



**US Army Corps
of Engineers**
Louisville District

VEGETATION VARIANCE REQUEST
INDIANAPOLIS WHITE RIVER NORTH
LFDRP
PHASES IIIA AND IIIC



Prepared by:
US Army Corps of Engineers, Louisville District

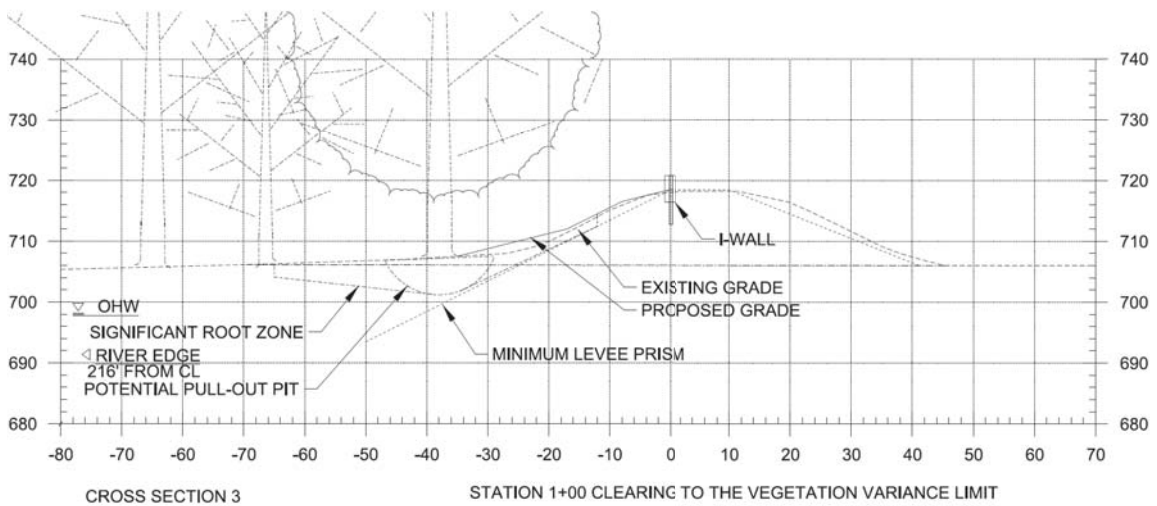
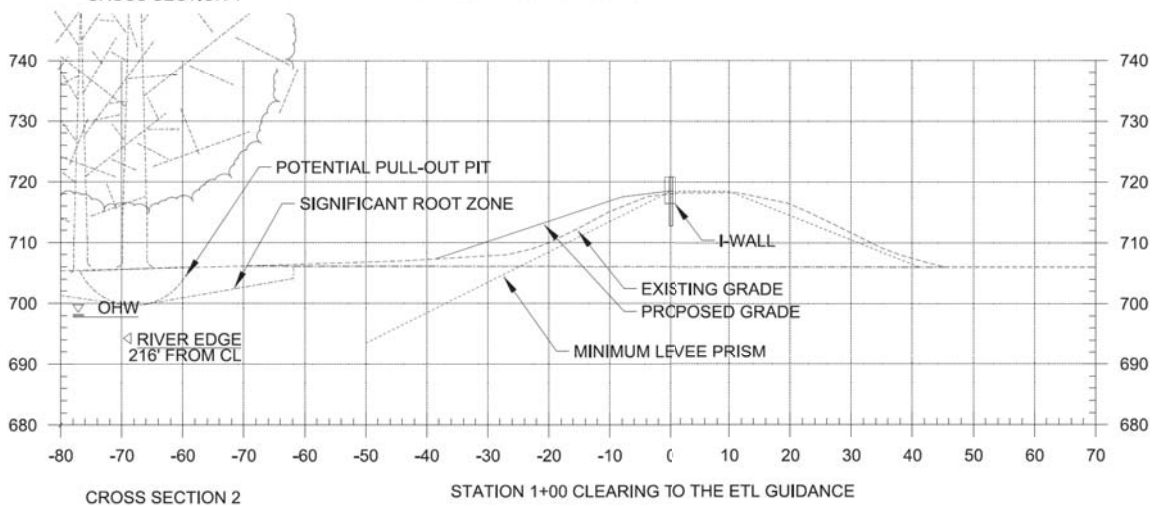
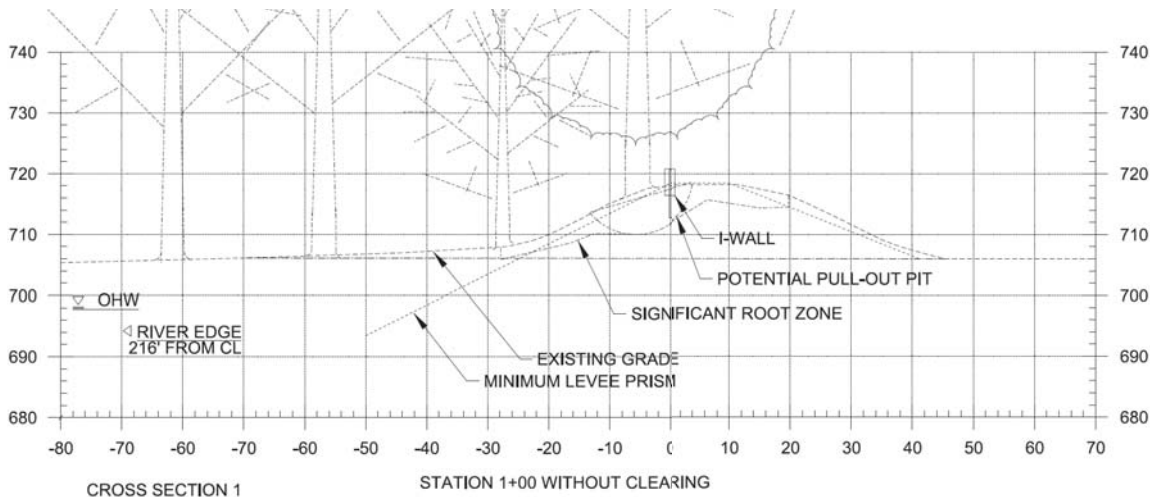
Dated: July 2016

EXECUTIVE SUMMARY

The Louisville District requests a Vegetation Variance for portions of Phases IIIA and IIIC of the Indianapolis North Flood Damage Reduction Project in accordance with ETL 1110-2-583. The district chose to follow the processes outlined in the draft USACE Policy Guidance Letter (PGL) - Process for Requesting a Variance from Vegetation Standards for Levees and Floodwalls, 77 F.R. 9637 (February 17, 2012) as a guide for documenting the analysis and rationale for the variance."

A Vegetation Variance would allow certain types and amounts of vegetation on levees and near floodwalls otherwise not permitted under ETL 1110-2-583 to remain under very site-specific circumstances. Such variances allow for the continuance of flood damage reduction benefits of levees/floodwalls while not allowing the level of protection to fall below the minimum permissible for PL 84-99 acceptability, or the levee/floodwall certification under the National Flood Insurance Program (NFIP).

The cover photo shows the current condition of Station 1+00 of Indy Phase 3A. This station is part of Variance Reach 1. The first cross section below illustrates the effects that vegetation and vegetation root systems currently have on the existing levee. The second cross section shows the amount of clearing ETL 1110-2-583 requires for station 1+00. The third cross section represents the Louisville District's proposal at station 1+00 for varying from the ETL in order to provide structural stability, functionality, access for flood fighting, and OMRR&R, while minimizing the clearing of mature riparian woody vegetation growing along the White River.



These cross sections are just a small illustration of the overall vegetation variance request. Some variance reaches preserve more trees while some preserve very few. Collectively this variance, once endorsed, will reduce the ETL required clearing by 1.82 acres. The reduction includes going from 8.4 acres to 6.9 acres on Phase 3A, and .94 acres to .62 acres on Phase 3C without sacrificing the intent of the ETL.

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References

<u>Publication #,</u>	<u>Proponent,</u>	<u>Title,</u>	<u>Publication Date</u>
1	<u>ETL-1110-2-583,</u>	CECW-CE, <i>Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures,</i>	30 April 2014, exp. 30 March 2019
2	<u>ETL 1110-2-569,</u>	CECW-EG, <i>Design Guidance for Levee Underseepage,</i>	1 May 2005
3	<u>ETL 1110-2-575,</u>	CECW-CE, <i>Phase II Interim Guidance for Evaluating Existing I-Walls,</i>	1 September 2011, exp. 1 June 2016
4	<u>EC 1110-2-6066,</u>	CECW-CE, <i>Engineering and Design: Design of I-Walls,</i>	1 April 2011
5	<u>EM-1110-2-1913,</u>	CECW-EG, <i>Design and Construction of Levees,</i>	30 April 2000
6	Policy Guidance Letter (PGL)-	<i>Process for Requesting a Variance from Vegetation Standards for Levees and Floodwalls,</i>	7 February 2012, from the <i>Federal Register/ Vol. 77, No 33/</i> Friday, Feb 17, 2012
7	<i>Design Analysis: I-Wall Evaluation and Remediation Phases IIIA and IIIC,</i>	USACE Louisville District,	September 2011
8	Geostudio 2012 Seep/W and Slope/W,	Geostudio International, Ltd.	May 2014 Release version 8.13.1.9253

Definitions

- 1 Variance Reach: The portions of the project that will not be cleared to the full width of the vegetation free zone defined by the ETL Guidance.
- 2 Phase: The overall North Indy project was broken into 3 phases for construction. This Variance addresses 2 of the phases, specifically Phase 3A and Phase 3C.
- 3 Section: A specific location of the project identified by station that visually describes the grade, below grade, and above grade perpendicular to that point of the alignment. A section can be representative of a range of stations as well.
- 4 VFZ: The vegetation-free zone is a three-dimensional corridor surrounding all levees, floodwalls, embankment dams, and critical appurtenant structures in all flood damage reduction systems. The vegetation-free zone applies to all vegetation except grass. Grass species are permitted, as described in Paragraph 4-8, for the purpose of erosion control.
- 5 ETL: The above referenced ETL-1110-2-583.
- 6 PGL: The above referenced Policy Guidance Letter (PGL).

1 AUTHORIZATION

The White River Indianapolis North Flood Damage Reduction Project was authorized by the Flood Control Acts of 1936 and 1946, 33 U.S.C. 701a-701r. The Government and the City Of Indianapolis (Local Sponsor/superintendent) have entered into a Project Cooperation Agreement (PCA) for construction of the White River Indianapolis North Flood Damage Reduction Project. Section 103 of the Water Resource Development Act (WRDA) of 1986, Public Law 99-662, as amended, specifies the cost sharing requirements applicable to the Project. Section 221 of the Flood Control Act of 1970, Public Law 91-611, as amended, and Section 103 of WRDA 1986, Public Law 99-662, as amended, provide that the Secretary of the Army shall not commence construction of any water resource project, or separable element thereof, until each Superintendent has entered into a written agreement to furnish its required cooperation for the project or separable element. The Superintendent does not qualify for a reduction of the maximum non-federal cost share pursuant to the guidelines that implement Section 103 of the WRDA 1986, Public Law 99-662, as amended.

