

Appendix B

Design

Appendix B

Princeville, North Carolina Flood Risk Management Integrated Feasibility Report and Environmental Assessment

Design

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1.1. Introduction

The purpose of this appendix is to provide the background information to explain and support the Design Portion of the Princeville Flood Risk Management Study. This includes the development and evaluation of the most effective and economical solution to reduce the frequency of flooding for the Town of Princeville. This information can also be used by reviewers and readers to evaluate the validity of the Design information and requirements used in this study.

1.2. Existing Conditions

The Town of Princeville is located along the Tar River south of Tarboro in eastern North Carolina. It is situated at a bend in the River and has historically been subjected to flooding. Authority to construct the Princeville Dike, Tar River Flood Control Project was granted in 1964 by the Chief of Engineers under Section 205 of the 1948 Flood Control Act as amended.

The project began construction in 1967 and consisted of a levee system running parallel to the river between the river and the Town of Princeville. It included two segments of levee and a segment of U.S. Highway 64. The northern segment of levee extended from U.S. Highway 64 northeasterly approximately 9,700 linear feet. Approximately 3,650 linear feet of U.S. Highway 64 extended south east from the northern levee segment. The southern segment extended south from U.S. Highway 64 approximately 4,250 linear feet.

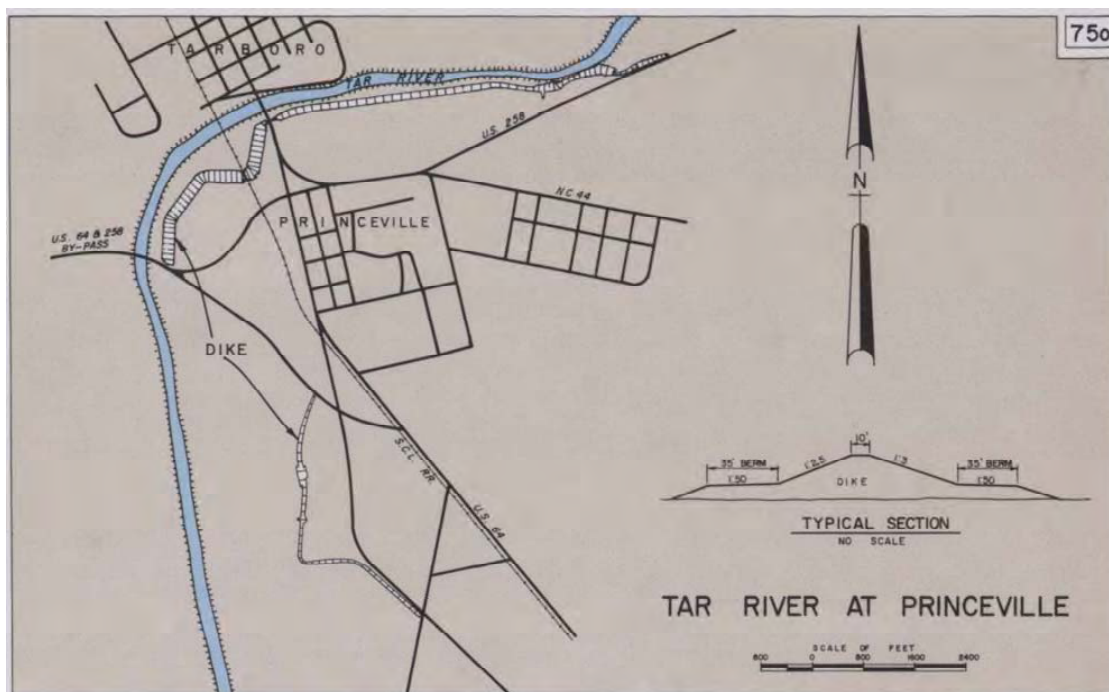


Figure 1.1 – Original levee and US 64 road alignments

The existing earth levee segments (non-highway) of the proposed project were constructed in 1967. Currently, no design analysis calculations for these levees have been located. It is believed that the levee was extended to a point of natural grade where the elevation was equal to the flood of record at the time of construction. The levee elevation would have been set two (2) feet above the flood of record plus an additional two (2) feet of freeboard. This results in a

relatively abrupt terminus for the levee at each end of the project with the levee sloping down from the top elevation to natural grade at a 3 horizontal to 1 vertical slope to natural ground.

A stop log structure is located in the northern segment of earthen levee at the rail location. The stop logs are stored in a building south of the levee adjacent to Main Street. The stop logs are installed in the structure annually. Inspections completed as part of the PL 84-99 program have identified that the structure has settled over time and is attributed to the dynamic loading of normal railway traffic. Although settlement has been observed, the existing structure remains capable of achieving a watertight seal when the stop logs are installed.

In 1995 NCDOT began construction on U.S. Highway 64 shifting the alignment west and upgrading the highway to a 4 lane divided principle arterial route. The new road alignment bisects the southern segment (Segment B, Figure 1.1) in two locations. The new road alignment resulted in portions of the highway fill being at a higher elevation than the levee. However, one exception is at an "S-curve" transition, which is landward of the existing levee, the embankment is actually lower than the equivalent USACE levee height. The S-curve transition left approximately 2300 linear feet of roadway below the existing levee elevation. Because of the elevation difference between the existing levee and the highway fill, floodwaters can overtop the existing U.S. Highway 64 and enter Town at that location if the existing levee is overtopped. The road fill was not intended to provide flood risk reduction. There are culverts with flap gates in U.S. Highway 64 between the existing earthen levee segments, however some of the highway drainage culverts through the fill were not equipped with back-flow prevention devices. Additionally, there are drainage culverts with flap gates in the existing levee segment B. The existing levee alignment after construction of U.S. Highway 64 is shown in Figure 1.2.

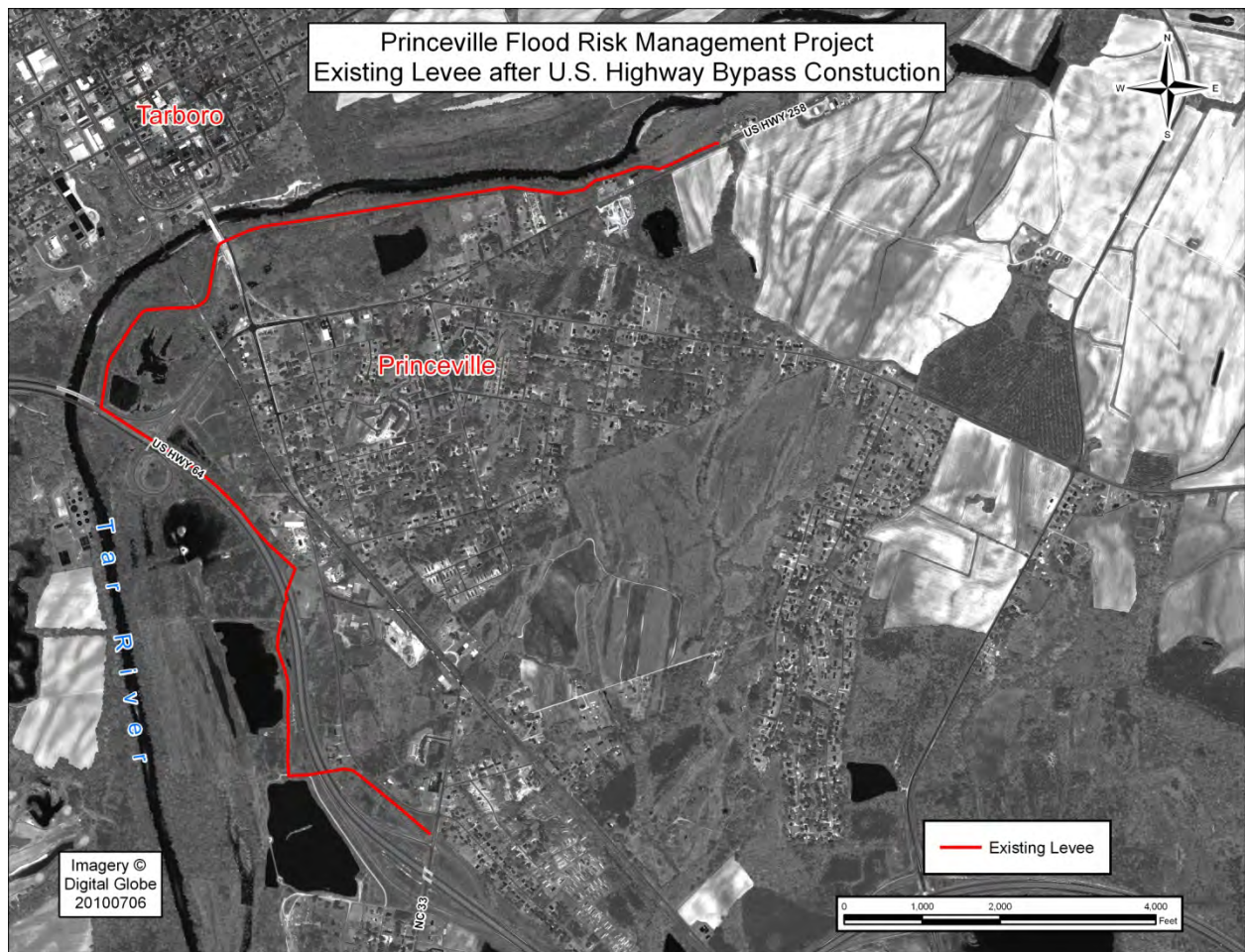


Figure 1.2 – Current US 64 and levee alignments

1.3. Design Objectives

The existing levees performed well providing protection for lesser, more frequent flood events. However, in 1999, the area was hit with Hurricanes Dennis and Floyd causing historic volumes in the Tar River. Hurricane Floyd was a magnitude greater than a 0.2 percent chance storm event. Flood waters backed up within the river basin entering the town from the south thru the N.C. Highway 33 overpass beyond the southern segment of levee. As the flood waters rose, water began to enter from the northeast beyond the northern segment of existing levee and eventually topped portions of the northern segment and U.S. Highway 64.

