Appendix G
ECONOMICS

Appendix G

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

Economics

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1.0 Introduction

1.1 Purpose and Scope

This section summarizes the economic information for the Princeville Flood Damage Reduction Feasibility Study. The study is being carried out under the Corps of Engineers' General Investigation (GI) program to develop and evaluate alternatives for implementing solutions to flooding and related problems for the Town of Princeville, Edgecombe County, North Carolina. The analysis identifies the extent of the economic impact from flooding with the existing project and, on a comparable basis, evaluates the range of Measures to increase project performance considered in the study. The analysis first requires a risk-based analysis of the flood problem under the existing condition (existing levee). The future without project condition is then determined, and finally a risk-based evaluation in terms of benefits, costs, and performance of various alternatives under the with-project condition is completed. This study is being cost shared by the Army Corp of Engineers – Wilmington District and the State of North Carolina – Department of Environment and Natural Resources.

1.2 References

This analysis was accomplished under the procedures outlined in the following: Economic and Environmental Principles and Guidelines for Water and Related Resources Implementation Studies (P&G); Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, dated 22 April 2000; ER 1105-2-101, Planning, Risk Analysis For Flood Damage Reduction Studies, dated 3 January 2006; and Risk-Based Analysis for Evaluation of Hydrology/Hydraulics and Economics in Flood Damage Reduction Studies (EC 1105-2-205), dated 25 Feb 1994.

1.3 The Problem

Following construction of the original levee, Hurricane Floyd in 1999 was the most significant and damaging flood event in the Princeville area. Under current conditions, floodwaters would initially enter Princeville at an approximately 5% chance event with actual flood damages beginning to accrue thereafter. Potential flood damages by event frequency escalate rapidly above an approximate 1.5% chance event to the 0.2% event (Floyd)

1.4 Authorization

The Princeville Flood Risk Management Study proposes modifications to a flood risk management project for the Town of Princeville, Edgecombe County, North Carolina, authorized under Section 205 of the Flood Control Act of 1948, as amended. The Main Report and accompanying documentation is provided under Section 216 of the Flood Control Act of 1970, 33 U.S.C. 549a, which authorizes the Secretary of the Army, acting through the Chief of Engineers, to review flood control projects previously constructed by the Corps of Engineers and to report to Congress on the advisability of any recommended modifications. Initial funding for the study was specifically provided in the Emergency Supplemental Act, 2000, (Public Law No. 106-246, Division B, Chapter 2), dated July 13, 2000, which appropriated $3.5 million in additional General Investigations funds, of which

$1.5 million "shall be for a feasibility study and report of a project to provide flood damage reduction for the Town of Princeville, North Carolina." Additional direction was provided in an Executive Order (E.O. 13146) issued on February 29, 2000, by President William Clinton, which required, in part, "agency assessments and recommendations to repair and rebuild Princeville, and, *to the extent practicable, protect Princeville from future floods*" (emphasis added). Preconstruction engineering and design (PED) activities, if funded, would be continued under the Section 216 study authority cited above.

2.0 Existing Conditions

2.1 Study Area Location and Description

The Town of Princeville is a small community of approximately 2,100 residents, located in the east central area of Edgecombe County. The city limits encompass a 1.39 square-mile area in the alluvial floodplain on the left descending bank of the Tar River, immediately across the river from Tarboro, North Carolina; refer to Figure 2.1Project Location Map. The study area is located in the eastern portion of North Carolina in the 1st Congressional District. The Tar River basin lies entirely within the State of North Carolina, and has a drainage area of 2,140 square miles above the towns of Tarboro and Princeville. The total drainage area of the Pamlico-Tar basin is about 3,610 square miles. The basin begins in the Piedmont Plateau, extends in a southeast direction, crosses the "Fall Line", and traverses the Coastal Plain to the Pamlico River and then on to Pamlico Sound. It is approximately 160 miles long and has an average width of 30 miles. The basin is primarily an agricultural area, with some manufacturing and lumbering. Corn, tobacco, and cotton are the principal crops. Rocky Mount, Tarboro, Princeville, Greenville, Henderson, and Washington, are among the towns located in the basin. The Town of Princeville has the unique historic significance of being the first town chartered by African Americans in the United States. Newly freed slaves originally settled the area that is now Princeville, shortly after the Civil War, in 1865. In February 1885, the North Carolina General Assembly passed the act to incorporate the town of Princeville, making it the nation's oldest black incorporated town.