2 INTRODUCTION

Flooding problems on the White River in Indianapolis North have been investigated at various periods since 1913, the year the White River in Indianapolis experienced the flood of record. Following the 1913 flood the City of Indianapolis developed a comprehensive plan to address flooding in the City. Since that time the City of Indianapolis worked with the Works Progress Administration to construct a levee at Rocky Ripple and Warfleigh. Construction of these levees were completed in the 1930's. In 1936 Congress authorized flood protection for the Warfleigh Sections of the Indianapolis Flood Damage Reduction Project. The project included channel improvement, levees, concrete walls and reconstruction or alteration of bridges.

A planning report was completed by the Louisville District in June 1952. This study was basically a reexamination of the authorized plan for Warfleigh. The plan considered in 1952 included extending protection to include Rocky Ripple. No changes were made regarding the length of the channel improvement, flood flow requirements, or degree of levee protection. Additional openings, ramps, wall construction, and appurtenant structures were considered necessary because of more intense development in the study area. Removal and reconstruction of several bridges would have been required. Although the report indicated a favorable benefit cost ratio of 1.2, the local flood protection plan was never finalized due to the lack of required local participation.

In 1969 the Louisville District investigated the flooding problems on the White River for the "Warfleigh Section of the Indianapolis Local Flood Protection Project but did not complete a full design. In 1995 a feasibility study was completed, in 1996 the General Reevaluation Report was completed and in 1998 the first plan set for construction of Indy North FDRP was completed. The Indianapolis North Flood

Damage Reduction Project was divided into three phases consisting of Phase IIIA, Phase IIIB, and Phase IIIC for a total length of approximately 3.8 miles of levees and floodwalls. Phase IIIA was constructed in 2004. Phase IIIC was constructed in 2009. Neither project has been completely turned over to the sponsor because the current vegetation does not meet the guidance provided by ETL 1110-2-583.

During the reconnaissance and feasibility stages of the Indianapolis North Flood Damage Reduction Project, there was extensive coordination between the U.S. Fish and Wildlife Service, the Indiana Department of Natural Resources, the Indiana State Historic Preservation Office, the sponsor – (Indianapolis Department of Public Works), the community, and the US Army Corps of Engineers (Louisville District) regarding limiting the clearing of mature trees within the project limits. However, it is not until November 2015 that a clearing limit agreement between all parties was made. The agreement is subject to the approval of this Vegetation Variance.

Flooding has occurred periodically on the White River in Indianapolis. The March 1913 flood, a 500-year event, is the flood of record for the White River in the Indianapolis area. Major floods also occurred in 1937 and 1943. In the period from 1953 through 2002, there were four significant flood events on the White River. The 1964 and the 1991 flood is estimated between a 15-year to 20-year flood event.

Since the levees were built in the 1930s, they have not been tested by high waters that threatened overtopping. The second ranking record flood occurred in 1991 and barely exceeded depths above the river side toe of levee. The point being we do not have historical evidence of the levee's performance. To this date The Corps has not been involved in flood fighting at the subject project location.

Since the 1991 flood, there have been additional flood events occurring in May 2002, July 2003, January 2005, January 2007, and most recently, March 2013. The flood in 2013 occurred during construction of Phase 3B Part 1 levee. It is the 8th highest flood stage recorded in Indianapolis history. It did not reach the toe of the river side slope.

Figure 1 is an overview of the Indianapolis North Flood Damage Reduction Project, Phases 3A and 3C. The 3A and 3C alignment totals 12,626 feet, 9,896 of which will be brought into full compliance with ETL 1110-2-583. This vegetation variance request pertains to the remaining 2,730 feet within the 6 Variance Reaches shown in Figure 1.

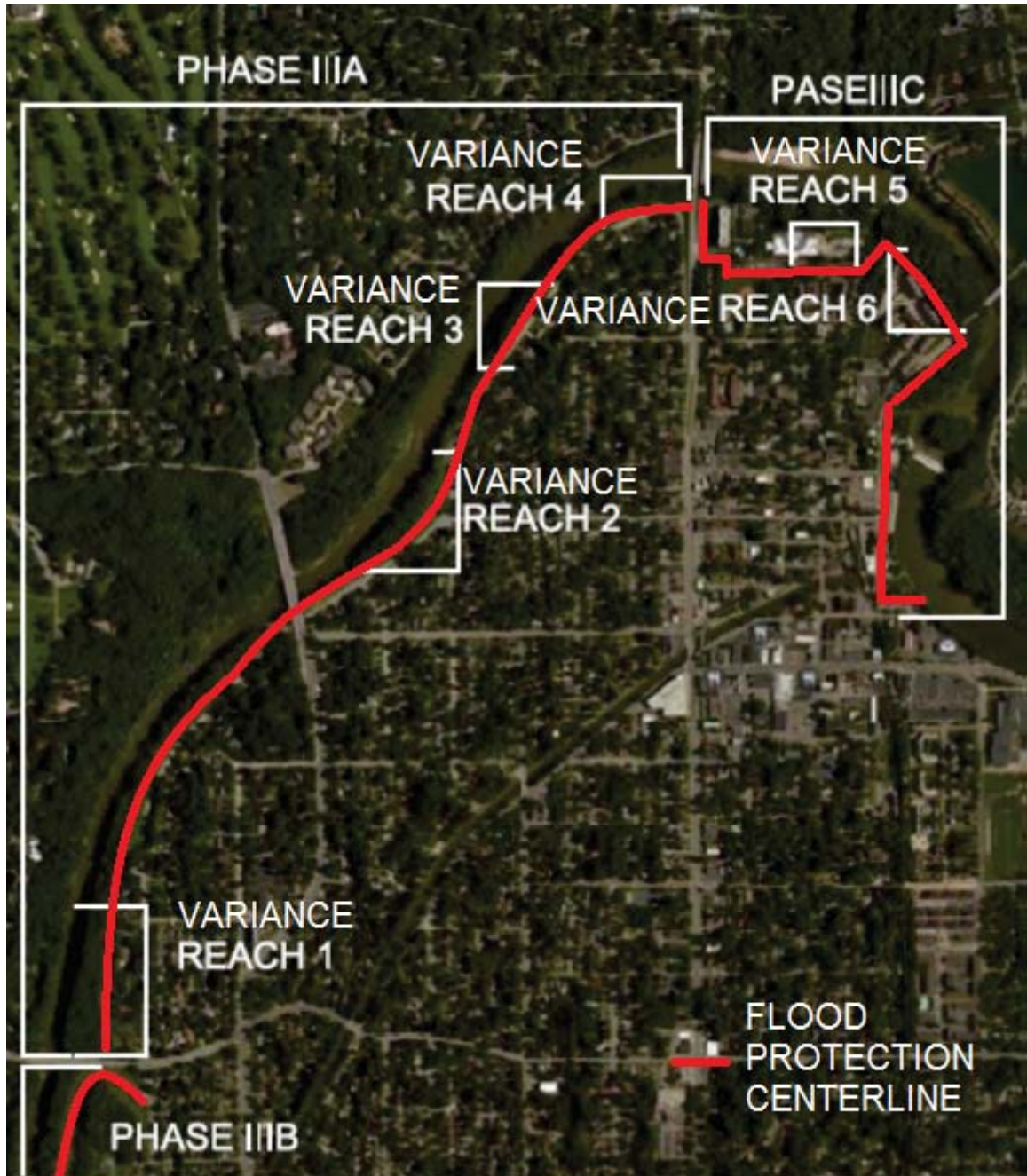


Figure 1. Indianapolis, Indiana Vegetation Variance Overview.

Phase IIIA:

Phase IIIA construction project consisted of improving the flood damage reduction elevation provided by a local existing non-federal levee (Warfleigh Levee) by raising its height by means of constructing an I-Wall along the levee crown. The I-Wall was constructed by driving sheet piling into the levee crown approximately five feet landward of the riverside edge, and covering the sheet piling with a concrete fascia.

The riverside levee slope varies from 1.5 Horizontal / 1.0 Vertical to 2.5 Horizontal / 1.0 Vertical, and is covered with mature trees and brush from the top of the river side levee crown down to the river. During construction of Phase IIIA the river side of the levee was not cleared in accordance with ETL 1110-2-583 nor was a Vegetation Variance approved. USACE has not provided final written notice of project completion to the sponsor, the completion and turn over are pending upon approval of this Vegetation Variance and completion of the required clearing and grubbing identified in the proposed clearing and grubbing contract. The sponsor currently provides Maintenance and Operation of the floodwalls and landside of the levee. No maintenance on the river side slope of the Phase 3A levee have been performed in over a decade because the sponsor is not authorized to do so prior to turnover. If the sponsor were authorized to perform maintenance it would not be feasible due to the densely vegetated cover.

The majority of the vegetation located in the ETL defined vegetation free zone (VFZ) will be cleared and grubbed by a government contract scheduled in 2017 (reference Section 3 of this document for more information on this scheduled contract work). The portions of vegetation described by Variance Reaches 1, 2, 3, and 4 (See Table 1 below) are the subject of this Vegetation Variance request and will not be cleared to the full limits of the ETL defined VFZ. In these Variance Reaches clearing and grubbing will still take place that satisfies the requirements as determined by analysis. All areas not included in the Variance Reaches will be cleared and grubbed to the full guidance of the ETL defined VFZ.

The Vegetation Variance requested for Phase IIIA will apply to approximately 1600 LF of the total 7,600 LF of levee/ I-Wall alignment in this phase. Phase IIIA generally consists of a sheet pile I-Wall system in the crown of an existing levee. At the time of the I-wall construction (2004), vegetation was only cleared to a distance of five feet from the river side face of the I-Wall (see cover photo). In the scheduled clearing and grubbing contract (2017) (see Section 3) vegetation will be removed from the river side levee slopes to widths varying from 15-40 feet from the riverside I-Wall face in the Variance Reaches. The variance would allow existing vegetation to remain within portions of the 15-foot minimum clear zone from the projected riverside levee toe in select Variance Reaches.

Phase IIIC:

Phase IIIC consisted of the construction of I-Wall and levee sections in the Broad Ripple area as well as the construction of a gate structure to control the flow of water into the Indianapolis Water Canal. The majority of this phase is constructed in an urban environment with little vegetation present in the ETL defined “vegetation free zone” with the exception of a few areas. The current scheduled clearing and grubbing contract (2017) (see Section 3) will clear and grub most of the vegetation on Phase IIIC present in the ETL defined VFZ.