As a result of the catastrophic flooding and historical significance of the town, then-President Clinton issued *Executive Order 13146*. The executive order directed to **“repair and rebuild Princeville, and to the extent practical, protect Princeville from future floods.”** As a result of the Executive Order, the scope of the study included a hydraulic and hydrologic model which evaluated the flood elevations for Princeville and Tarboro. It was determined that Princeville is subject to flooding during lesser, more frequent flood events than even the 0.5 percent annual chance exceedance flood event. The results are presented in Appendix A.

Based on the flooding observed during Floyd and current levee design guidelines, it was determined that the levee should be extended at both ends to natural grade equal to the elevation of the top of levee. Several alternatives were evaluated and an incremental analysis

was performed in order to determine the most economically justified route and protection elevation for the levee extensions. Alternatives evaluated included extension of the existing levee system, as well as, evaluation of varying segment elevations.

In order to evaluate alignment alternatives, drainage structures were field located, inspected and surveyed to identify deficiencies. Figure 1.3 shows location of the culverts within the limits of the alternatives analyzed. Ten (10) drainage structures were identified as part of the existing project with each having backflow prevention devices installed. The evaluated alternatives identified two (2) structures within the U.S. Highway 64 right-of-way that will require new backflow prevention devices as part of the southern extension (Segment 1) of the existing levee system. Additionally, four (4) structures were identified that may require the inlet elevation to be raised as part of the proposed project.– One (1) structure within the N.C. Highway 111 right-of-way will require new backflow prevention device and two (2) culverts will be required to be removed as part of the northern extension of the existing levee system. Figure 1.3 depicts the location of the existing culverts within the existing and proposed project limits. Table 1.1 provides detailed information concerning the culverts.

The levees were overtopped during Floyd at which time erosion occurred at some locations due to the sandy material from which these levees are constructed. The segments were repaired as part of the recovery operations. A centerline survey of the northern levee indicates areas of minor subsidence that will require repair to ensure that design elevations are maintained.

The Recommended Plan is shown in Figure 1.4. The discussion below describes how the flooding problem was solved within the segments of the overall project. The Recommended Plan is also illustrated in drawing G102 of Attachment 1 to this Appendix.

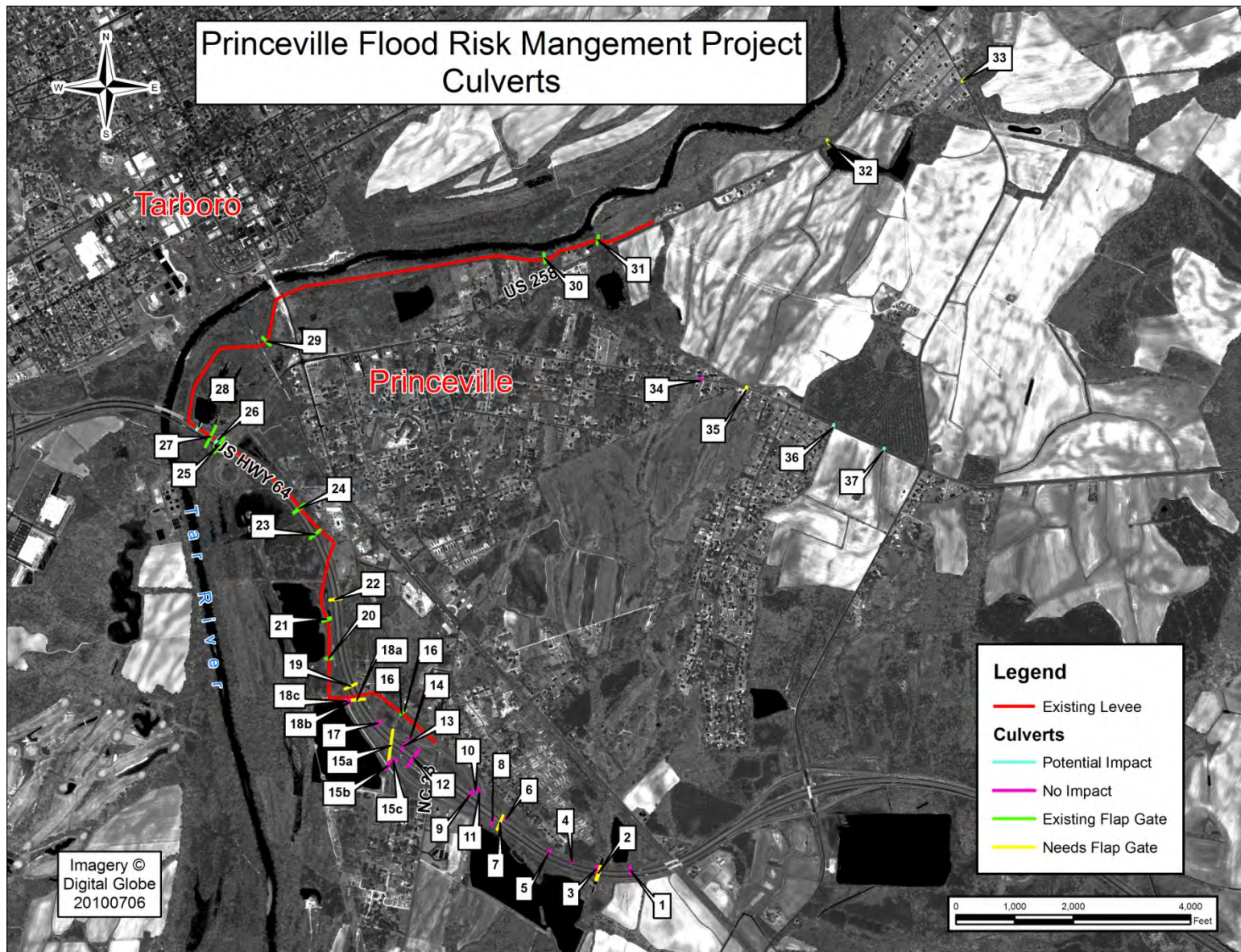


Figure 1.3 – Princeville Levee Culverts

Table 1.1: Drainage Culverts and Descriptions

Pipe Number	Size	Material	Note
Vicinity of US Highway 64 (Segment 1)			
1	15"	CMP	Nothing required for Recommended Plan
2	7'x6'	Triple Box	Needs New Flap Gate
3	15"	CMP	Nothing required for Recommended Plan
4	12"	CMP	Nothing required for Recommended Plan
5	15"	CMP	Nothing required for Recommended Plan
6	15"	CMP	Nothing required for Recommended Plan
7	36"	RCP	Needs New Flap Gate
8	15"	CMP	Nothing required for Recommended Plan
9	30"	CMP	Nothing required for Recommended Plan
10	24"	RCP	Nothing required for Recommended Plan
11	15"	CMP	Nothing required for Recommended Plan
12	24"	RCP	Nothing required for Recommended Plan
Vicinity of US Highway 64 (Segment 2)			
13	15"	CMP	Nothing required for Recommended Plan
14	12"	CMP	Nothing required for Recommended Plan
15a	60"	RCP	Needs New Flap Gate
15b	60"	RCP	Nothing required for Recommended Plan
15c	36"	RCP	Nothing required for Recommended Plan
16	48"	RCP	Part of existing Princeville FRM project
	48"	RCP	Part of existing Princeville FRM project
	60"	RCP	Part of existing Princeville FRM project
17	15"	CMP	No Impact to project
18a	18"	RCP	Needs New Flap Gate
18b	18"	RCP	Nothing required for Recommended Plan
18c	24"	RCP	Nothing required for Recommended Plan
19	30"	RCP	Extend pipe 50-feet, add new flap gate , adjust existing inlet elevation
20	30"	RCP	Part of existing Princeville FRM project
21	48"	RCP	Remove
	48"	CMP	Remove
	60"	RCP	Construct new (100 LF) with new flap gate
22	54"	RCP	Extend pipe 75-feet, add new flap gate, add box with inlets, adjust existing inlet elevation
23	24"	CMP	Extend pipe 50-feet, add new flap gate, adjust existing inlet elevation
24	24"	RCP	Extend pipe 75-feet, add new flap gate, adjust existing inlet elevation
	36"	RCP	Extend pipe 75-feet, add new flap gate
25	30"	RCP	Part of existing Princeville FRM project and has flap gate
26	12"	CMP	Need rim elevation, may need to re-grade and raise rim