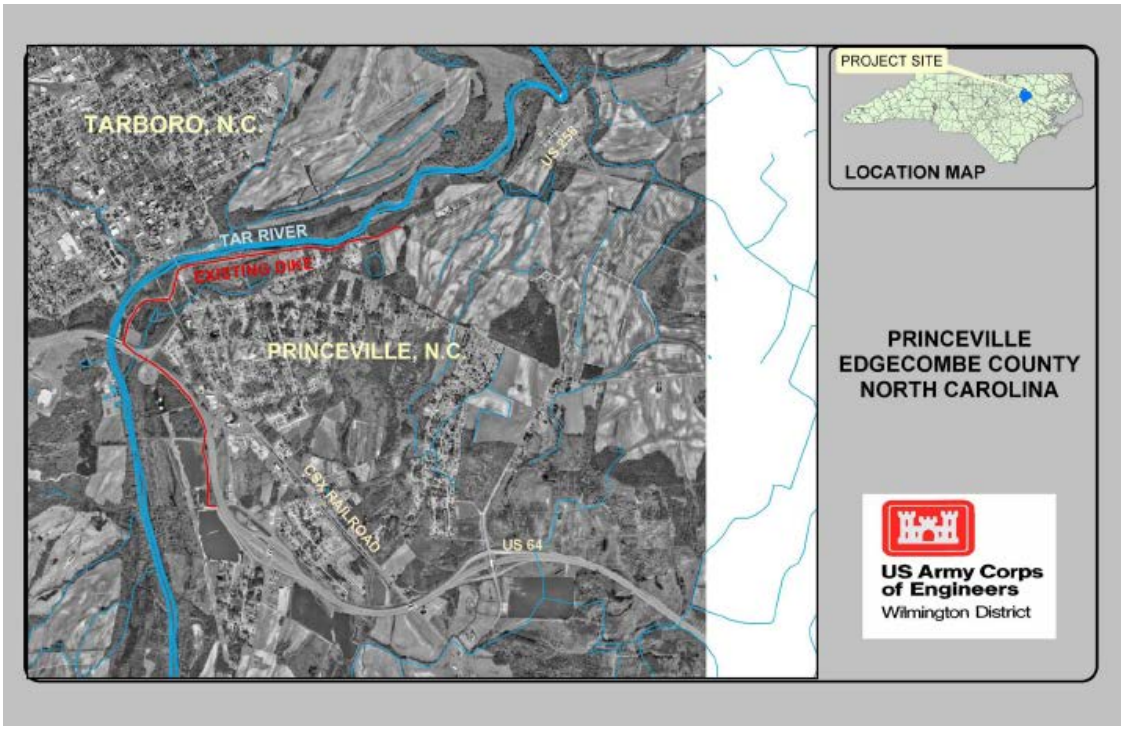

Figure 2-1: Princeville, North Carolina Study Area

2.2 Existing Socio-Economic and Demographic Characteristics.

2010 census statistics estimated the population in Edgecombe County was 56,552 persons, with 21,680 households and 14,842 families. The population density was 111.6 people per square mile (43/km²). The population estimate of 56,552 is an increase from the 2000 census of 1.7%. Of the 100 NC counties in 2010, Edgecombe ranked 50th in size and 95th in per capita income ($16,747).

Table 2.1: Local and Regional Population Comparisons,1990- 2010 Census

Year	Princeville	Edgecombe County	North Carolina
2010	2,082	56,552	9,535,471
2000	940	55,606	8,049,313
1990	1,652	56,558	6,628,637

Data from the corresponding US Census survey was used for population estimates

Edgecombe County has gradually lost residents since the late 1980s. This condition can be attributed to a decline in the farming economy and a shift to a service economy, mainly concentrated in more urbanized areas. Table 2.1 displays the population trends from 1990 to 2010, for Princeville, Edgecombe County, and North Carolina. While this table shows a

sharp decline in Princeville's population in 2000, it is important to note that roughly half of the populous was displaced by the impacts Hurricane Floyd. Table 2.1 indicates recovery beyond pre-storm population levels by 2010.

According to the U.S. Census Bureau Fact Sheet (2006-2010 Estimate), the majority of the population in Princeville was African-American, at 96.3 percent. 2.6 percent of the population was reported to be white, and the remaining percentage was reported as "other". The percentage of African-Americans in Princeville greatly exceeds those of the state, and nation, which were reported at 21.5 and 12.6 percent, respectively.

In 2010, there were 775 households in Princeville, out of which nearly 30% had children under the age of 19 living with them, 28% were married, living together, and 29.8% were non-families. 26.5% of all households were made up of single individuals and 11.5% of the population is someone who was 65 years of age or older. The average household size was 2.69 and the average family size was 3.25.

2010 Census data states that the population of Princeville included 30.8% under the age of 19, 6.5% from 20 to 24, 21.4% from 25 to 44, 29.8% from 45 to 64, and 11.5% who were 65 years of age or older. The median age was 38 years. For every 100 females there were 81.5 males. For every 100 females age 18 and over, there were 76.9 males. The U.S. Census Bureau Fact Sheet (2006-2010 Estimate) indicates a median income for a household in the town of $21,066, which is 40.4% of the national average of $51,914. It also indicates a per capita income for the town of $12,024, which is 43.9% of the national average which is $27,334. About 38.9% of the population is below the poverty line; 2.8 times the national average.

Much of economic activity in Princeville revolves around production and service occupations, with some employed in sales and construction. Per the 2010 Census data, production, transportation and moving services accounted for 34.9% of employment followed by service occupations (28.9%), sales and office (18.0%), management, professional, and construction, extraction and maintenance. By comparison, in 2010, production, transportation and material moving were the largest of 20 major sectors in Edgecombe County. It had an average wage per job of $31,527. Per capita income grew by 19.0% between 1995 and 2005 (adjusted for inflation). Table 2.2 displays this regional and state employment distribution by activity.