The only areas not to be cleared within the ETL defined VFZ on Phase IIIC are defined by Variance Reach 5 and Variance Reach 6 (see Table 1). Variance Reach 5 is an area with I-wall only. Unlike on Phase IIIA this portion of I-wall is not constructed on top of a levee. Variance Reach 5 refers to a section of I-wall that was constructed parallel to an existing condominium complex; the I-wall has a clear and well maintained land side, but is limited to 10 feet of VFZ due to a lack of right of way from the I-Wall to the condominium building. The ETL defined VFZ in this scenario is 15 FT. The presence of the trees, shrubs, and fence do not affect the sponsor's ability to for access, maintenance or flood fighting. The variance requests approval to allow trees, fence, and shrubs to remain in the 10-15 foot portion of the ETL defined VFZ. The ETL allows for a variance in the VFZ when right of way is not attainable.

Variance Reach 6 is a section of existing levee which was increased in height by placing as much as three feet of fill in order to raise the height of the levee to reduce the potential for future flood damage (2009). This section of Phase IIIC is along a wooded portion of the river; currently mature trees and brush extend from the top of levee down to the river. Vegetation is present on the entire river side slope and obstructing the crown of the Phase IIIC levee from Sta. 25+00 to Sta. 32+00. In the current scheduled clearing and grubbing contract (2017) (see Section 3) vegetation will be removed to a width of 33 feet (measured horizontally) from the center of the levee crown. This will clear most of the ETL defined VFZ. The rest of the vegetation in this area is requested to remain as part of the variance request.

The Vegetation Variance requested for Phase IIIC will apply to approximately 630 LF of the total 4,876 LF of levee and I-wall in this phase. All other portions of Phase IIIC will be cleared and grubbed to meet the minimum guidelines of ETL 1110-2-583 as part of the clearing and grubbing government contract scheduled for 2017.

Phase IIIB:

Phase IIIB has been partially completed and is progressing toward final completion. All portions of Phase IIIB have been and will be constructed to meet the guidance provided by ETL 1110-2-583. Phase IIIB will not be discussed further in this Vegetation Variance.

3 PROPOSED CLEARING AND GRUBBING GOVERNMENT CONTRACT (2017)

The riverside slope of Phase IIIA and portions Phase IIIC of the Indy North Flood Damage Reduction Project have been constructed in a manner that is *NOT* acceptable to provide structural integrity, functionality or accessibility for operation, maintenance, repair, inspection, monitoring, and flood fighting of these phases of the levee system.

The sheet pile I-wall that was constructed in 2004 will not properly function unless the levee foundation it sits on is regularly and properly maintained. This has not happened in over a decade and will continue to provide an increased risk of flooding.

All of Phase IIIA and portions of Phase IIIC will require the clearing and grubbing of existing vegetation present in the areas identified by the ETL defined VFZ. Plans and specifications have been prepared for contract work for clearing and grubbing required to complete the two phases prior to final notice of construction completion and full assumption by the local sponsor of all operation and maintenance requirements. See Appendix A for the clearing and grubbing plans.

The current plans to complete Phase IIIA and Phase IIIC still do not completely remove all of the vegetation to meet the guidance of ETL 1110-2-583 even though all of the areas will have some clearing executed. The scheduled clearing and grubbing project seeks to preserve vegetation in 6 specific Variance Reaches. Preservation of vegetation in these areas is necessary for the following reasons;

- Providing the sponsor with a consistent VFZ rather than one that significantly varies from station to station based on levee overbuild and undulating topography which affects the definition of the riverside levee toe.
- Meeting the request of the sponsor, Federal and State resource agencies and the residents of the community to give a diligent effort to limit loss of high quality, mature bottomland hardwood vegetation and corresponding wildlife habitat, including for the Indiana bat.
- Lack of needed Real Estate to clear to the ETL defined VFZ.
- Minimizing the loss of vegetation and wild life habitat in portion of levees that are overbuilt or have benched area. (See section 4).

The areas that do not satisfy the ETL defined VFZ meet the standards outlined in the Policy Guidance Letter- *Process for Requesting a Variance from Vegetation Standards for Levees and Floodwalls* dated February 7th, 2012. The clearing and grubbing contract (currently scheduled in FY 2017) will commence only after the completion and approval of this Vegetation Variance Request.

4 DESCRIPTIONS OF VARIANCE REACH 1 THROUGH 6

The Variance Reaches described below are only those areas that will not be fully cleared to the ETL defined VFZ during the scheduled clearing and grubbing contract (2017) (see Section 3) and are the subject of this Vegetation Variance request. They are identified in this report as Variance Reach 1 – 6. In each of the 6 Variance Reaches some clearing and grubbing is included in the scheduled clearing and grubbing contract but not the entire ETL defined VFZ. The 6 levee Variance Reaches are discussed below and outlined in Table 1:

Table 1. Variance Reach Outline

Variance Reach	Phase	Station begin	Station end	Total Length Ft	Clearing width, ft. (Proposed)	ETL defined VFZ (Average Width, ft.)	Variance Reach total length, ft.
1	IIIA	0+00	4+00	400	35	65	570
1	IIIA	4+00	5+70	170	40	46	
2	IIIA	43+00	45+50	250	35	42	750
2	IIIA	45+50	49+00	350	15	75	
2	IIIA	49+00	50+50	150	35	43	
3	IIIA	57+20	61+00	380	40	43	380
4	IIIA	73+00	77+00	400	35	46	400
5	IIIC	36+10	38+40	230	10	15	230
6	IIIC	25+00	32+00	700	33	33-54	400

ETL 1110-2-583 defines the minimum clearing limits and establishes the limits based on the USACE defined levee toe. The majority of the variance request comes in areas where the natural pre-project ground creates a defined riverside levee toe that requires excessive amounts of vegetation removal. If the levees were built to the minimum standards, the ETL defined VFZ would be much smaller. In some areas the entire levee is built larger than it is required and causes the ETL defined VFZ to be much wider. In other areas the base of the river side of the levee has a bench that extends the ETL defined VFZ (See Figure 2 Typical Cross-sections of Benching and Overbuild below). In both scenarios the Vegetation Variance requests approval to clear and grub less vegetation in those areas. Each Variance Reach has been analyzed at specific stations to meet the guidance of the PGL. Cross sections for every station of each Variance Reach can be found in Appendix A. Each cross section is annotated per the guidance of the PGL.

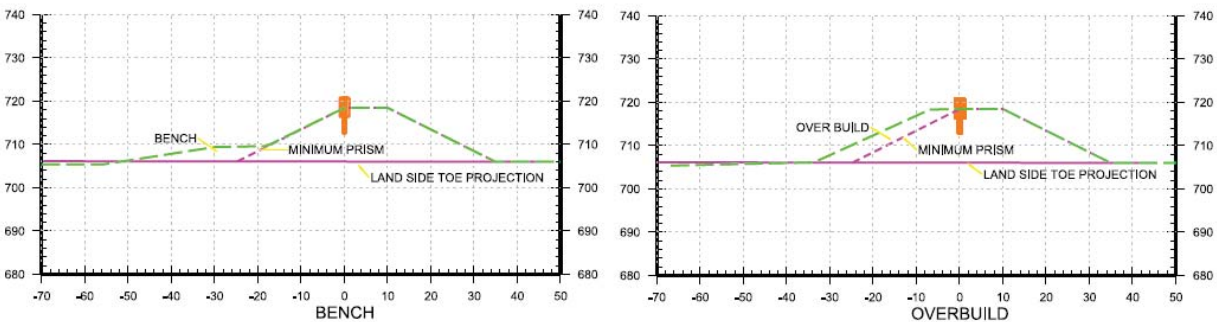


Figure 2. Typical Cross-section of Benching and Overbuild.

Variance Reach 1 - is over built and has a bench on the river side of the levee toe. This over build and bench projects the landside toe much further away from the levee crown and therefore expands the ETL defined VFZ. This Vegetation Variance requests approval to leave the variance zone identified in the cross sections on sheets CS301

and CS302 in Appendix A for the reasons listed in Section 3. Station 1+00 is shown in Figure 3 below and is an example cross section of Variance Reach 1. The cross sections shows that the proposed clearing contract would remove the likeliness of future significant tree roots and root balls from growing into the minimum analytical prism as defined in Section 7 of this document. The scheduled clearing and grubbing contract (2017) (see Section 3) will remove all of the current roots in the proposed VFZ. See Appendix B for the clearing and grubbing project specification. The completion of the clearing and grubbing contract and vegetation variance as proposed will provide structural stability, functionality, access for flood fighting, and OMRR&R

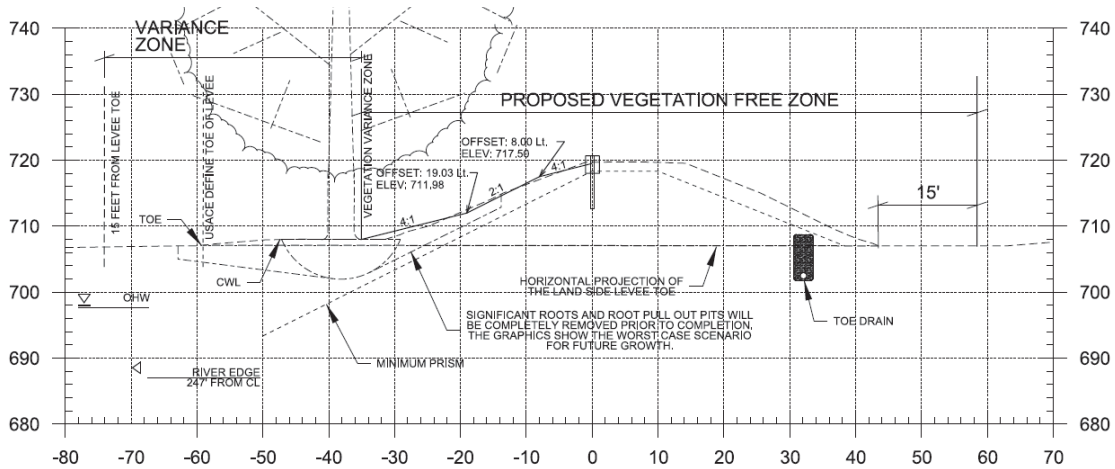


Figure 3. Typical Cross-section of Variance Reach 1.

Variance Reach 2 - includes the levee only portion of Phase IIIA. This area incorporates an over-build section on both the river and the land side that has a very wide crown and shallow slopes. The cross sections, on sheets CS303, CS304, and CS305 in Appendix A, show that the proposed clearing contract would remove the existing tree roots and root ball from the minimum analytical prism. Station 48+00 is shown in Figure 4 below and is an example cross section of Variance Reach 2. Also shown on the cross sections in Appendix A is the land side of Variance Reach 2. In 2004, 4 groups of 6 ornamental trees were planted on the land side levee overbuild section; approximately 11 of them currently remain. The largest of these trees are approximately 25 feet tall and 4 to 6 inches in diameter at breast height. For the purpose of the Vegetation Variance, based on the PGL, it is assumed that these trees have the potential to grow to approximately 80 feet in height with estimated 18 foot wide, 6 foot deep root balls. The cross sections shows that the proposed clearing contract would remove the likeliness of future significant tree roots and root balls from growing into the minimum analytical prism, on both the land side and river side, as defined in Section 7 of this document. The land side variance zone 2 allows the trees mentioned above to remain but does not allow for future planting. In order to allow these land side trees to remain a secondary toe drain will be constructed to bypass any current or future root damage to the current toe drain. Both toe drains will be inspected annually by the sponsor. The scheduled clearing and grubbing contract (2017) (see Section 3) will remove all of the current roots in the proposed VFZ. See Appendix B for the clearing and grubbing project specification.