Pipe Number	Size	Material	Note
27	30"	CMP	Part of existing Princeville FRM project and has flap gate
28	12"	CMP	Need rim elevation, may need to re-grade and raise rim
Vicinity of U.S. Highway 258 (Segment 3)			
29	60"	CMP	Part of existing Princeville FRM project and has flap gate
30	48"	RCP	Part of existing Princeville FRM project and has flap gate
31	48"	CMP	Part of existing Princeville FRM project and has flap gate
32	4'x4'	Box	Beyond proposed alignment, does not have flap gate
Vicinity of Shiloh Farm Road			
33	48"	CMP	Beyond proposed alignment, does not have flap gate
Vicinity of N.C. Highway 111 (Segment 4)			
34	18"	RCP	Beyond proposed alignment, does not have flap gate
35	2-27"	ERCP	Replace with new 48" RCP and new flap gate
36	18"	RCP	Potential removal to be evaluated during PED
37	15"	RCP	Potential removal to be evaluated during PED

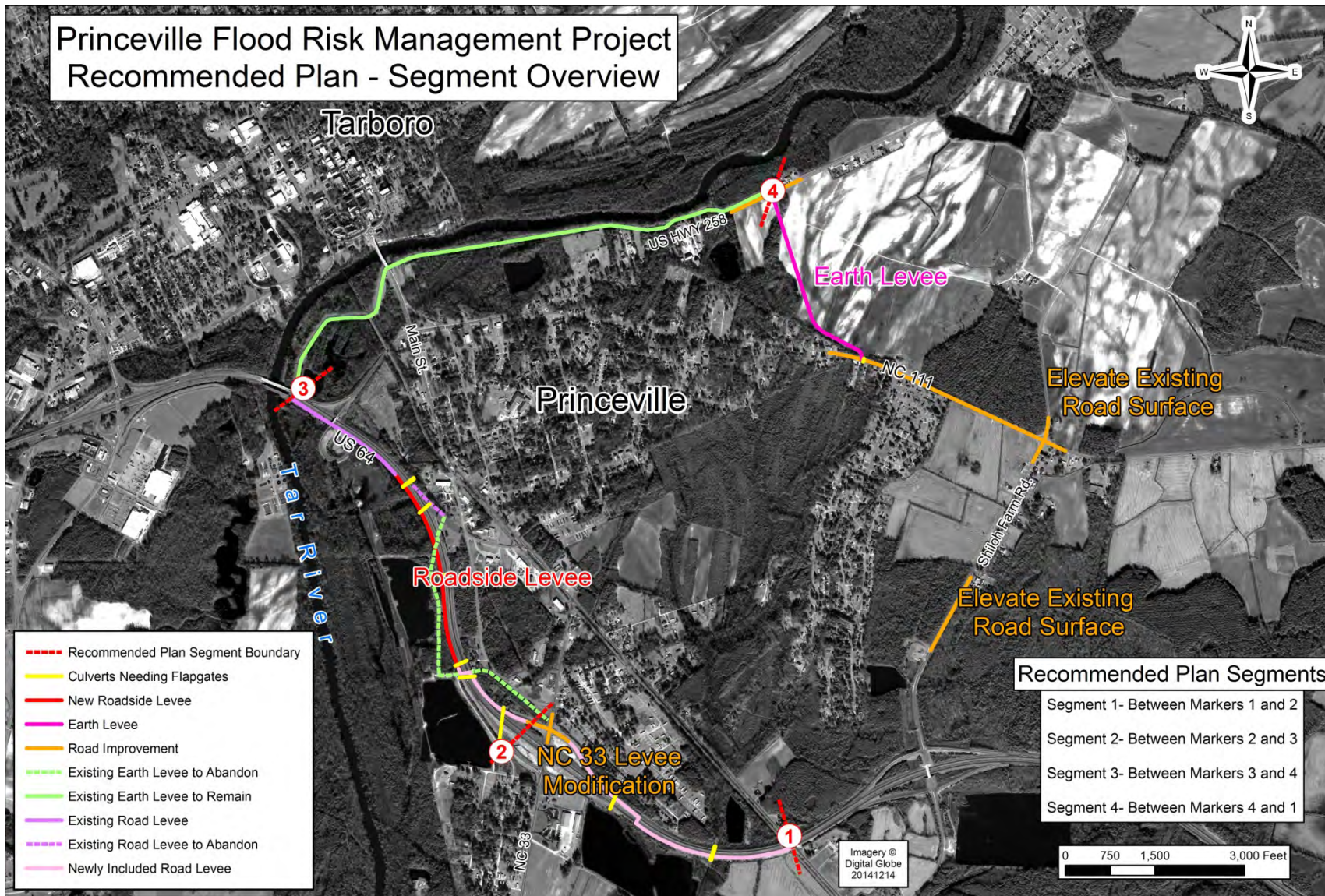


Figure 1.4 – Princeville Recommended Plan Segments

1.4. Project Segment 1

The Recommended Plan is an extension of the existing southern levee segment (or southern extension) downstream to high ground identified as Segment 1 (Figure 1.5 and Attachment 1 drawings CF101 thru CF103). It begins at the crossing of U.S. Highway 64 and Main Street and extends along U.S. Highway 64 approximately 5,000 linear feet in a northwesterly direction to the on-ramp location from N.C. Highway 33 to U.S. Highway 64. The Recommended Plan utilizes the height of the highway embankment which ranges in elevation from 64 feet to 78 feet to serve as the line of protection.

Construction of U.S. Highway 64 included the installation of twelve drainage pipes/culverts to allow for proper drainage of the roadway. These structures were located in the field and inspected to evaluate potential impact to the flooding within Princeville. Pipes 1, 3 through 6, 8, 9, 11 and 12 were found to have no potential for conveyance of floodwaters for the Annual Exceedance Probability of 0.5 percent. As part of the Recommended Plan, pipes 2 and 7 were identified as requiring installation of backflow prevention devices.

Additionally, as part of the Recommended Plan, pipe 10 will require grading within the right-of-way and the installation of approximately 300 linear feet of 24" culvert under N.C. Highway 33 to allow runoff from the grassed median and pipe 9 to drain through Pipe 12 toward the Tar River side of the Highway.

The existing earth levee ends west of N.C. Highway 33 with a top of levee elevation of 44 and existing ground elevation of 39. U.S. Highway 64 was constructed with a grade separated interchange with N.C. Highway 33 with US 64 constructed on an overpass of N.C. Highway 33 with elevation 43 at the interchange. The existing elevation for N.C. Highway 33 will allow flooding to occur through the interchange that will bypass the southern terminus of the levee. Several options were considered for containment at this intersection including the installation of a floodgate at the overpass and extending the levee through N.C. Highway 33. A flood gate was ruled out due to cost, maintenance and reliability concerns.

The extension of the southern terminus will require raising the intersection of the west bound off and on ramp of U.S. Highway 64 and N.C. Highway 33. The Recommended Plan will require raising the intersection to a minimum elevation of 47.0 at the intersection and ramps. This will allow the alignment to utilize the embankments from the interchange and ramps as the line of protection.

The design of vertical curves will be in accordance with the North Carolina Department of Transportation Highway Design Manual. The high point is proposed at the intersection in order to provide adequate safe sight distances for oncoming traffic. It is recommended that the speed limit be reduced from 45 mph to 35 mph along N.C. Highway 33 from Main Street through the U.S. Highway 64 interchange in order to locate the high point at the intersection with no impacts to vertical clearances at the overpass. Figure 1.6 is the proposed N.C. Highway plan and profile. The NCDOT Division Engineer is willing to support the reduction in speed limit due to the residential development in this area.

Table 1.2: Quantities for Recommended Plan - Segment 1

Levee Elevation	47.0
Flap Gates (number of locations)	2
Clearing and Grubbing (acres)	2.0
Earthwork (cubic yards)	6,000
Demolition of Asphalt (square yards)	4,700
Asphalt for NC 33 (square yards)	2,300
Asphalt for Ramps (square yards)	2,400
24" Drainage Pipe (linear feet)	300
Clear vegetation from US HWY 64 Embankment (acres)	3.5

*Values in table represent total quantities to achieve the Recommended Plan.

The fill quantities were estimated using cross sections from a topographic map that was developed using 2007 LIDAR data with contour interval of 2 feet that was collected by the State of North Carolina. All vertical data was in North American Vertical Datum of 1988 (NAVD88). The topographic map was created with 1 foot contour interval. The fill quantity was calculated using the average end method in Bentley InRoads V8i.