Table 2.2: 2010 Occupation Distribution, by Percent

Occupation	Princeville	Edgecombe County	North Carolina
Management, professional, and related occupations	12.8	20.4	33.9
Service Occupations	28.9	18.8	16.0
Sales and office occupations	18.0	23.4	24.4
Farming, fishing, and forestry occupations	0	1.51	0.7
Construction, extraction, and maintenance occupations	5.3	5.1	10.6
Production, transportation, and material moving occupations	34.9	26.1	14.4

Source: 2010 U.S. Census

3.0 Future Without Project Conditions

3.1 Future Without Project Socio-Economic and Demographic Projections

"Future Without-Project Conditions" comprise forecasts for potential future conditions based on best available data concerning existing conditions, on-going trends, and probable future occurrences. The forecasts are given for a defined "period of analysis" of 50 years, during which time changing climatic, weather, land use, and hydrologic conditions may impact a project. Forecasting these conditions can be subjective and difficult, but it is essential in order to determine the necessity for, and effectiveness of, proposed flood risk management projects. The Princeville community under Future Without-Project Conditions assumes that there would be no new flood risk management measures developed and implemented.

North Carolina Office of State and Budget Management data for Edgecombe County, reported in 2010, shows a decline in the population, projecting to 2030. These estimated projections show a possible decline of around 20 percent of the population. While future without project conditions for the socio-economic climate of Princeville cannot be accurately estimated, it is assumed that the town will follow regional trends, and decline in population as migration to more urban areas continues. Table 3.-1 provides an interpolated projection of the population in Edgecombe County.

Table 3-1 Edgecombe County Population Growth Projections 2010 – 2030

	Population 2010	Population 2020	Estimated Population 2030	Population Change 2010 to 2020	Estimated Population Change 2020 to 2030
Edgecombe County	56,552	54,348	52,308	-2,204	-2,040

US Census Bureau

While future without project conditions for the socio-economic climate of Princeville cannot be accurately estimated using County population projections as a proxy, it is assumed that the town will follow regional trends and decline in population as migration to more urban areas continues, perhaps realizing some growth during the latter half of the period of analysis, as suggested by the current County population projections.

Perpetuation of the existing conditions and associated sporadic flooding will continue to impact housing and commercial property values, commercial enterprise, agriculture, commerce, and the existing infrastructure in the Town of Princeville, the latter of which currently represents a large Federal and non-Federal investment. Area residents and supporting agencies and businesses will continue to incur additional post-flood recovery costs associated with continuing periodic flood inundation. The absence of further risk reduction would most likely result in declines in economic and social attributes. Additionally, in the future without-project condition, long-term exposure to flood risks at the level they are, and will be, may cause further degradation of the community as a whole.

4.0 Project Alternative Comparison

4.1 Goals

The primary planning study (and potential project) goals for the Princeville feasibility study, as established by the residents, County, State of North Carolina (Local Sponsor), and Presidential Executive Order are:

- Assess the flooding problems and to "protect the town from future floods "to the extent practicable." (Executive Order No. 13146).[1]
- Improve flood risk management for the Town of Princeville, thus better-protecting and preserving the social fabric of this nationally-important cultural resource, better protect Federal and local investments, reduce risks to life and safety, and substantially reduce flood inundation damage to the community.

[1] Executive Order No. 13146 – President William J. Clinton, February 2000: Federal Assistance for the Future and Sustainability of Princeville, North Carolina.

4.2 Objectives

In order to satisfy the primary goals, the following Objectives were identified:

- Evaluate the existing flood risk reduction system at Princeville, its current level of floodflow exclusion, and where needed, provide a cost-effective, technically-sound, and environmentally acceptable plan to better promote the exclusion of floodwaters from the town to a frequency substantially lower than that which currently exists, and so doing, reduce monetary flood inundation damage potential by at least 75%.
- Evaluate and ensure the adequacy of plans for flood warning and evacuation, and for Flood Risk Management Education and Communication for the residents. Key in the latter is the assurance of adequate access to flood egress routing before and during large flood events. This would provide local residents and community officials with adequate knowledge to make sound decisions regarding their flood risk, allow timely evacuation, and ensure a reduction in risk to life and safety to residents during flood periods.
- Address floodflows entering town through existing ungated culverts in the existing Highway 64 embankment, which currently cause damage in low-lying areas.
- Address floodflows from entering town through the existing underpass at Highway 33, by various structural measures, to substantially reduce flooding from that source, and better ensure egress by that route.
- Address overtopping of the existing levee and subsequent overtopping, at an existing low spot on Highway 64, by structural means, to substantially reduce flooding from that source, and to better ensure egress and continued use of Highway 64 during hurricane events.
- Address floodflows circumventing the levee system at its northern terminus, and substantially reduce frequency of inundation to residences.
- Reduce hazards for drowning or trapping residents within lower-lying portions of town, by both non-structural and structural means.
- Reduce threats to existing and future Federal and local investment. This includes Federal investments made to the Town Hall, community center, HUD-funded housing developments, and others, by structural means.
- Enhance long-term community sustainability through reduction of flood threats.
- Reduce flood risk to primary services such as town government, community services, police, and fire, so they remain effective during and after large flood events.
- Improve the interior drainage system to remove threats caused by interior floodwaters, during periods in which floodwaters within the Tar River are high enough to cause ponding behind the existing levee, when normal drainage outlets are closed.

4.3 Identification of Management Measures

Following determination of problems and opportunities, and development of goals and objectives, a set of measures were developed. A **Measure** is a feature or activity to be accomplished at a specific site for the purpose of addressing the project goals and objectives. Types of Measures are as follows:

Measures are considered either Structural or Non-structural:

- A **Structural Measure** is a built **feature** which would address project objectives.
- A **Non-structural Measure** is an **activity** which could be implemented to address project objectives.