Variance Reach 2 of the Vegetation Variance requests approval to leave the variance zone identified in the cross sections on sheets CS303, CS304, and CS305, for the reasons listed in Section 3. The completion of the clearing and grubbing contract and vegetation variance as proposed will provide structural stability, functionality, access for flood fighting, and OMRR&R.

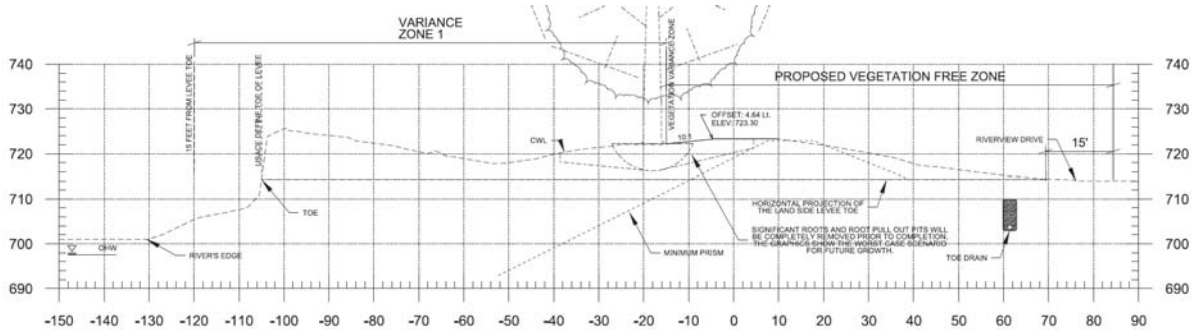


Figure 4. Typical Cross-section of Variance Reach 2.

Variance Reaches 3 and 4 - request small variances that reduce the ETL defined VFZ from an average of 45 feet, from the riverside face of the I-wall, to 40 feet and 35 feet respectively. Variance Reaches 3 and 4 are overbuilt and have shallow slopes that cause a wider ETL defined VFZ. The cross sections, on sheets CS306 in Appendix A show that the proposed clearing contract would remove the likeliness of future significant tree roots and root balls from growing into the minimum analytical prism as defined in Section 7 of this document. The scheduled clearing and grubbing contract (2017) (see Section 3) will remove all of the current roots in the proposed VFZ. See Appendix B for the clearing and grubbing project specification. Station 75+00 is shown in Figure 5 as an example cross section for Variance Reaches 3 and 4. Variance Reach 3 and 4 of the Vegetation Variance requests approval to leave the variance zone identified in the cross sections on sheets CS306, for the reasons listed in Section 3. The completion of the clearing and grubbing contract and vegetation variance as proposed will provide structural stability, functionality, access for flood fighting, and OMRR&R.

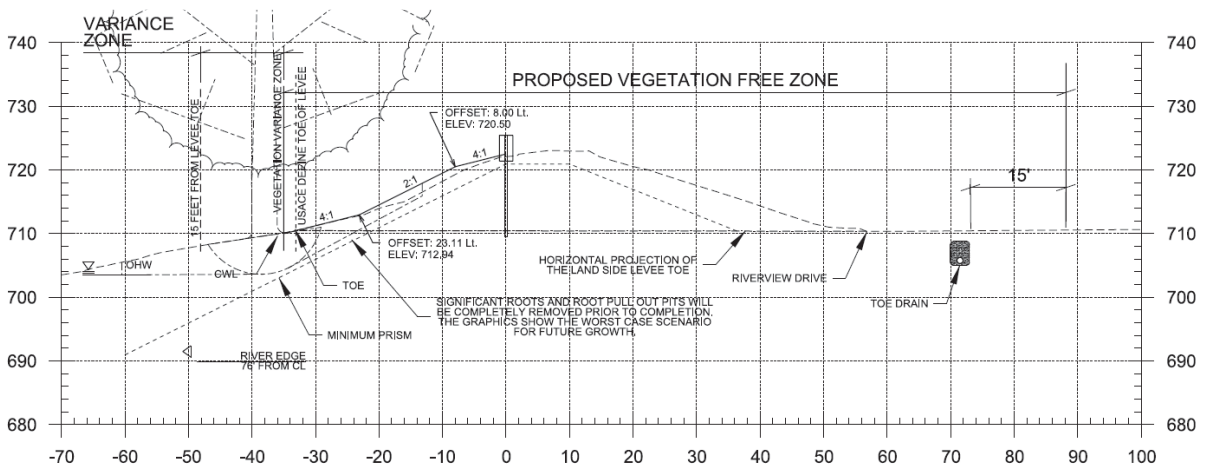


Figure 5. Typical Cross section for Variance Reaches 3 and 4.

Variance Reach 5 - consists of sheet pile I-wall that was constructed between new condominiums and East 57th Street. The river side of this I-wall is cleared to the ETL defined VFZ and due to the presence of East 57th St will remain clear. On the land side there is approximately 19 feet between the face of the I-wall and the face of the condominiums. During construction of Phase IIIC 10 feet of that area was acquired by the sponsor in the form of an easement. This space is a uniformed and well maintained corridor and can be described as follows: Directly adjacent to the wall is a 4 foot wide strip of well-maintained grass, followed by a 6 foot wide sidewalk. Outside of the sponsors easement, 10 feet from the face of the wall begins a decorative metal fence, and behind the metal fence are well trimmed shrubs. At approximately 13.5 feet from the face of the wall, there is a row of decorative trees. Variance Reach 5 request a variance for the trees, the shrubs, and the fence to be allowed to remain. The cross section, on sheet CS307 in Appendix A, shows the root ball of a 40 foot tall tree identified by the PGI. The property with trees, shrubs and fence adjacent to the I-wall is owned by the condominiums and an easement has not, and is very unlikely to be acquired. More importantly this Variance Reach poses no issues with OMRR&R. Station 38+00 is shown in Figure 6 as an example cross section for Variance Reach 5. This section currently provide structural stability, functionality, access for flood fighting, and OMRR&R. No clearing and grubbing in this area is proposed.

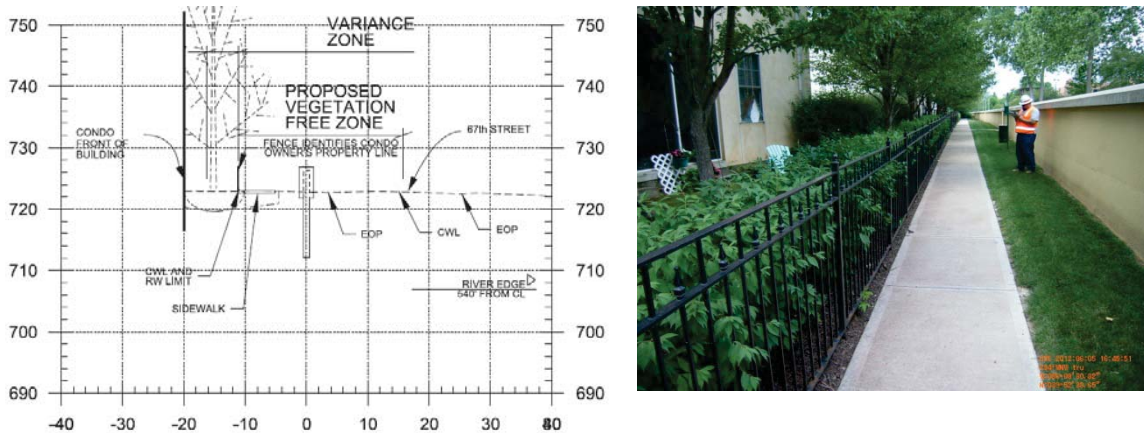


Figure 6. Typical Cross-section for Variance Reach 5 with Photo.

Variance Reach 6 - request a variance for the levee only portion of Phase IIIC. This Variance Reach will be cleared 33 feet from the river side crown of the levee in the direction of the river as part of the scheduled clearing and grubbing contract (2017) (see Section 3). In some parts of this Variance Reach the entire ETL defined VFZ is cleared, while in others up to 25 feet of the ETL defined VFZ, on the river side, will remain vegetated. In this area the riverside slope of the levee is overbuilt. The cross sections, on sheet CS307 in Appendix A, shows that the proposed clearing contract would remove the likeliness of future significant tree roots and root balls from growing into the minimum analytical prism as defined in Section 7 of this document. The scheduled clearing and grubbing contract (2017) (see Section 3) will remove all of the current roots in the proposed VFZ. See Appendix B for the clearing and grubbing

project specification. Station 26+00 – 30+00 is shown in Figure 7 as an example cross section for Variance Reach 6. The completion of the clearing and grubbing contract and vegetation variance as proposed will provide structural stability, functionality, access for flood fighting, and OMRR&R.

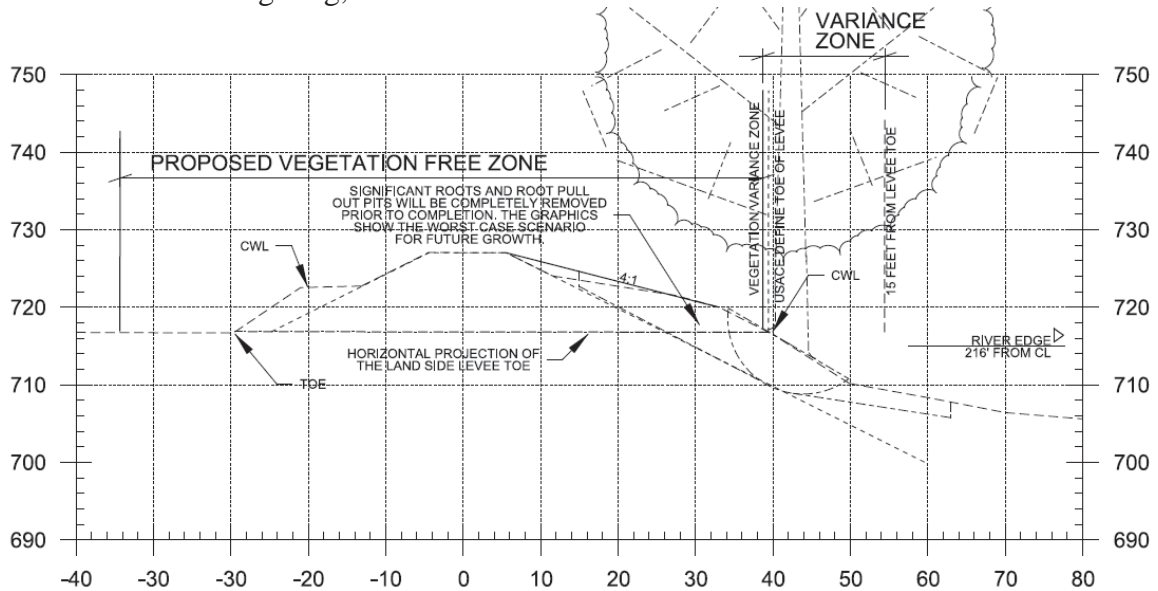


Figure 7. Typical Cross-section of Variance Reach 6.