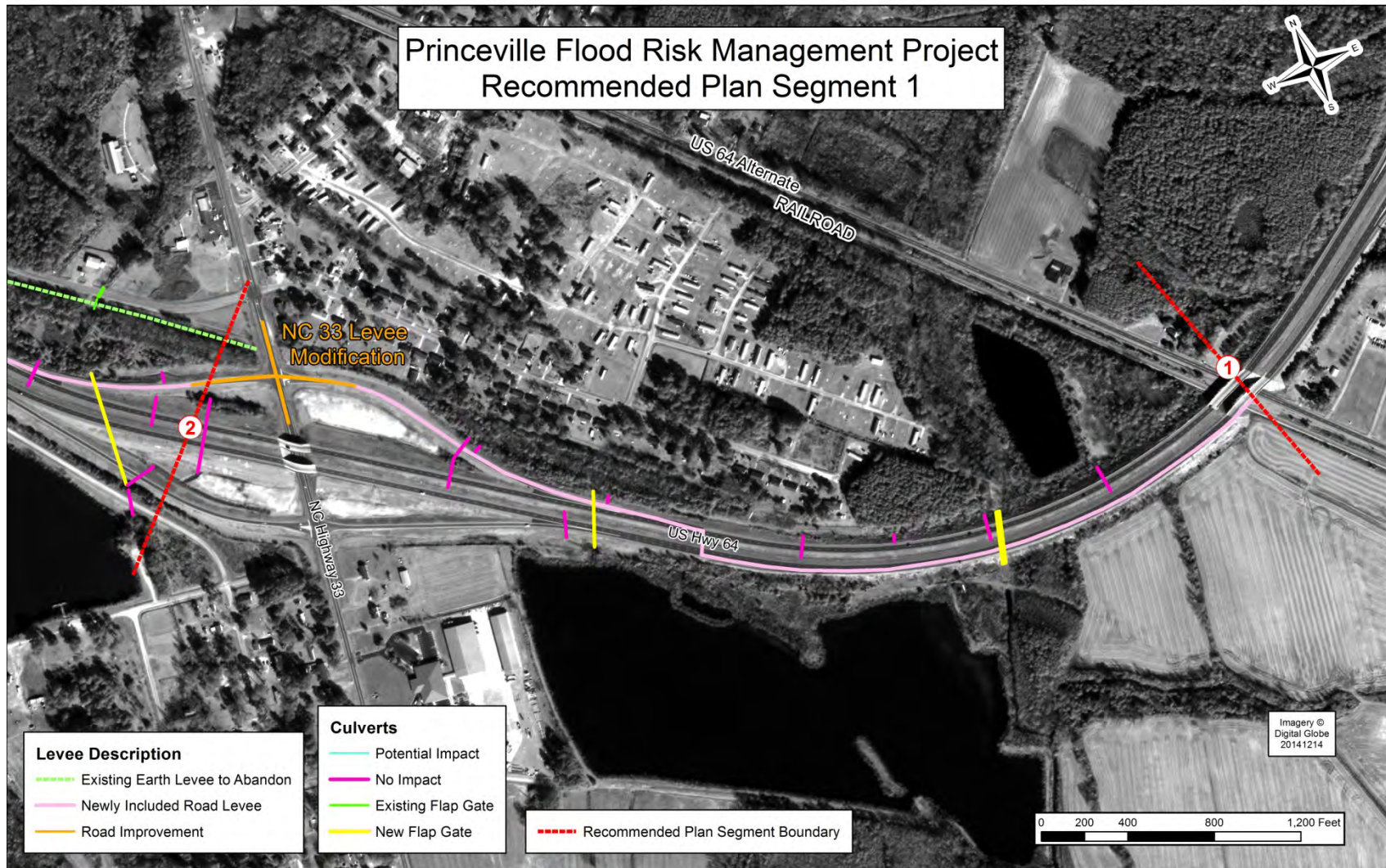


Figure 1.5 –Segment 1

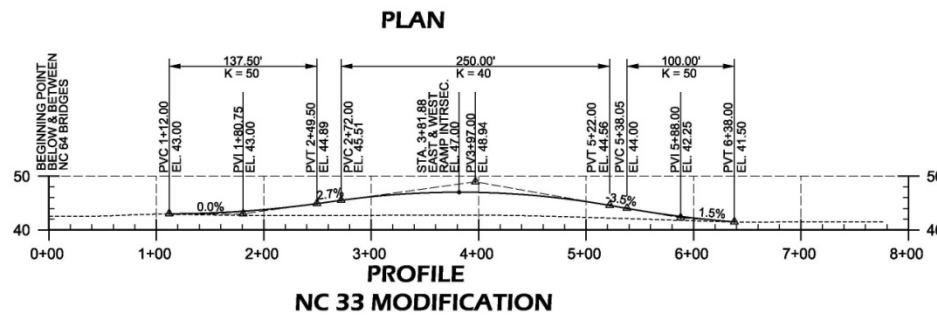
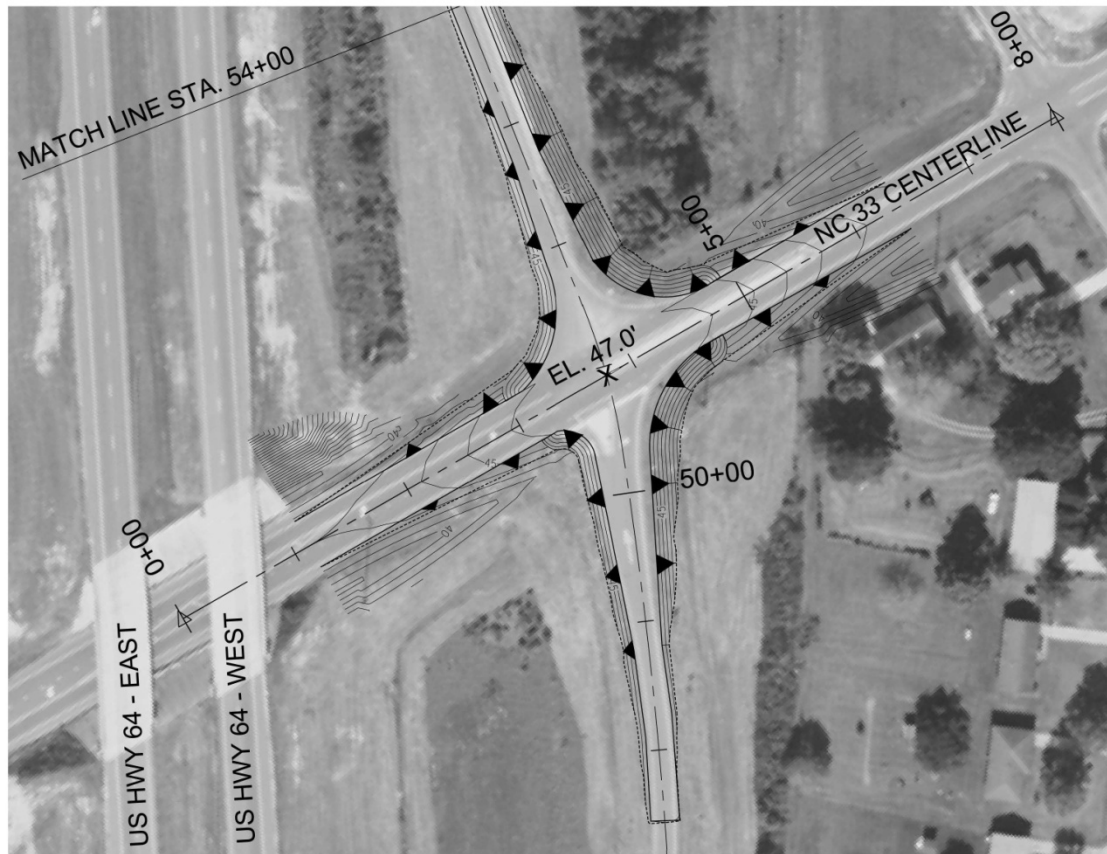


Figure 1.6 - N.C. Highway 33 Plan and Profile- Segment 1

1.5. Project Segment 2

Segment 2 (Figure 1.7 and Attachment 1 drawings CF103 thru CF105) begins at the N.C. Highway 33 interchange and extends in a northwesterly direction to the existing northern levee segment near the westbound bridge abutment of U.S. Highway 64 over the Tar River. The Recommended Plan includes improvements to U.S. Highway 64 and abandonment of the existing southern levee (previously called “Dike B”) and adoption of a portion of U.S. Highway 64 embankment as the new line of protection.

The existing levee includes 3,650 linear feet of U.S. Highway 64 extending southeast from the existing northern levee segment. The Recommended Plan includes construction of a “shoulder levee” adjacent to a low spot in the existing U.S. Highway 64 river side embankment. The “shoulder levee” will prevent overtopping up to the design event water surface elevation. The shoulder levee would be 3,450 linear feet long with a fill volume of 61,500 cubic yards. A portion of the shoulder levee would occupy approximately five (5) acres of wetlands on the river side of the existing levee. Wetland mitigation is addressed in paragraph 8.9 WETLANDS of the main report.

The shoulder levee would require construction of new earth levee adjacent to the river side of U.S. Highway 64. The new shoulder levee section will include: 3 horizontal to 1 vertical slope, a 10’ top width set at increasing elevation per increment, installation of 24” drainage pipe and inlet structures between the levee and east bound lane. Figure 1.8 is a typical section of the shoulder levee.