Numerous measures were identified which could accomplish project goals and objectives under these six options. The complete list of all applicable measures follows:

Structural Measures:

- Upstream dams/reservoirs
- River channel enlargement
- Modify existing bridges
- Bypass channel
- Drainage modification
- Flood proofing structures
- Ring levees
- Raise existing levee
- Existing levee extensions
- Culvert modifications

Non-Structural Measures:

- Elevate and raise structures
- Acquisition of structures/properties and relocation of residents
- Flood warning
- Evacuation
- Flood risk management education and communication
- Zoning changes
- Floodplain restrictions

These measures and alternative alignments are further expanded on in Section 5.1 and 5.2 of the Main Report.

4.4 Initial Evaluation of Alternative Plans

Evaluation of alternative plans is based primarily on a comparison of existing (it should be noted that existing and future conditions are expected to be the same, under the belief that there will be little development in the river basin or floodplain over the 50 year planning horizon) conditions to each of the with project alternative conditions. The benefits of the alternatives are measured as the gain (change) in flood risk management benefits over the future without project conditions. The costs of implementing each of the alternatives are then compared with the benefits provided by that alternative, using cost effectiveness criteria, as described in the Corps of Engineers Evaluation of Environmental Investments Procedures Manual IWR Report #95-R-1 Initial costs of the previously mentioned measures are listed in table 4.1 below:

Table 4.1 Summary of Planning Level Total Cost Estimates for Options & Measures

Options/ Measure(s)	**Total Planning Level Cost** (2010 Dollars)
Option 1 – Eliminate Risk Through Acquisition and Relocation	$540,000,000
Option 2 – Reduce Risk / Modify Existing Levee	
Northern Ext – Alignment A	$29,500,000
Northern Ext – Alignment B	$29,500,000
Northern Ext – Alignment C	$29,600,000
Northern Ext – Alignment D	$34,900,000
Northern Ext – Alignment E	$32,000,000
Northern Ext – Alignment F	$34,900,000
Northern Ext – Alignment G	$34,000,000
Eastern Ext – Alignment H	$28,800,000
Eastern Ext – Alignment I	$21,100,000
Option 3 – Reduce Risk / Raise Existing Levee	
Raise Levee and Mitigate Induced Flooding Damages	$91 million, not including mitigation costs
Option 4 – Reduce Risk / Large Scale Measures	
Upstream Dams & Reservoirs.	>$91,000,000, not including mitigation costs
River Channel Enlargement	>$50,000,000, not including mitigation costs

Modify Existing Bridges	>$15,000,000, not including mitigation costs
Bypass Channel	$150-$400,000,000, not including mitigation costs
Option 5 – Non Structural Measures	
Flood proof Structures	$75,000,000 - $100,000,000
Elevate Structures by Raising	$24,000,000 (applies to only 25% of structures)
Flood Warning and Evacuation	Will be updated as part of on-going State and local efforts
Zoning	Minimal; would be implemented with other measures
Floodplain Restrictions	Has been implemented by Town of Princeville
Option 6 – Bring Existing Levee up to Current Levee Standards	Not needed (see discussion in Geotechnical, below)

4.5 Initial Measures (Alternatives) Evaluated

The Wilmington District presented a wide variety of potential structural and nonstructural damage reduction measures to the town, county, and state governments. These measures included upstream reservoirs, channel and bridge conveyance improvements, a bypass channel, levee modifications, flood proofing, elevation, and relocation. Many of these measures were dropped from further consideration due to social, environmental, or technical reasons before costs and benefits could be estimated. The initial measures were compared to existing damages, in absence of a Future Without hydrological analysis. It is believed that damage conditions will most likely remain static, given lack of future development or infrastructure improvements. The Without Project damages are listed in table 4-3

The only measure remaining after preliminary screening was modification of the existing levee. Such a modification could include combinations of raising and lengthening the existing levee, but not to the elevation of requiring a ring levee, or reducing the conveyance of the Tar River floodplain. An increase in the existing levee elevation, for the main part of the levee, was determined to cause an increase in the river flood stages and so screened out. Further investigation of levee modification consisted of differing alignments to extend the levee to prevent flanking by floodwaters where the existing ground is low. Results of initial measure screening are listed in the Main report in sections 5.1 and 5.2

4.6 Alternatives

The following are Alternative plans which have been formulated from various combinations of the Measures. All Alignments include Flood Warning and Evacuation Plan, Flood Risk Management Education and Communication Plan, Backflow devices S side, and interior drainage. Some measures would result in permanent relocation of all the residents out of the flood prone land that is now the town of Princeville.