5 VARIANCE ELIGIBILITY FROM PARAGRAPH 6C(1) OF THE PGL

The Louisville District used the following factors in deciding to pursue this variance.

- Indianapolis North Local Flood Damage Reduction Project was authorized by the Flood Control Acts of 1936 and 1946, 33 U.S.C. 701a-701f.
- The project has advanced into engineering, design and construction phases of development.
- USACE has not provided final written notice of the project’s completion, which is pending the completion of clearing and grubbing in accordance with the ETL, PGL, and this Vegetation Variance.
- The levee sponsor has not begun OMRR&R on the riverside slope of levees as of this date.
- The levee sponsor concurs with the content of this Vegetation Variance request.

6 GENERAL DESCRIPTION OF EXISTING VEGETATION AND ROOT PIT.

The White River banks have a diverse population of trees and shrubs. The following is a list of trees present in the areas being considered for a variance:

Red maple, Silver maple, Sugar maple, tree-of-heaven, Hackberry, Buttonbush, Redbud, Dogwood, American beech, Witch hazel, Smooth hydrangea, Tulip tree, Sweet gum, Japanese honeysuckle, Amur honeysuckle, Black gum, Sycamore, Eastern cottonwood, Black cherry, White oak, Swamp white oak, Shumard oak, Post oak, and Sandbar willow.

This variance does not have tree planters or tree planter berms, and does not include a pruning guide. In lieu of providing the characteristics for the representative list of species at maturity, the levee Variance Reaches being considered for a variance have all been analyzed using the largest possible tree and root ball as established in Enclosure 3 Figure 2 of the PGL. The design tree and root ball assumes an 80 foot tall tree with a root ball 18 feet in diameter and 6 feet deep.

7 MINIMUM ANALYTICAL PRISM

The minimum analytical prism on this job differs depending on the site conditions. This Vegetation Variance was evaluated utilizing three different minimum levee prisms. The three applications are:

1. Levee only minimum prism: Variance Reach 2 and Variance Reach 6 utilize the levee only minimum prism. In these areas, the 10 foot wide crown is placed in the cross section at the elevation of the .333% annual chance exceedance storm plus free board. The side slopes are displayed at 2H:1V on the river side and 2.5H:1V on the land side. This is the minimum structural cross section for a levee.
2. Levee with 8 foot sheet pile minimum prism: Variance Reach 1 utilizes this prism. In this variance, the top of the sheet pile I-wall is located at the elevation of the .333% annual chance exceedance storm plus free board. The I-wall stick up (S) is shown 2.3 feet tall which is the maximum stick up for an 8 foot sheet pile I-wall. The minimum levee crown (W) is 10 feet wide. The I-wall is placed at the river side edge of the minimum levee crown. The minimum embankment slopes are 2H:1V on the river side and 2.5H:1V on the land side. The minimum prism slopes extend beyond the base of the levee. See Figure 8 for the Levee and I-wall Minimum Analytical Prism drawing.

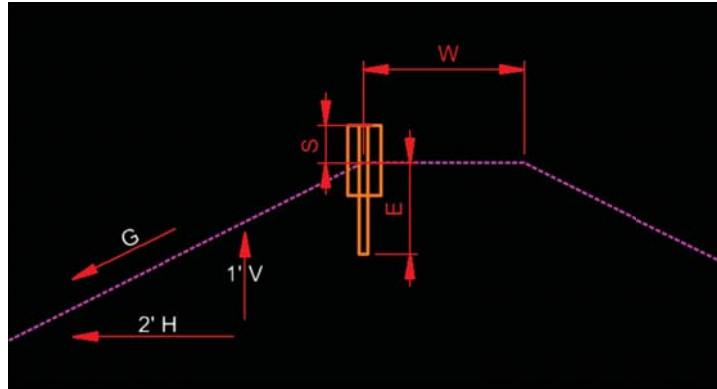


Figure 8. Levee and I-wall Minimum Analytical Prism.

3. Levee with 16 foot sheet pile minimum prism: Variance Reach 3 and Variance Reach 4 utilize this prism. In this variance, the top of the sheet pile I-wall is located at the elevation of the .333% annual chance exceedance storm plus free board. The I-wall stick up (S) is shown 4.6 feet tall which is the maximum stick up for a 16 foot sheet pile I-wall. The minimum levee crown (W) is 10 feet wide. The I-wall is placed at the river side edge of the minimum levee crown. The minimum embankment slopes are 2H:1V. The minimum prism slopes extend beyond the base of the levee.

These minimum prisms have been evaluated for slope stability and for seepage. The results are discussed in Section 8. Variance Reach 5 is not discussed in this section because there is no levee present therefore no minimum prism.

8 GEOTECHNICAL ANALYSIS OF THE MINIMUM LEVEE PRISM

The purpose of this section is to define the minimum levee prism for use in this Vegetation Variance. In order to define the minimum prism, seepage and slope stability were analyzed modeling the proposed minimum prisms at three critical cross sections that are within the Variance Reaches.

Seepage and slope stability were analyzed in accordance with EM-1110-2-1913 and ETL 1110-2-569. Seepage and stability analyses were modeled with water to the top of the I-wall or the top of the levee if no I-wall is present. Exit gradients are required to be below 0.5. For stability, the riverside rapid drawdown factor of safety is required to be 1.0 or greater, and the required factor of safety for landside-steady state-drained (effective stresses) is required to be 1.4 or greater per Table 6-1b in EM 1913. End of Construction (Undrained) analyses were not performed, as this existing levee embankment has been in place for several decades and pore pressures have long since stabilized.

Material parameters are consistent with those as utilized in the *Design Analysis: I-Wall Evaluation and Remediation Phases IIIA and IIIC*, September 2011, which are shown in Table 2.

Table 2. Material Parameters for Seepage and Stability Analyses.

Material	Levee Fill	Clay Foundation	Sand
Unit Weight (psf)	120	115	120
Phi (deg)	27	28	30
Cohesion (psf)	100	0	0
Total Phi (deg) *	20	27	N/A
Total Cohesion (psf)*	200	50	N/A
Permeability (ft/s)	1.6E-7	3.3E-6	1E-5

*for rapid drawdown analysis only

The stratification of the soils are shown in Figure 9. In general, the levee fill consists of a sandy, silty clay. Some borings show more sand and others more clay. The foundation is modeled as a 10 feet thick layer of sandy, silty clay at the surface, underlain by a permeable sand. Most borings then show a layer of stiff clay till overlying bedrock. The stiff till was not modeled in the analysis due to its impermeable nature and irrelevancy. The sand aquifer was exposed to the river in the analyses to simulate a direct connection to the source.

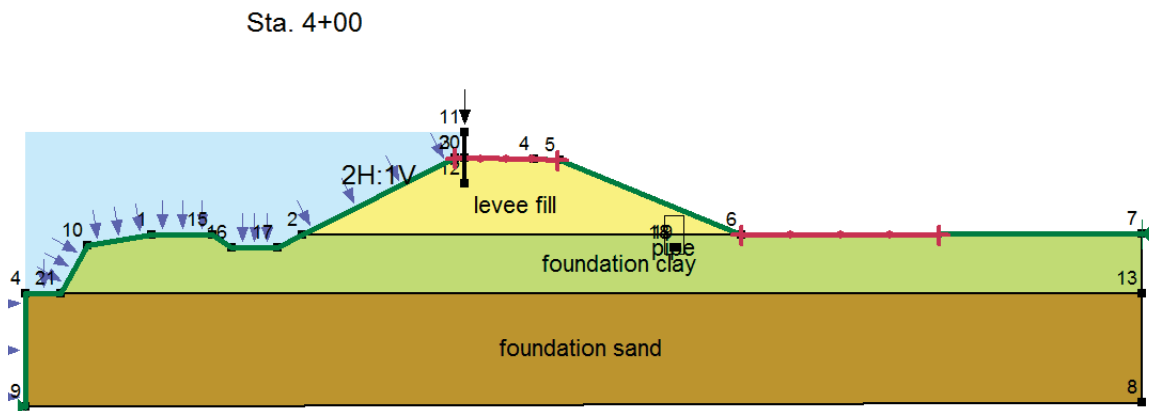


Figure 9. Typical Configuration of Soil Stratigraphy.

The first Station modeled was 4+00. This section represents Variance Reach 1. This section of levee has a short I-wall on top of the embankment. Slopes meeting the required factors of safety consisted of 2H:1V on the riverside and 2.5H:1V on the landside. Figures 10 thru 14 are cross sections of the results from the seepage and stability analyses at Station 4+00. Figures 13 and 14 show a water filled riverside gap modeled along the sheetpile wall per requirements of EC 1110-2-6066.

Sta. 4+00

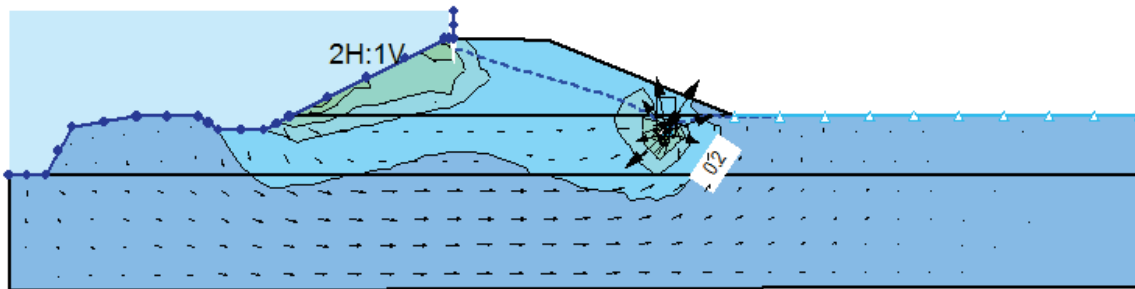


Figure 10. Results of Seepage Analysis for Sta. 4+00.

