Creek above elevation 653.43.
2. West Chickamauga Creek above elevation 667.43.
3. Pumping station No, 1 trouble.
4. Pumping station No. 2 trouble.
5. Pumping station No. 3 trouble.

Upon reception of alarms 1 or 2 city personnel are to place the appropriate pumping stations in automatic control. In the event that the creek alarms fail to operate, pumping station sump high water alarms will give a redundant creek level alarm. When any trouble conditions are experienced at any of the pumping stations such as pump trip, loss of voltage, fuse blown, breaker trip, or level relay loss of voltage/fuse blown (additionally, at pumping station No, 1. trouble includes the transformer alarms for high temp, low liquid level, and pressure relief valve operation), city personnel should take immediate action to restore pumping station normality. Although there is only one alarm for pumping station trouble for each pumping station at the sewage treatment plant, local indication via indicating lights located on the switchboards at each pumping station will aid in isolating the condition. All alarms are sent to the sewage plant via leased South Central Bell telephone lines using amplitude modulated audio tones. The tone equipment is wired for fail-safe operation; that is, abnormal conditions prevent tone transmission. All alarms are delayed from triggering the annunciator at the sewage treatment plant for 10 seconds to prevent nuisance alarms.

Appendix C

Levee Plans and Original TVA Documents

C1. Plan/Profile Sheets

C2. 2011 Levee Compliance Determination Plans (Electronic Only)

- **A. Condition Assessment Plans – Appendix D**
- **B. As-built Maps – Appendix E**

C3. 1976 Tennessee Valley Authority South Chickamauga Creek Project (Electronic Only)
(Note that Vertical Datum is NGVD 1929.)

- **A. South Chickamauga Creek Project Plans**
- **B. Operation Manual (Original)**
- **C. Maintenance Manual (Original)**