A. For the initial increment of flooding, flow begins to occur at an approximately 5% chance flood event, through the group of culverts along the U.S. Highway 64 embankment. This is discussed as flooding Increment 1. **Analysis:** There is approximately $340,000 in average annual damages preventable within the zone covered by the first increment of flooding. The majority of these structures are slab-on-grade, or low foundation wall construction. Purchase and removal costs for this group of structures exceeds the cost of installing flap gates on existing culverts, therefore the non-structural floodproofing measure for this increment was screened from further consideration. By far, the simplest and most cost-effective measure, consisting of flapgate installation and culvert modifications (to only those culverts currently passing flow from the river back into the Town of Princeville through existing levees and embankments) was also deemed technically viable, and environmentally sound, and was carrried forward as the only remaining solution to flood inundation arising from that source (Increment 1) of flooding. This preliminary alternative would also include non-structural measures such as updated floodplain management, updated evacuation plans, and others. **This group of measures is henceforth referred to as Alternative 1. The preceding group of measures comprising Alternative 1 possesses an approximate 45% probability of containing the 1% chance flood event.**

B. The next increment of flooding occurs either by floodflows entering town through the highway underpass at the junction of N.C.Highway 33 and U.S. Highway 64, or, by overflow of the U.S. Highway 64 embankment upstream of that point, over a low spot in the highway. Potential measures or alternatives to eliminate these sources of flooding could be built at a lower or higher level of flood exclusion; therefore, flooding issuing from these two points, but at a lower or higher elevation of flood depth, is henceforth referred to as flooding Increment 2. There is approximately $423,000 in average annual damages preventable within the zone covered by the second, and approximately $442,000 within the third increment of flooding.

There are three possible measures or preliminary alternatives that can be applied to provide flood risk reduction for Increment 2 of flooding. These consist of: a) purchase and removal of structures and contents from the zone affected by Increment 2, b) a stop-log structure at the underpass of Highway 33 at Highway 64, combined with a saddle or shoulder levee on the low spot on Highway 64, or c) interchange raising at the interchange of Highways 33 and 64, combined with a shoulder levee on the low spot on Highway 64. **Analysis:** For Increment 2, the majority of structures are primarily slab-on-grade, and also low foundation wall construction. Purchase and removal costs for this group of structures far exceeds the cost of installing either a stop-log structure at the underpass, or by modification of exit and entrance ramping and the roadway of N.C. Highway 33

which connects them, and by installation of a shoulder levee applied to the inside (landward) or outside (riverside) slope of the Highway 64 embankment. Additional analysis of the stop-log at Highway 33/64 interchange indicated that the height necessary, and risks associated with long-term reliability in its consistent application, would be far outweighed by the reliability of the interchange raising measure. Consequently, the stop-log measure was also dropped from further consideration. This preliminary alternative would also include non-structural measures such as updated floodplain management, updated evacuation plans, and others. Thus**, the screened pairing of measures/preliminary alternative consisting of an interchange raising at Highways 33 and 64, combined with a lower shoulder levee is henceforth discussed as Alternative 2 (reducing risk from Increment 2 flooding). The preceding group of measures comprising Alternative 2 possesses an approximate 45% probability of containing the 1% chance flood event.**

C. Additional risk reduction, to solve flooding Increment 3, can also be achieved by the following measures or preliminary alternatives: a) adding additional structures to a buy-out and removal plan, or b): by raising both the interchange at Highways 33 and 64, and also adding additional height to the saddle levee on Highway 6**4. Analysis:** Purchase and removal costs for this group of structures also far exceeds the cost of installing a higher exit and entrance ramp and higher saddle levee, thus, the purchase and removal opportunity was dropped from further consideration. Thus, only the saddle levee on Highway 64, and the interchange raising at Highways 33 and 64, were carried forward for further consideration. This preliminary alternative would also include non-structural measures such as updated floodplain management, updated evacuation plans, and others. **The screened pairing of a preliminary alternative consisting of a higher interchange raising at Highways 33 and 64, combined with a higher shoulder levee is henceforth discussed as Alternative 3 (reducing risk from Increment 3 flooding). The preceding group of measures comprising Alternative 3 possesses an approximate 65% probability of containing the 1% chance flood event.**

D. For the next increment of flooding, inundation can occur by floodflow circumvention of the existing levee at its northern terminus, and by overtopping of roadways on the north and east perimeter of town. Flooding from these sources is referred to as flooding Increment 4. There are many preliminary alternatives that can provide risk reduction for floodflows issuing from this source. These consist of: a) purchase and removal of all structures and contents within the fooprint impacted by floodflows circumventing the levee at its northern terminus, and also from additional sources overtopping Highway 258 and Shiloh Farm Road, or b): structural measures discussed for Increments 1 and 3 above, combined with a number of new levee extensions running along various alignments, to connect the northern and southern terminii of the levee, protecting remaining portions of the Town of Princeville. **Analysis:** Purchase and removal costs for this group of structures consists of the vast majority of structures within the Town of Princeville (an estimated cost of between $86 and $90 million), which far exceeds the cost of various structural measures discussed as Increments 1 and 3, and those measures comprising Increment 4 discussed below. A number of alternative levee alignments were also analyzed, as shown in Figure 5.3 and discussed in Table

5.2. Alignments A through H protect a greater number of structures, some of which are not in the footprint of the Town of Princeville, but all at a much more significant cost per structure, and overall cost as shown in Table 5.2. Refinement of an alignment along preliminary Alignment "I" was demonstrrated to be most cost-effective, and also maximized risk reduction to both life and property, of all those alignments analyzed, and was optimized along alignment "I" as modified, shown in Figure 5.3, in purple. The group of structural measures consisting of flap gates along the Highway 64 embankment (Increment 1), saddle levee on Highway 64 and interchange modifications at Highways 33 and 64 (Increment 3), plus the new levee extension running along Alignment "I" modified, to connect the northern and southern terminii of the levee, and protecting remaining portions of the Town of Princeville, and interior drainage management features (Increment 4), **is henceforth discussed as Alternative 4.** This preliminary alternative would also include non-structural measures such as updated floodplain management, updated evacuation plans, and others. **The preceding group of measures comprising Alternative 4 possesses an approximate 76% probability of containing the 1% chance flood event.**