Sta. 4+00

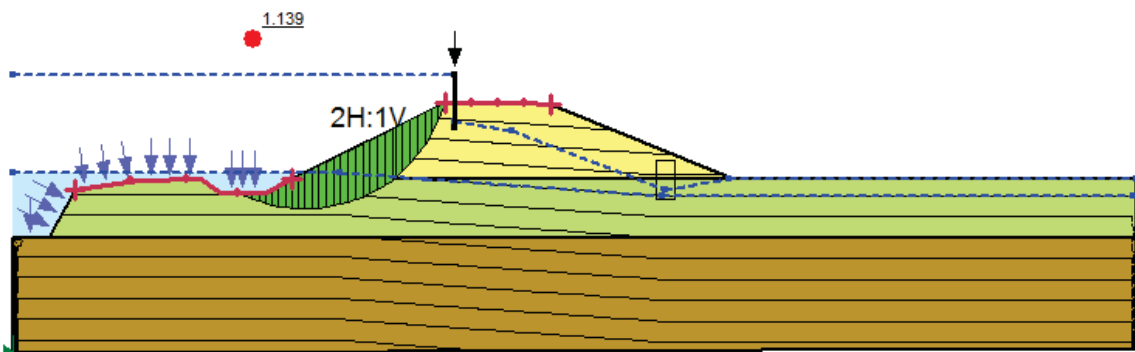


Figure 11. Slope Stability Results for Rapid Drawdown Analysis at Sta. 4+00

Sta. 4+00

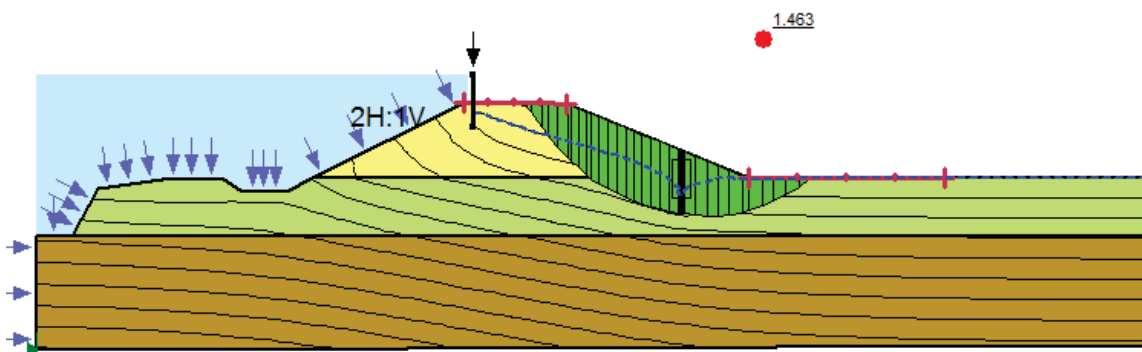


Figure 12. Steady State Landside Drained Stability Analysis for Sta. 4+00.

Sta. 4+00 w riverside crack

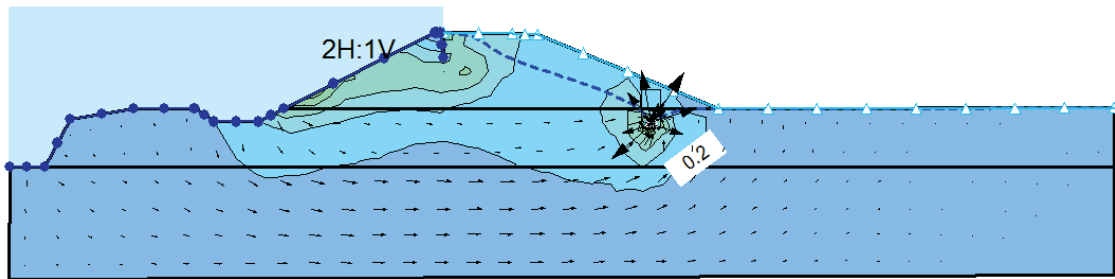


Figure 13. Steady State Seepage with Gap at Floodwall Sta. 4+00

Sta. 4+00 w riverside crack

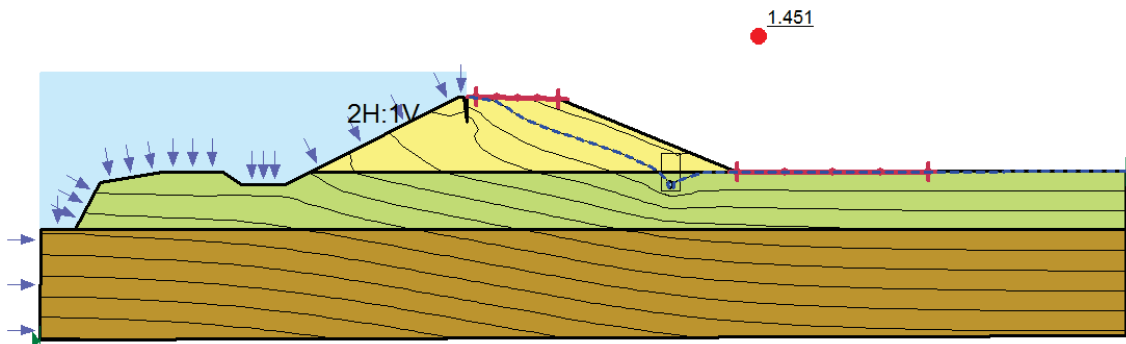


Figure 14. Steady State Landside Drained Stability Analysis with Gap at Floodwall, Sta. 4+00

The second cross section analyzed is located at Sta. 48+00 in Variance Reach 2. This section does not have an I-wall enlargement, but the levee height was raised during the I-wall construction project (2004). This minimum prism also represents Variance Reach 6. This analysis was used in both Variance Reach 2 and Variance Reach 6 because the areas were nearly identical in soil types and material properties. Slopes meeting the required factors of safety consisted of 2H:1V on the riverside and 2.5H:1V on the landside. Figures 113 thru 15 are cross sections of the results from the seepage and stability analyses at Station 48+00.

Sta. 48+00

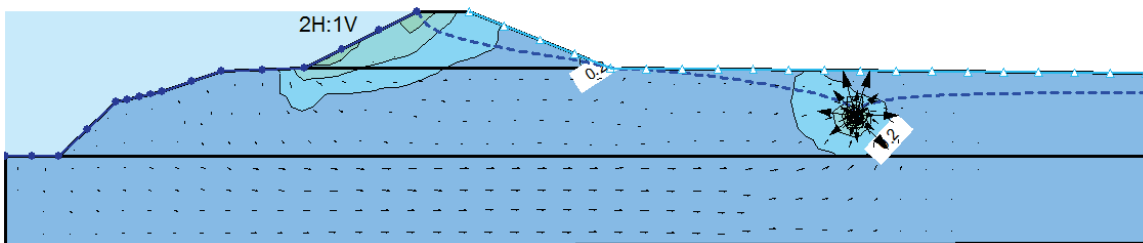


Figure 15. Seepage Analysis for Sta. 48+00.

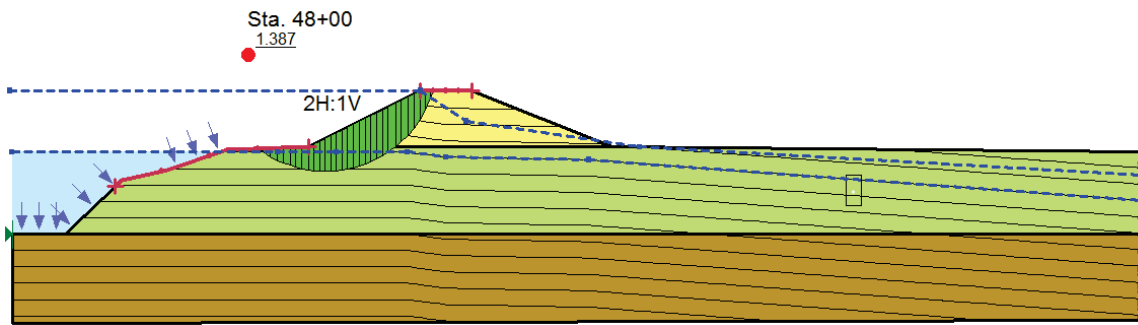


Figure 16. Riverside Rapid Drawdown for Slope Stability Analysis at Sta. 48+00.

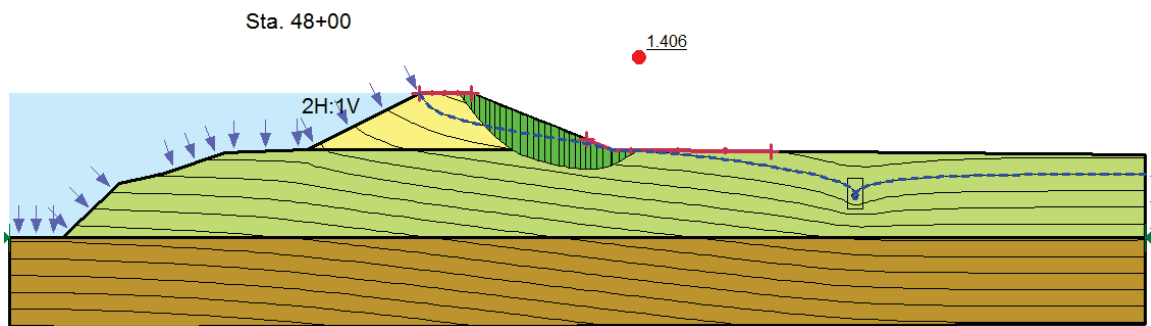


Figure 17. Steady State Landside Slope Stability Analysis at Sta. 48+00.

The third section analyzed is located at Sta. 59+00 in Variance Reach 3. This section has an I-wall on top of the levee. This minimum prism also represents Variance Reach 4. This analysis was used in both Variance Reach 3 and Variance Reach 4 because the areas were nearly identical in soil types and material properties. The slopes meeting the required factors of safety consisted of 2H:1V on the riverside and 2H:1V on the landside. The riverside slope was able to be steeper in this model due to the location and benefits of the deeper toe drain along the landside levee toe. Figures 18 thru 20 are cross sections of the results from the seepage and stability analyses at Station 59+00. Figures 21 and 22 show a water filled riverside gap modeled along the sheetpile wall per requirements of EC 1110-2-6066.

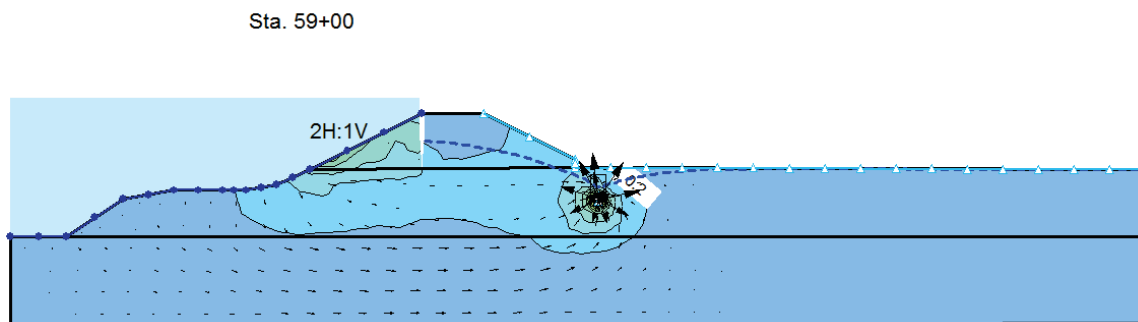


Figure 18. Steady State Seepage Analysis at Sta. 59+00.