Pipes 13, 14, and 17 were identified to have no impact to the project. Pipes 16, 20, 21, 25 and 27 were included in the existing levee and were found to have flap gates currently installed. Due to the proposed shifting of the line of protection, pipes 16, and 20 will no longer require backflow prevention. Pipes 15, 18, 19, 22, 23 and 24 were identified as needing backflow preventers due to the realignment. Pipe 21 will require relocation with the new pipe as 60-inch RCP.

The Recommended Plan includes minor grading of the median ditches and installation of approximately 1500 linear feet of 24” pipe and 5 new inlets to maintain protection elevation within the median and to allow for proper drainage.

U.S. Highway 64 is the regional evacuation route as selected by emergency management agencies. Currently sections of the Highway can be overtopped during the 0.5 percent annual chance exceedance flood event. Corps staff met with representatives of NCDOT on February 28, 2014 to walk through proposed project features and implementation requirements, and exchange information. The Recommended Plan was developed based on meetings with NCDOT. The NCDOT District Engineer expressed preference to placing the proposed levee improvements adjacent to the eastbound lanes to protect U.S. Highway 64 as an evacuation route.

Table 1.3: Quantities for Recommended Plan - Segment 2

Elevation	47.0
Flap Gates (number of locations)	8
Clearing and Grubbing (acres)	7.5
Earthwork (cubic yards)	61,500
Swales (linear feet)	4,100
24" Drainage Pipe (linear feet)	1625
30" Drainage Pipe (linear feet)	50
36" Drainage Pipe (linear feet)	75
54" Drainage Pipe (linear feet)	75
60" Drainage Pipe (linear feet)	100
Drop Inlets	6
Clear vegetation from US HWY 64 Embankment (acres)	1.0

*Values in table represent total quantities to achieve the Recommended Plan.

The fill quantities were estimated using cross sections from a topographic map that was developed using 2007 LIDAR data with contour interval of 2 feet that was collected by the State of North Carolina. All vertical data was in North American Vertical Datum of 1988 (NAVD88). The topographic map was created with 1 foot contour interval. The fill quantity was calculated using the average end method in Bentley InRoads V8i.

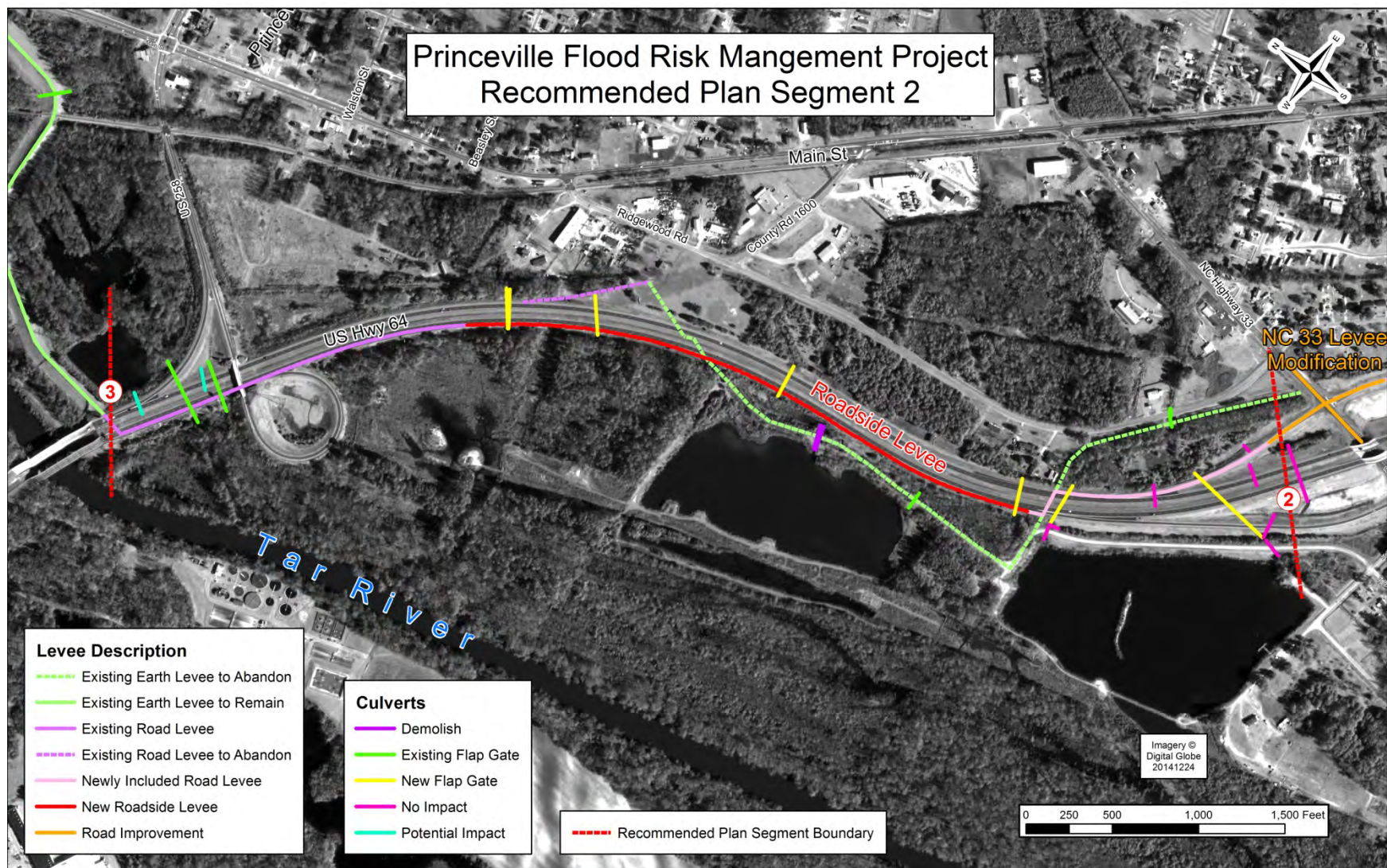


Figure 1.7 – Segment 2

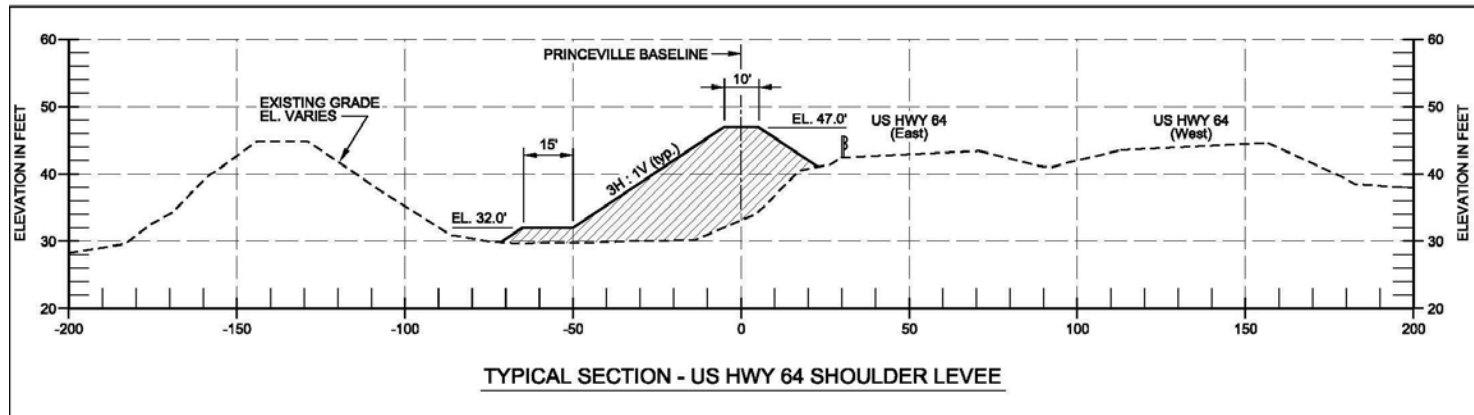


Figure 1.8 Typical Section Proposed Shoulder Levee – Segment 2

1.6. Project Segment 3

Segment 3 (Figure 1.9 and Attachment 1 drawings CF105 thru CF109) of the Recommended Plan includes the existing north segment of levee from the west bound lane bridge abutment of U.S. Highway 64 over the Tar River approximately 9,700 linear feet east to the terminus at U.S. Highway 258. This portion of the levee was topped in several locations during Hurricane Floyd. The breaches repaired during the recovery operations were restored to elevation of 48.0.

The existing earth levee includes 3 culverts that were identified to have existing flap gates in place and in working condition. The levee is penetrated at two locations, approximately 2,000 linear feet east of the bridge abutment with the CSX railway and 900 additional feet for Main Street. An existing stop log structure is located at the CSX crossing and is being stored indoors by Edgecombe County.