E. For the next increment of flooding, which occurs at flood depths averaging two feet higher than those addressed by Increment 4, many additional measures would be required to prevent inundation of the Town of Princeville. This additional increment of flooding is henceforth referred to as flooding Increment 5. Measures formulated to provide risk reduction for this increment of flooding could be addressed by either a non-structural plan consisting of purchase and removal of almost all structures within the Town of Princeville, and many low-lying structures within the Town of Tarboro, at an estimated cost in excess of $150 million, or the following structural measures, including: a) addition of closure structures at the underpass at the interchange at Highways 33 and 64, at the CSX Railroad, and at the Main Street bridge; b) further raising and extending the shoulder levee applied to the inside slope of the Highway 64 embankment; c) by raising and extension of the levee extension discussed above, and including longer portions of a raised system on Highways 258 and NC-111; d) the fixing of additional low spots and areas of lower ground on the existing levee structure; e) a short reach of floodwall along the northern levee extension; and f) raising of Shiloh Farm Road south of NC-111. This group of measures, while providing a consistent level of risk reduction for the entire town and project reach, would cause induced impacts to the Town of Tarboro, which would have to be mitigated by installation of additonal measures including floodwalls and levee modifications adjacent to Tarboro, and also potential modification of Highway 64 and its bridge over the Tar River, to prevent entry of floodflows from that source, and to prevent backwater effects upstream. **Analysis:** Purchase and removal costs for this group of structures consists of the vast majority of structures within the Town of Princeville (an estimated cost of over $150 million), exceeds the cost of various structural measures discussed as Increments 1, 3, 4 and 5, and was thus, screened from further consideration. The measures contained in this alternative would create a deeper ring levee condition, which would create a higher hazard when overtopped. As ingress and egress from town would no longer be possible by virtue of overtopping elsewhere along Highway 64, the key evacuation route from points east, it is carried forward for further comparison. **This group of measures is henceforth discussed as Alternative**

5. The preceding group of measures comprising Alternative 5 possesses an approximate 98% probability of containing the 1% chance flood event.

F. For the next increment of flooding, henceforth referred to as flooding Increment 6 all measures discussed above in Increment 5 would be modified to provide an even higher level of flood risk reduction, equivalent to an approximately two foot higher project. This additional increment of flooding could be addressed by either a non-structral plan consisting of purchase and removal of almost all structures within the Town of Princeville, and a larger percentage of structures within the Town of Tarboro, at an estimated cost in excess of $200 million, or the following structural measures, including: a) addition of an even higher group of closure structures at the underpass at the interchange at Highways 33 and 64, at the CSX Railroad, and at the Main Street bridge; b) further raising and extending the shoulder levee applied to the inside slope of the Highway 64 embankment; c) further raising and extending the levee extension discussed above, and including longer portions of a raised system on Highway 258; d) the fixing of additional low spots and areas of lower ground on the existing levee structure; e) a short reach of floodwall along the northern levee extension; and f) the raising of the entirety of Shiloh Farm Road. This group of measures, while providing a consistent level of risk reduction for the entire town and project reach, would cause additional induced impacts to the Town of Tarboro, which would have to be mitigated by installation of additonal measures including even higher floodwalls and levee modifications adjacent to Tarboro, and also the raising of Highway 64 and its bridge over the Tar River, to prevent entry of floodflows from that source, and to prevent backwater effects upstream. **Analysis:** Purchase and removal costs for this group of structures consists of the vast majority of structures within the Town of Princeville and many within the Town of Tarboro (an estimated cost of over $200 million), exceeds the cost of various structural measures discussed as Increments 1, 3, 4, 5, and 6, and was thus, screened from further consideration. As with Increment 5, the measures contained in this alternative would create a deeper ring levee condition, which would create a higher hazard when overtopped. As the key ingress and egress from town necessary for evacuation from points east, it is carried forward for further comparison. **This group of measures is henceforth discussed as Alternative 6. The preceding group of measures comprising Alternative 6 possesses an approximate 99% probability of containing the 1% chance flood event.**

4.7 Economic Survey Overview.

An initial data collection effort for the feasibility study was accomplished by GREENHORNE & O'MARA, INC accompanied by MA Engineering Consultants, INC., Cary, NC, to serve as the traditional (non GPS) survey crew. The logistics of data collection were coordinated and checked for completeness and efficiency.

At each structure:

- A "shot" was taken as close as possible to, but within ten feet (10') of the front door at the finished floor elevation;
- Additional shots were taken at the existing grade elevation adjacent to the front door, and at the lowest grade on the lot/parcel;
- Attribute data was entered into the data collectors pertaining to the structure's street address, status, condition and type;
- A digital photo was taken of the structure;
- A log sheet was completed as redundant data record and the digital photo file name was added;
- The structure was marked on a copy of the local GIS map to prevent duplicate locations;

The purpose was to provide horizontal and vertical data, as well as attributes describing a structure's type, status and condition, in a GIS SDSFIE STANDARD Geodatabase for use in the Princeville Flood Reduction Study.