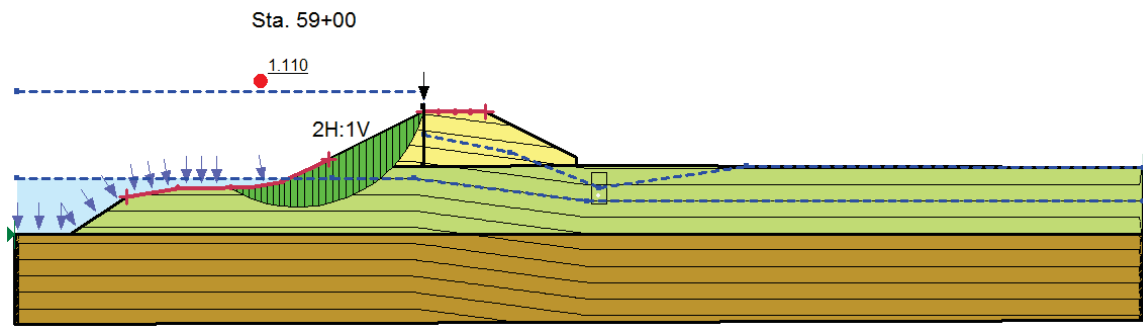


Figure 19. Riverside Rapid Drawdown for Slope Stability Analysis at Sta. 59+00.

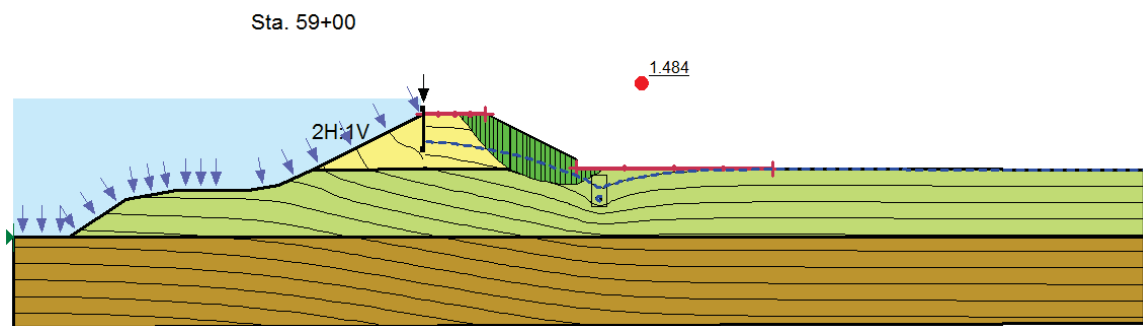


Figure 20. Steady State Landside Slope Stability Analysis at Sta. 59+00.

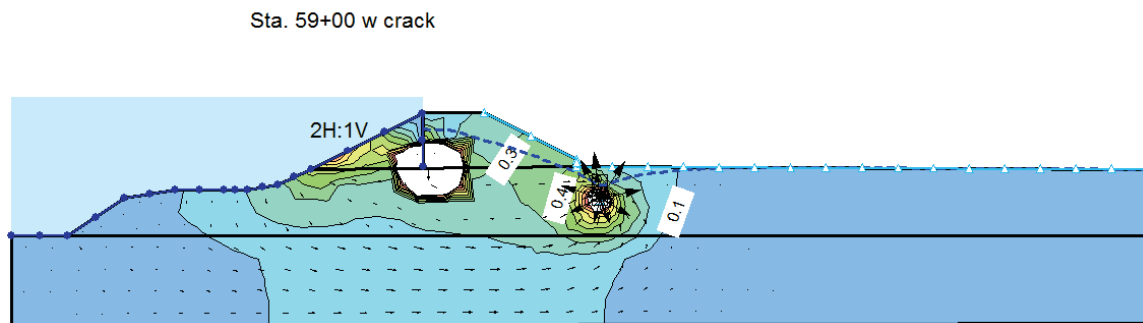


Figure 21. Steady State Seepage with Gap at Floodwall, Sta. 59+00

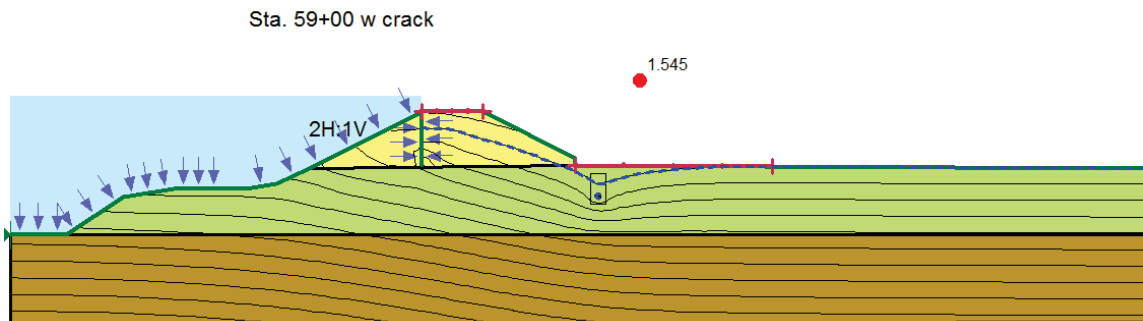


Figure 22. Steady State Landside Slope Stability Analysis with Gap at Floodwall, Sta. 59+00

Results of all analyses are defined in Table 3.

Table 3. Results of Slope and Seepage Analyses

Station	Seepage Exit Gradient (<0.5 req.)	Rapid Drawdown FoS (FoS of >1.0 req.)	Steady State Landside FoS (FoS of >1.4 req.)
4+00	0.2	1.14	1.46, 1.45*
48+00	0.2	1.39	1.41
59+00	0.3-0.4	1.11	1.48, 1.54*

*from analysis assuming riverside floodwall gap

In summary, the levee prism shape that is acceptable from a geotechnical standpoint is as defined below:

Table 4. Minimum Prism Embankment Slopes.

Variance Reach*	Land side slope	River side slope
1, 2, & 6	2.5H:1V	2H:1V
3 & 4	2H:1V	2H:1V

* Variance Reach 5 is I-wall installed on level, natural ground and no minimum levee prism analysis is required.

All Variance Reaches currently have landside slopes that meet or exceed the prisms required above. Upon completion of the scheduled clearing and grubbing contract (2017) (see Section 3) the land and river side slopes will meet or exceed the minimum prisms defined above. Therefore, the levee prisms are sufficiently buffered from any impacts posed by the vegetation retained within the VFZ under this Vegetation Variance.

9 CROSS SECTIONAL ANALYSIS.

The cross sections included in Appendix A have been analyzed. The cross sections show that any future tree that grows near the edge of the variance zone would not produce a root pull out pit large enough to extend into the minimum levee prism. All current significant roots will be grubbed up to the clearing and grubbing limits as part of the scheduled clearing and grubbing contract (2017) (see Section 3). Trees that become unstable due to substantial root lost will also be removed. The cross sections also show that root pull out pits will not approach within 8 feet of the landside toe drains or the sheet pile I-walls.

The cross sections identify the design tree specified by Enclosure 3 of the PGL and shows that the designed root ball and overthrow pit will not penetrate the minimum levee prism.

The tree roots and over throw-pits do not impact the function of any structures designed to control under seepage or through seepage.

The cross sections also show the estimated significant roots that may be present on the largest potential tree that is either present or that could grow in the future. The significant root area, which is identified by roots that are larger than .5 inches in diameter, are assumed to be as wide as the canopy of the design tree and below the tree extend to the bottom of the root pull out pit. For this variance the design tree canopy is estimated to be a maximum of 50 feet in diameter. The depth of the significant root system is estimated to be 6 feet at the center and 2 feet on the outside perimeter.

All current significant roots will be completely grubbed out in the scheduled clearing and grubbing contract (2017) (See Section3). Also see Appendix B to see the Clearing and Grubbing Specification that will be part of contract. The future significant roots that could potentially grow back into VFZ are also shown to not encroach the minimum levee prism. The significant roots will not theoretically ever grow back into the minimum levee prism.

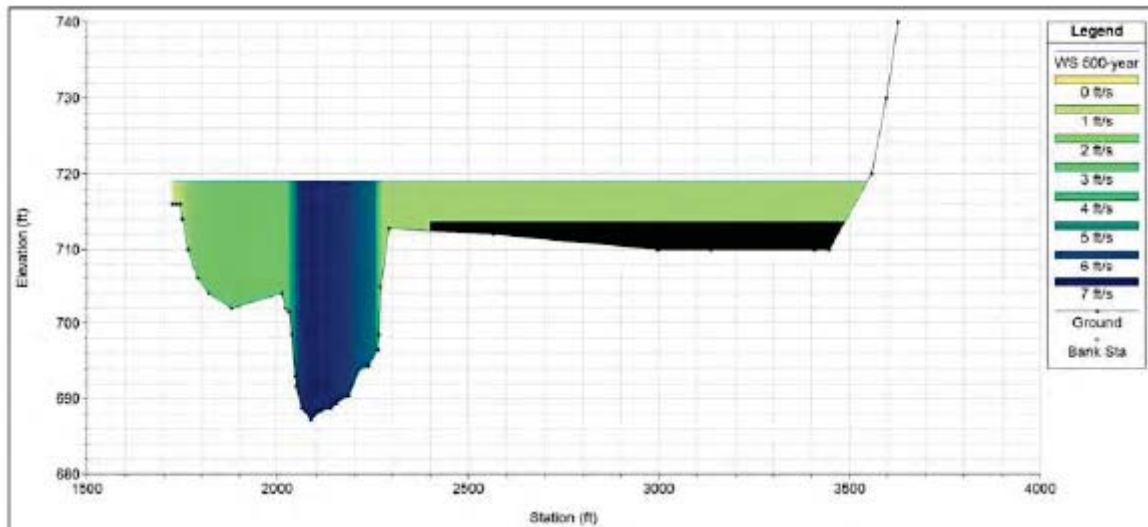
10 HYDRAULIC ANALYSIS

SCOUR:

It isn't anticipated that scour will occur within the 6 Variance Reaches of the White River where trees are being left in place in the ETL defined VFZ. For a scour analysis, it's assumed that a significant root ball of a downed tree will occur, thereby increasing the chances of scour starting at the root ball during an overbank flooding event. However, the types of soil in all six Variance Reaches where the trees are located are mainly clay type soils that do not tend to erode easily unless exposed to very high flow velocities in excess of 4-6 feet per second. Based upon hydraulic modeling performed by US Army Corps of Engineers LRL, the overbank velocities for significant floods are in the 1.0 to 2.1 feet per second range. Other trees that block the flow paths of the overbank flows would also tend to reduce the effects of scour. It should also be noted that all 6 Variance Reach locations are either along the inside bend of the White River or along straight sections of the White River, whereas erosion would normally occur along the outside bend of the river further enhancing the ability of the areas to withstand scour and erosion concerns. With the trees removed, the velocities will increase some but not a significant amount. There would be no significant difference to erosion.