The Main Street Bridge over the Tar River connecting Princeville to Tarboro was recently replaced. The District coordinated with NCDOT thru the Section 408 process to ensure limited disturbance to the levee during the bridge construction, proper tie-in of the levee to the new abutment including providing a design roadway elevation of 48.5. The District has requested as-built surveys of the construction area including cross sections at the levee tie in points.

The Recommended Plan does not require modifications to the existing levee in Segment 3.

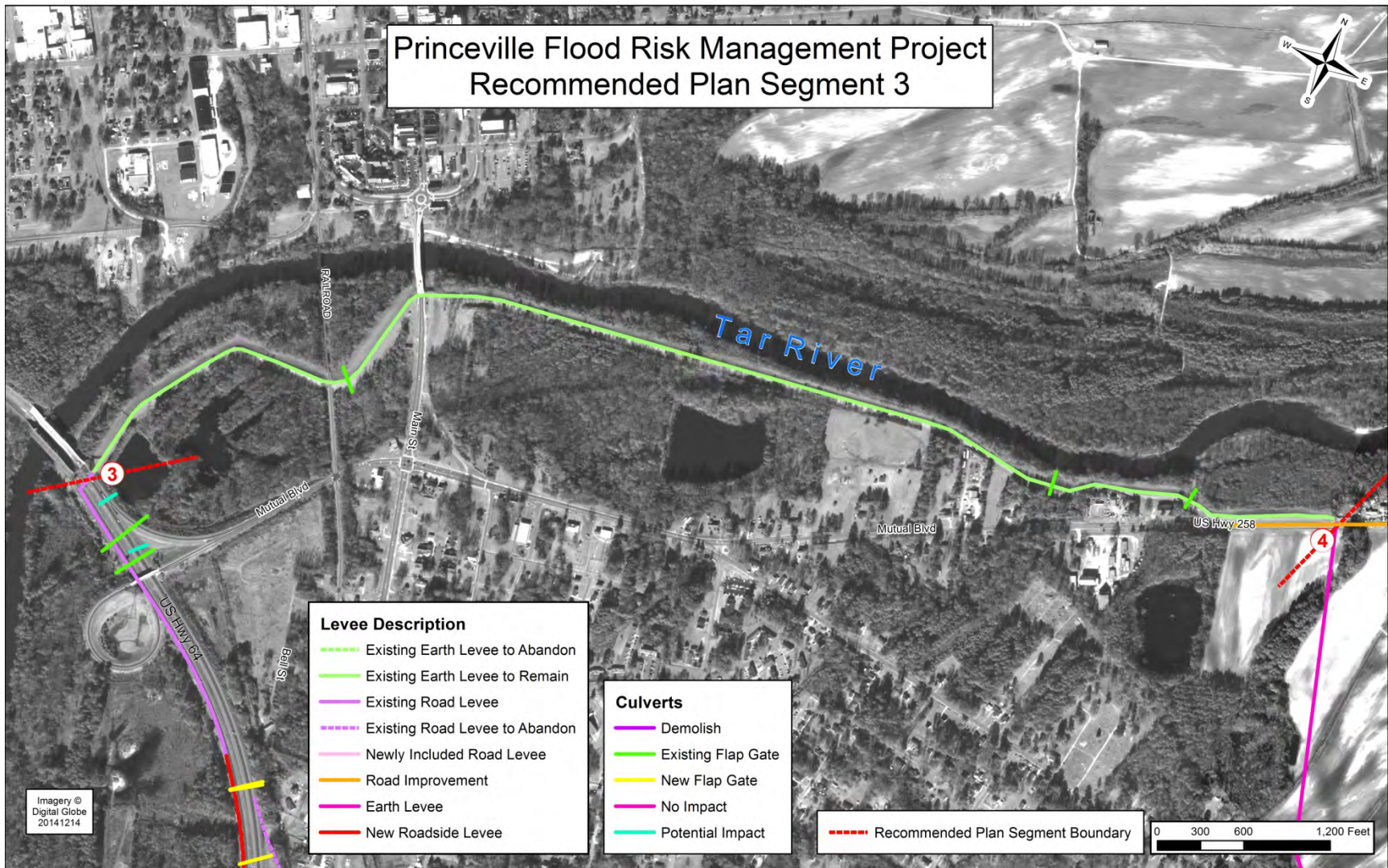


Figure 1.9 – Recommended Plan - Segment 3

1.7. Project Segment 4

Currently flooding in this area occurs as backwater from the Tar River fills the drainage ditches located in the area. Specifically, water enters thru culverts 32 and 33 filling the farm pond and drainage ditches within the fields which are approximately elevation 41. Floodwaters then fill the field (elevation 42) and adjoining ponds (pond at approximate elevation 36) which then crosses under U.S. Highway 258 bypassing the end of the existing levee.

The existing project terminates on ground that is approximately 3 feet lower than the top of levee with the existing top of levee being elevation 48 and the adjacent grade being elevation 45. Segment 4 (Figure 1.10 and Attachment 1 drawings CF109 thru CF114) is an extension of the existing northern levee segment (or northern extension) to high ground.

Based on how flooding occurs in this area, the Recommended Plan extends the existing levee system, provides a line of protection from the farm field ditches to the wooded wetlands and farm pond just south of U.S. Highway 258 adjacent to culvert 31. The line of protection is an earthen levee that will be extended to the southeast across U.S. Highway 258 across the field approximately 3,300 linear feet where it enters the N.C. Highway 111 right-of-way. The proposed levee alignment will require approximately 1,300 linear feet of U.S Highway 258 to be raised in order to raise the road over the elevation of the new line of protection (Segment 3). The proposed levee alignment will require approximately 3,350 linear feet of N.C Highway 111 to be raised in order to provide the required line of protection. The proposed levee along N.C. Highway 111 continues eastward to the intersection with Shiloh Farm Road where it will turn south for approximately 400 linear feet to tie to existing grade elevation of 49.0. The height of the N.C. Highway 111 proposed embankment will need to be raised 1 - 7 feet with the majority being less than 2 feet to elevation 49 in order to serve as the levee.

Four (4) existing culverts were identified along N.C. Highway 111. Culvert 34 will have no impacts to the project. Culvert 35, a double 27 inch diameter elliptical concrete pipe, will require lengthening, the installation of a new headwall and backflow prevention devices on the downstream (northern) end of the culvert. Culverts 36 and 37 appear to convey local drainage for shoulder drainage of the highway. Each of the culverts flows from riverside to the landward side of the line of protection into the project area and will be required to be removed.