For later iterations of the report, a method employing the latest LIDAR data for the area was employed. This method allowed to team to resurvey the ground elevations, in conjunction with the latest Edgecombe County tax data. This LIDAR data was then compared to the previous ground survey data for a reasonableness test, which generated like results. First floor elevations from the original survey were used in conjunction with the GIS based data to determine flood damages.

4.8 Residential, Commercial, Agricultural and Public Economic Data Collection

Field survey data was collected for 1016 structures for residential, commercial, agricultural, and public entities within survey limits as defined by the Government within the town of Princeville, NC. Data included: finished floor elevation, adjacent ground elevation and lowest grade elevation. Attributes pertinent to each individual structure were logged consisting of the structure's status, type and condition. Where possible, data was collected employing the Global Positioning System/Real-Time Kinematic (GPS/RTK) methodologies relative to NAD 1983 NC State Plane Grid and NAVD 1988, vertical. Traditional total-station survey instruments were used, calculating trig-elevations with horizontal locations, where overstory and other obstructions excluded the use of GPS/RTK. All total station work was based on control points set by GPS/RTK. A digital photograph was taken of each structure. All data was converted from the survey data collectors into GIS shapefiles using Leica and TDS software. Shapefiles were then loaded

into the SDSFIE Standard Structures Geodatabase using standard GIS object loading procedures.

Most structures fall within the residential category, including: apartments, double-, single-wide mobile homes, brick, wood, and concrete homes. The other remaining structures include agricultural, commercial and public entities. Of the 1495 structures surveyed, 1061 structures were used to derive damages because survey results included items covered in structure values such as garages, barn, etc. The valuation of the structures used as inputs into HEC-FDA were based on tax assessments from 2010.

4.9 Determination of Valuation Methodology for Structures

Structure values are a critical source of risk and uncertainty in the stage-damage curve. It is used to directly determine the damage to the structure and indirectly to determine damage to the structure's contents. Depreciated replacement value is the appropriate measure of structure value for Corps studies, and it was confirmed with SAD Real Estate personnel that the valuations conducted by the County followed USACE common practices in applying depreciated valuation to the structures in the study area. Structure value for residential, commercial, agricultural, and public facilities was based on a mix of information obtained directly from County Assessor's Office and estimates based on representative samples of other typical structures in the study area. Electronic files obtained from Edgecombe County that contained structure footprint data and land parcel data (including parcel valuation data) was used to assign values to most structures in the data inventory. For structures without assessed values an estimate of the structure value was based on representative samples of other typical structures.

It is valid to note that the average home value was $77,300 in Princeville as of August 2015. The average home values in North Carolina and the United States are $148,200 and $188,400 respectively (www.zillow.com), or 192% and 244% higher in average value than the average home value in the Princeville study area.

4.10 Depth Damage Relationships

Commercial, Residential, Agricultural, and Public damages consist of physical inundation damages to structures and contents (equipment, inventory, etc.). During an in-progress review meeting, Corps experts advised the potential use of available generic depth-damage relationships if survey form data were not available. Curves developed and available from a recent New Orleans District were specifically suggested for evaluation of suitability for use in this study. The New Orleans District was contacted and it was determined that these curves were appropriate because flooding characteristics were similar, and both study areas covered urbanized and rural areas having a mix of residential, commercial, and industrial development with similar types of construction. The New Orleans District functions included measures of error needed in risk-based analysis. Depth-damage relationships used in this study were obtained from the following source(s):

Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVR) in Support of the Jefferson and Orleans Flood Control Feasibility Studies, (June 1996), U.S. Army Corps of Engineers, New Orleans District. Structure depth-damage functions and related uncertainties are presented for three different types of construction: metal frame, masonry bearing, and wood frame wall

structures. Content depth-damage functions and related uncertainties are presented for commercial, residential, agricultural and public property categories.

Application of the above depth damage relationship depended on structure type and construction characteristics. Residential structures were divided into single-double wide mobile homes, brick homes, concrete homes, wood homes and apartments. Other structures include commercial, public and agricultural. Commercial structures were categorized as masonry bearing walls. Depth-damage relationships were formulated for each structure type, for each content type, and for the following two hydrologic conditions: (1) riverine or rainfall flooding – short duration (one day) freshwater; and hurricane flooding – long duration (one week). The New Orleans District depth-damage functions were applied to each damage category assuming a long duration of water in the Town of Princeville in the event of a storm.

Table 4-2 displays the distribution of study area damage categories: residential, commercial, agricultural and public entities.

Table 4-2 Percent Distribution of Damage Categories in Study Area

CATEGORY	PERCENT OF TOTAL STRUCTURES
Residential	92%
Commercial	3%
Agriculture	3%
Public	2%

4.11 Uncertainties about Economic Data

Economic uncertainties are associated with structure and content values, structure elevations, and depth-percent damage relationship. According to EC 1105-2-205, when using conventional survey equipment the assumed error is plus/minus 0.05 feet at 800' with a standard deviation of 3.0 percent, assuming that error represents a 99 percent confidence interval and assuming normal distribution. The standard deviation is used as one parameter in a normal distribution representing the first floor elevation of each structure. The mean value of the distribution is assumed to be the measured elevation. For this study, a standard deviation of 0.3 feet was used to define the uncertainty in the first-floor elevations. For all structures the value of the structures was assigned a standard deviation of 10 percent of the building value; the ratio of the value of the contents to the structure was allowed to vary with a standard deviation of 10 percent; and other/structure value ratio was given a standard deviation of 2.0.