WHITE RIVER VELOCITIES DURING .2% CHANCE EXCEEDANCE STORM EVENT:

In a separate study performed for Phase IIIB of this project, Christopher Burke Engineering's Hydraulic study shows that a .2% chance exceedance storm would produce river velocities approaching 7 feet per second in the center of the river, but in the overbank areas, the velocities would reduce below 2 feet per second. This study confirms the velocities modeled by the US Army Corps of Engineers LRL.



*Elevation Vertical Datum is NGVD 1929

Figure 23. White River .2% Chance Exceedance Storm Velocity Profile at Capitol Avenue.

This graphic displays White River velocities at a sample location near the project site. The model and graphic were produced by Christopher Burke Engineering for a study unrelated to the clearing of the trees in this phase.

11 STRUCTURAL ANALYSIS

Upon completion of the scheduled clearing and grubbing contract (2017) (see Section 3) vegetation will no longer impact the floodwall. The I-wall monoliths and sheet piling located in Variance Reaches 1, 3, and 4 will be cleared to ETL defined VFZ for I-walls (for I-walls only, not including the levee), including in the areas requesting a Vegetation Variance. The I-walls are all located on top of the pre-existing levee embankments and will benefit from the proposed riverside clearing of the levee slope. All remaining vegetation will then be at least 15 feet horizontally from the I-walls which is the ETL defined VFZ for I-walls.

In Variance Reach 5 of Phase IIIC, the small trees and shrubs are maintained 10-13 feet from the floodwall, and the tree roots have the potential to grow within 9 feet from the embedded sheet pile. The trees and shrubs are not currently nor in the future will be of sufficient size to cause any structural impacts. The minimum distance for root balls approaching a sheet pile I-wall is 8 feet (As defined by the PGL). This area could not be improved or cleared regardless of the tree/root situation due to the lack of real estate.

Floodwalls on Phase IIIA and IIIC were evaluated in 2007 under the then current *Phase II Interim Guidance for Evaluating Existing I-Walls*, CECW-CE 13 October 2006, and later EC 1110-2-6066 *Engineering and Design of I-Walls*, 1 April 2011. See the referenced *Design Analysis: I-Wall Evaluation and Remediation Phases IIIA and IIIC*,

September 2011 for results. Remediation to increase the embedment to stickup ratios were completed under a government contract in 2011 to satisfy current criteria.

No other non-earthen structures are impacted by vegetation under the proposed Vegetation Variance.

12 MAINTENANCE CAPABILITY OF THE SPONSOR.

The maintenance crews who work for the local sponsor (City of Indianapolis)'s have established grading guidelines and expressed confidence in their ability to properly maintain the areas being cleared as part of the scheduled clearing and grubbing contract (2017) (See section 3). The maintenance crews have also shown that they are capable of maintaining and mowing a 2H: 1V slope. The equipment the crews use in this area is a Toro 72" ZTR. The crews currently mow the land side of the Phase IIIA levee that is a 2H: 1V slope in several locations. Feedback from the maintenance crews suggests that the best grading plan includes a relatively flatter slope at the top and bottom of the embankment.

The scheduled clearing and grubbing contract (2017) (see Section 3) includes a grading plan that will restore the riverside slope of Phase IIIA to create a more easily maintainable slope. Refer to Figure 24 Typical Proposed Cross Section Grading Plan for a typical section of the Phase IIIA grading plan. The grading plan creates a consistent slope 7 feet wide at the top of the levee embankment that is graded toward the river at approximately 4H: 1V. Next the slope would continue at 2H:1V and at the base of the slope a minimum of a 7 foot wide area graded at a 4H:1V slope.

Monuments are included in the scheduled clearing and grubbing contract (2017) (see Section 3). The monuments will be metal fence posts 8' tall and painted white. The monuments will extend 8' into the air to identify the horizontal and the vertical clearing responsibilities of the sponsor and will relay to the maintenance crews what cleared areas need to be maintained. Posts will be placed 100' apart only in areas adjacent to woody vegetation. This information will be included in the O&M manual as well.

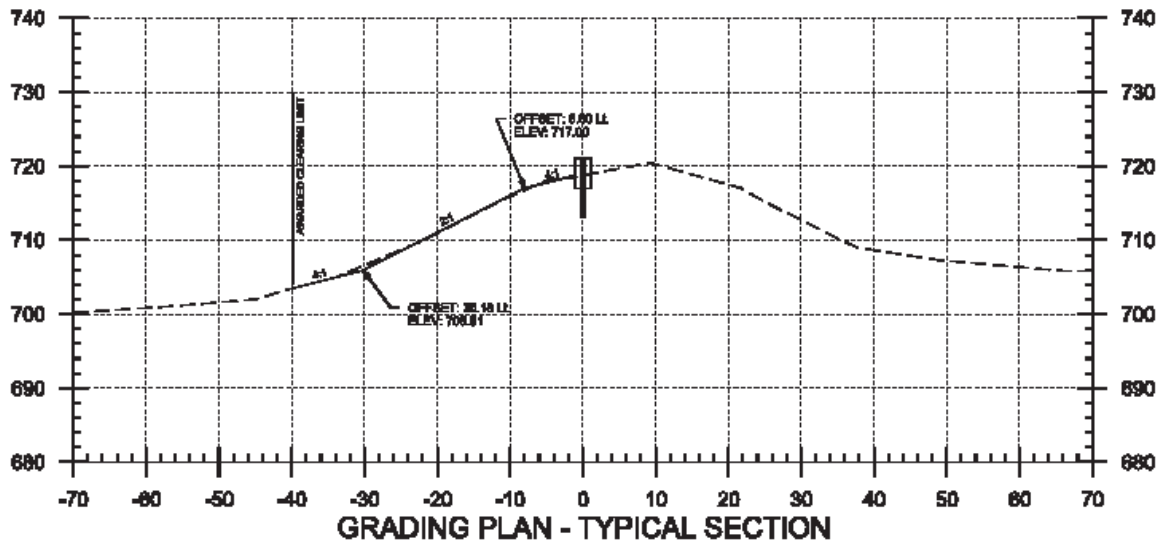


Figure 24. Typical Proposed Cross Section Grading Plan.

13 ADDITIONAL SUBMITTAL REQUIREMENTS

Additional information requested in the PGL, Enclosure 3, Submittal Requirements can be found below. Each requirement not included in the above report is listed below and identified by the paragraph number.

PARAGRAPH 5E (ACCESS)

Upon completion of the scheduled clearing and grubbing contract the access to Indianapolis Phase IIIA and Phase IIIC will not only be retained but will be much improved. No section of flood wall or levee will be inaccessible.

PARAGRAPH 6 (ROUTINE INSPECTION REPORT)

No routine or periodic inspections have ever been completed on this project. Additionally no LSAC ratings have been performed either. When the project is completed and turned over, a consequence characterization will be completed as part of the screening process. At that point inspections will be performed.

PARAGRAPH 7 (PERFORMANCE HISTORY)

HISTORIC STORMS AND FLOODS.

The most recent severe flooding in Indianapolis occurred in January 1991 when flooding, estimated at a 7% chance exceedence flood event, forced evacuation of approximately 500 homes, causing extensive property damage. This flooding interrupted utility service to thousands of homes, damaged numerous roadways, impaired access to the public, and resulted in several life threatening injuries.

Particularly hard hit by this flooding was Ravenswood, which lies a few miles north of this project area.

In the period from 1953 through 1990, there were six events when the White River exceeded zero damage elevation, with the April 1964 flood being the largest even during this time period. The 1964 flood was slightly greater than the January 1991 event, and is estimated to be between a 7% and 5% chance exceedence frequency flood. Since the January 1991 flood event, only one other flood approached zero damage elevation, which occurred in July 2003. The March 1913 flood was the flood of record for the White River for the Indianapolis area with an estimated frequency of about 0.2 % chance (500-year).

PARAGRAPH 9 (ENVIRONMENTAL COMPLIANCE)

Direct, indirect, and cumulative effects of the proposed 15-foot vegetation clearing on the environment were analyzed in accordance with the National Environmental Policy Act (NEPA), 42 U.S.C. § 4321. et seq., in the Final Supplemental Environmental Impact Statement (FSEIS) for the Indianapolis North Flood Damage Reduction Project, dated Jun 2013. The Corps' decision to implement the 15-foot vegetation clearing was documented in the subsequent Record of Decision (ROD) for the Project, signed 27 June 2014. Environmental mitigation plans for the proposed clearing of the levees have been reviewed and approved by the Indiana Department of Natural Resources (DNR) and coordinated with the United States Fish and Wildlife Service (USFWS). These plans include planting approximately 65.5 acres of native trees, shrubs, and grasses within the White River watershed in accordance with the Indiana DNR habitat mitigation guidelines. To lessen potential impacts on federally endangered Indiana bats (*Myotis sodalis*) and federally threatened northern long-ear bats (*Myotis septentrionalis*), no trees greater than three inches diameter at breast height (DBH) will be cut from 1 April through 30 September.

PARAGRAPH 10 (O&M MANUAL)

The manual is current for all project areas currently being maintained and operated by the sponsor and will be updated to include any future phases including the scheduled clearing and grubbing contract (2017 see Section 3).

PARAGRAPH 12 (LEVEE SPONSOR POC)

Michael Massonne is the Senior Project Manager for the Indianapolis Department of Public Works. His contact information is as follows:

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Office of Mayor Joe Hogsett - City of Indianapolis

michael.massonne@indy.gov P: (317) 327-8701 C: (317) 445-1130

14 CONCLUSION

The scheduled clearing and grubbing contract (2017) (see Section 3) and the approval of this Vegetation Variance will complete Phase IIIA and Phase IIIC. Upon completion both phases will be turned over to the Sponsor (The City of Indianapolis) for OMRR&R.

This Vegetation Variance demonstrates that after the scheduled clearing contract, all 6 Variance Reaches will be adequately cleared and grubbed to meet the variance guidance outlined in the PGL. The report also shows that the scheduled clearing and grubbing plan completes the project and accomplishes the goal of ETL 1110-2-583 by maintaining structural integrity and functionality of the levee system, and by improving the accessibility of the levee system for operations, maintenance, repair, inspection, monitoring, and flood fighting of the levee system. This report discusses the scheduled clearing and grubbing contract (2017), the 6 Vegetation Variance Reaches, eligibility requirements, existing vegetation and root balls, the minimum analytical prism, the analysis of the minimum prisms, structural analysis, cross section analysis, the sponsor's maintenance capabilities, scour, and White River velocities.

The Louisville District Army Corps of Engineers submits this Vegetation Variance request for approval, in accordance with the Policy Guidance Letter (Process for Requesting a Variance from Vegetation Standards for Levees and Floodwalls) dated 7 February, 2012.