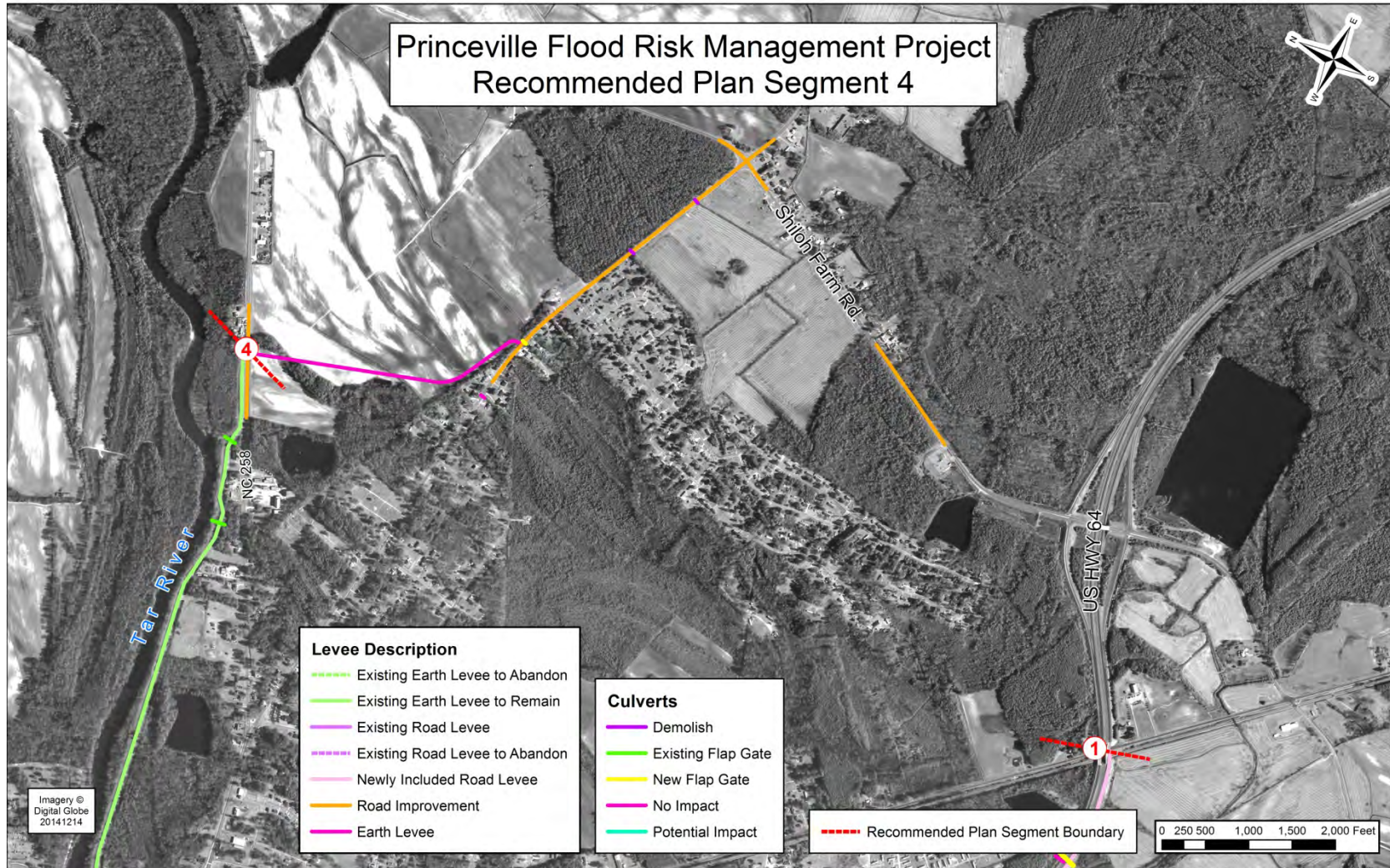
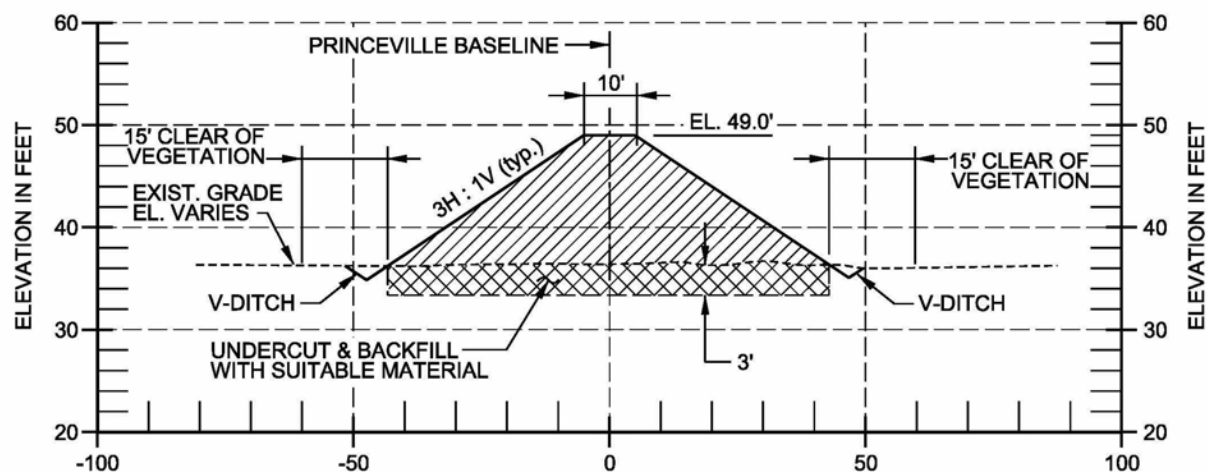


Figure 1.10 – Segment 4

The earthen levee (Figure 1.11) will consist of a 10 foot wide top with 3 horizontal to 1 vertical slope for the embankments. Height of the levee will average four (4) feet and will have an average bottom width of 35 feet. Additionally, a 15 foot wide vegetation clear zone will be established at the base on each side of the levee. A 100 foot wide right-of-way will be required thru the field for a total of approximately 10.5 acres of land. Additionally, the earthen levee will cross three small tributaries of the Tar River creating disturbance with two areas approximately 100 feet by 10 feet and one area approximately 100' by 25' or 0.1 acres of disturbance. The alignment of the levee was designed to avoid and minimize wetland impacts to the greatest extent practicable.

A subsurface geotechnical investigation is not available for the current alignment but is planned to be completed during PED phase. Based on previous experience, an organic laden layer of loam has been assumed to be located within the footprint of the levee thru the farm fields. Any organic material will be required to be removed within the foundation of the levee and backfilled with suitable material. Actual quantities will be verified during PED phase but a three (3) foot zone has been included in the quantity calculations.



TYPICAL SECTION - EARTHEN LEVEE - SEGMENT 4

Figure 1.11 - Typical Earthen Levee Section for Recommended Plan – Segment 4

Construction of the levee will require the installation of v-ditches along the levee base in order to provide positive drainage. The river side of the levee will require approximately 1,100 linear feet of ditching to divert drainage flowing from one field ditch toward the farm pond adjacent to the levee alignment into another field ditch connected to a farm pond north and east adjacent to culvert 32. The land side of the levee will require approximately 1,200 linear feet of ditching to divert drainage from culvert 34 toward the wooded wetland and farm pond adjacent to the levee.

U.S. Highway 258 is classified as a minor arterial highway and N.C. Highway 111 a major collector highway by the NCDOT with each highway having a posted speed limit of 45 mph. (Road classification based on map of Edgecombe County prepared by NCDOT Division of Highways – GIS Unit in coordination with the USDOT, 1994). Raising the roadway elevations will require upgrades to meet current design standards in the NCDOT Highway Design Manual. This will include the widening of the paved lanes from 10 to 12 feet, widening of the shoulder to include 4 feet of paved shoulder and 4 feet of grassed shoulder and installation of guard rail as necessary based on slope height. The shoulder is widened by 5 feet on the side containing the

guard rail to allow for its installation. There is a 200 linear foot transition between the segments. Figure 1.12 is a typical section for the Recommended Plan.

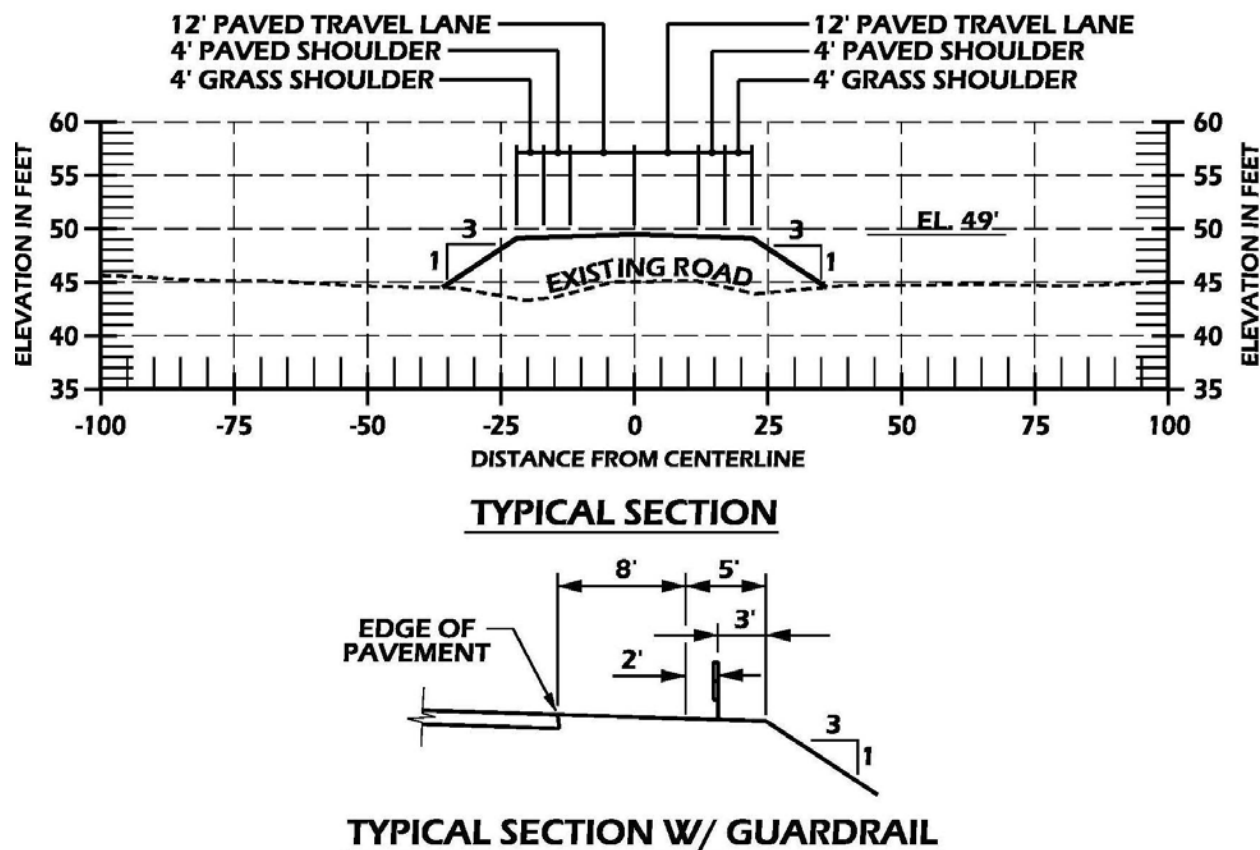


Figure 1.12 - Typical Sections for U.S. Highway 258, N.C. Highway 111 and Shiloh Farm Road – Segment 4

The design of vertical curves will be in accordance with the North Carolina Department of Transportation Highway Design Manual. Based on the posted speed limits and these guidelines, a K value of 150 was used for sags and a K value of 300 was used for crests. For U.S. Highway 258, the ramp over the earthen levee will require approximately 750 linear feet to the crest elevation of 49.0 and 550 linear feet back to existing grade for a total length of 1,300 linear feet. For N.C. Highway 111, the ramp up to the crest elevation of 49.0 will be approximately 550 linear feet. The transition down to existing grade at its intersection with Shiloh Farm Road will be 400 linear feet along each direction of the intersection.

Thirty seven (37) driveways will be adjusted to accommodate the road raise along N.C. Highway 111 and Shiloh Farm Road. The driveways are proposed to be constructed at varying slopes not to exceed 10% grade having a minimal 10' vertical curve in lieu of a single break point that could lead to grounding of the vehicle at the top or bottom of the slope. Generally speaking 8-10% is the typical maximum slopes for residential driveways with some areas of the country allowing 15% in "hilly" terrains, 12.5% is normal tolerance for comfortable pedestrian traffic and 7% for parking vehicles. NCDOT will allow driveways tying to roads with no curb and gutter to vary from 2 percent to 25 percent and does not have requirements beyond the right-of-way. Figure 1.13 is a typical driveway section for the Recommended Plan showing drainage away from the residential structure to a point 20 feet from the structure. It is not recommended to increase the driveway slope beyond 10 percent.

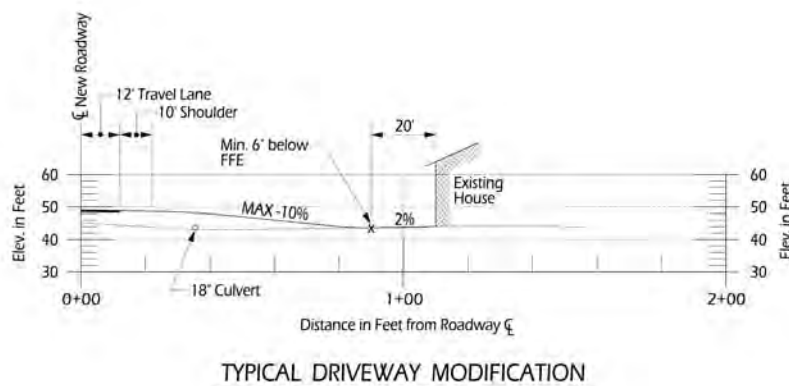


Figure 1.13 - Typical Driveway Section

In addition to the 37 driveways to be adjusted, one residential road, Strickland Drive, will require a ramp. The ramp is estimated to be 30 feet wide and 50 feet long. Strickland Drive serves as the only entrance for the Southern Terrace Subdivision. Access to the approximate 305 lot subdivision will be impacted with roadway improvements along N.C. Highway 111. In order to minimize disruptions to access and mixing of residential traffic with construction, a temporary access drive should be provided (Figure 1.14). A 20 foot wide 900 foot long 6 inch deep crushed aggregate base access drive is proposed to connect between Newton Avenue within the subdivision and Harris Hill Lane.

The Recommended Plan will require raising a low section of Shiloh Farm Road in-order to provide a consistent level of protection for all sides of Princeville. The road raising consists of a section starting approximately 2,500 feet south of the intersection of Shiloh Farm Road with N.C. Highway 111 and runs south for approximately 1,400 linear feet and will require up to 2 feet of fill to an elevation of 49.3. The proposed pavement section will match the existing 20' wide section for Shiloh Farm Road. Fill will match the existing 3 horizontal to 1 vertical slopes for the embankments.

Table 1.4: Quantities for Segment 4

Elevation	49.0
Flap Gates (number of locations)	1
Clearing and Grubbing (acres)	20.5
Excavation of unsuitable material (cubic yards)	32,100
Earthwork (cubic yards)	48,000
V-Ditches (linear feet)	3,300
Demolition Asphalt (square yard)	15,600
Demolition of Culverts (linear Feet)	80
Asphalt Roadway (square yard)	27,100
Asphalt Driveways (square yard)	2,500
Extend Culvert (linear feet)	25
Driveway Culverts (each)	27
Guard Rail (linear feet)	600
Gravel Drive (square yards)	2,700

*Values in table represent total quantities to achieve the Recommended Plan.

The fill quantities were estimated using cross sections from a topographic map that was developed using 2007 LIDAR data with contour interval of 2 feet that was collected by the State of North Carolina. All vertical data was in North American Vertical Datum of 1988 (NAVD88). The topographic map was created with 1 foot contour interval. The fill quantity was calculated based on typical cross sectional areas applied at changes in existing grade elevations.

1.8. Interior Drainage

Three interior storage areas would be connected to drainage pipes through the levee which would include flap gates. Interior drainage would prevent structure flooding up to the design event water surface elevation.

Princeville experiences localized flooding from intense, short-duration thunderstorms due to flat terrain and random blockages of drainage structures from debris accumulation. When the existing levee was designed in the 1960's, the runoff from the western and southwestern part of town was intended to drain into low areas adjacent to the levee. The interior drainage flow was intended to be discharged to the river through ten project outlets that penetrate the existing levee. These ten outlets are equipped with back-flow prevention devices that, under normal flow conditions, do not hinder runoff discharge from draining into the river and simultaneously prevent river flood waters from flooding the interior areas. When river water levels rise above the culvert outlets, runoff builds up behind the levee and is stored in the low areas adjacent to the levee. The areas in which this ponding occurs are large enough to contain the runoff, therefore flooding is kept from reaching any interior structures in areas inland of the USACE levee.

Structures in Princeville could be better protected from flooding when ponding occurs from floodwaters entering from un-gated culverts along the Tar River. The entire system, areas included in the original design and areas affected by the construction of new levees, was evaluated using EM-1110-2-1413 *Analysis of Interior Areas*. Any new levee construction would incorporate the necessary features for adequate interior drainage inside the new levee.

2.0 Surveying, Mapping, and Other Geospatial Data Requirements

Topographic map that was developed using 2007 LiDAR data with contour interval of 2 feet that was collected by the State of North Carolina. All vertical data was in North American Vertical Datum of 1988 (NAVD88). The topographic map was created with 1 foot contour interval. Topographic surveys will be conducted of each Segment during PED for preparation of construction documents.

3.0 Design Standards

Design criteria considered but were not limited to guidance provided in:

- a) North Carolina Department of Transportation, 2007, Roadway Design Manual.
- b) U.S. Army Corps of Engineers, 2000, Engineer Manual 1110-2-1913, Design and Construction of Levees.
- c) U.S. Army Corps of Engineers,, 1995 Engineer Manual 1110-2-1806 Earthquake Design and Evaluation For Civil Works Projects.

4.0 Constructability

Construction period anticipated is for three separate contracts as follows:

Contract #1 – US HWY 64 Shoulder Levee (Segment 2), 15 months;
Contract #2 – US 258 and Earthen Country Levee (part of segment 4), 15 months; and
Contract #3 - Intersection at NC HWY 33 (Segment 1) and HWY 64 ramps; plus NC 111 and NC 1523 (Shiloh Farm Road), 22 months.

Contract #3 construction will require traffic control sequenced to reduce interruption of traffic at 3 intersects. Note there may be a 5 month manufacturing lead time for large diameter flap gates has to be evaluated when considering each segment construction time periods.

5.0 Summary

The existing levees performed well providing protection for lesser, more frequent flood events. However, in 1999, the area was hit with Hurricanes Dennis and Floyd causing historic volumes in the Tar River. Based on the flooding observed during Floyd and current levee design guidelines, it was determined that the levee should be extended at both ends to natural grade equal to the elevation of the top of levee. The Recommended Plan proposes the following:

Segment 1 - The extension of the southern terminus will require raising the intersection of the west bound off and on ramp of U.S. Highway 64 and N.C. Highway 33. Two culverts will require backflow devices to be installed.

Segment 2 - Includes improvements to U.S. Highway 64 and abandonment of the existing southern levee (previously called “Dike B”) and adoption of a portion of U.S. Highway 64 embankment as the new line of protection. Construction of a “shoulder levee” adjacent to a low spot in the existing U.S. Highway 64 river side embankment. The “shoulder levee” will prevent overtopping up to the design event water surface elevation.

Segment 3 - The Recommended Plan does not require modifications to the existing levee.

Segment 4 - Extends the existing levee system, provides a line of protection from the farm field ditches to the wooded wetlands and farm pond. The line of protection includes: an earthen levee, approximately 1,300 linear feet of U.S Highway 258 to be raised, approximately 3,350 linear feet of N.C Highway 111 to be raised, and approximately 700 linear feet of Shiloah Farm Road to be raised.

Interior Drainage - Three interior storage areas would be connected to drainage pipes through the levee which would include flap gates. Interior drainage would prevent structure flooding up to the design event water surface elevation. The entire system, areas included in the original design and areas affected by the construction of new levees, was evaluated using EM-1110-2-1413 *Analysis of Interior Areas*.



Figure 1.14 – Temporary Access Drive Location – Segment 4