4.12 Structure Elevations and Uncertainties

Structure depth percent damage curves obtained from New Orleans District for homes without basements was selected and used as appropriate for the type of structure (e.g. 1-story without basement, 2-story without basement, etc.) These curves were generic and were determined to be appropriate for use in the Princeville study based on similar nature

of flooding. Content to structure value ratios were chosen based on the particular structure depth percent damage curve used for the structure. For no basement residential structure, ratio was set at 30% of structure value for apartments and 50% for all other residential structures.

A similar function was prepared for each of the damage categories as follows: Ratio was set at 80% for commercial structures; and set at 50% for both agricultural and public structures.

4.13 Analysis Years

The future with and without project conditions are evaluated over a 50 year period of analysis. The study configuration in the HEC-FDA Flood Damage Reduction Analysis program requires selection of a base year and a future year during the period of analysis to define damage and project performance for specific time periods during the life of a project. The analysis year represent static time periods during which the hydrologic engineering and economic data must be developed for the analyses. The existing condition analysis year for the Princeville study is 2010. The future condition analysis years for Princeville study are 2026 for the base year (assumed to be the first year any proposed project would be implemented and in place) and 2076 for the future year. The expected annual damage for each year in the analysis period is computed, discounted back to present value and annualized to determine the equivalent value over the analysis period.

4.14 Damage Categories

The predominant land uses and investment in the study area are residential, commercial, agricultural, and public structures. In particular, agricultural structures not crops are considered for damage categories because information about crops planted were not available at the time of the survey. While agricultural damages are not included in this evaluation, it should be noted that inclusion of any average annual damage to croplands would increase the benefit to cost ratio. Potential flood damages are based on damages to structures and damages to contents, including inventory and equipment for commercial and public properties.

4.15 Damage Calculation Methodologies and Uncertainties

Foregone flood damages were calculated utilizing HEC-FDA developed by the Hydrologic Engineering Center, for incorporation of risk and uncertainty in the analysis of alternatives. FDA is the USACE certified model for estimating eliminated flood damages, and therefore, flood-related benefits in the various with-project conditions.

The eight profiles included the 0.50, 0.20, 0.10, 0.04, 0.02, 0.01, 0.004, and 0.002 probability events. In addition to specific economic data uncertainties discussed in previous sections, the program allows quantification of uncertainties in the discharge-exceedance probability function for each reach, the stage-discharge function for each reach, and the aggregated stage-damage functions by category for each reach, and incorporates those uncertainties in the integration of hydrologic and hydraulic engineering and economic analysis of the with and without project conditions using the Monte Carlo simulation techniques.

Flood damages for various flood events are computed based on the level of investment subject to flooding, the beginning damage elevation, and the estimated damage to that investment with various depths of flooding. Values of investment subject to flooding, structure elevations, and foundation heights (to indicate the elevation at which first floor flood damages would be estimated to occur) along with associated uncertainties were entered into the HEC-FDA program for each structure or groups of structures in the study area. Damage susceptibility functions and associated uncertainties for the various types of structures and contents determined as described in preceding paragraphs were also entered into the HEC-FDA program. The HEC-FDA program references each structure's first floor elevation or beginning damage elevation to the corresponding frequency event elevation at the reach index point. Individual stage-damage relationships at each structure for each investment category are then computed with risk and aggregated to the reach index location in the HEC-FDA program for integration of economic and hydrologic engineering data. Use of the HEC-FDA program for analysis facilitates the assessment of the tradeoff between risks and costs.

4.16 Existing Condition Physical Damages

Damages for the Princeville study consist of physical inundation damages to the residential, commercial, agricultural and public structures and their contents. Early analysis of each levee unit area indicated that if a levee failed, all of the protected area could be flooded. The protected areas vary in elevations between the upper and the lower reaches. Depending on the location of levee overtopping or failure, the stage interior to the levee may be different than the stage exterior to the levee, and this relationship has been accounted for in the analysis. Existing conditions flood damages are presented in Table 4-3.

Table 4-3, Existing Condition Damages, By Reach, By Frequency of Event, 2010 Dollars

	Damage Reach			
Annual Exceedence Probability	Lower 1	Upper1	Upper2	Total
0.04	--	--	--	--
0.025	--	--	--	--
0.02	--	--	--	--
0.015	$ 0	$ 0	$ 81	$ 81
0.01	$ 41	$ 212	$ 7,840	$ 8,094
0.009	$ 94	$ 1,495	$ 8,111	$ 9,700
0.008	$ 166	$ 11,412	$ 8,359	$ 19,936
0.007	$ 249	$ 33,896	$ 8,608	$ 42,752
0.006	$ 380	$ 38,997	$ 8,877	$ 48,254
0.005	$ 698	$ 43,278	$ 9,169	$ 53,145

0.004	$ 1,801	$ 45,699	$ 9,517	$ 57,016
0.002	$ 6,337	$ 52,568	$ 10,676	$ 69,580
0.001	$ 13,538	$ 59,205	$ 11,390	$ 84,133

Under existing conditions damage to structures begins in the lower study reach at around the 75 year level. Damages in the upper and end reaches begin at or below the 100 year event. In Table 4-3 Estimated damage throughout the reaches ranges between $81,000 at the 25 year to over $84 million at the Floyd level events (between the 500 and 1,000 year events).

4.17 Comparison of Alternatives

Screening cost estimates and estimated construction periods for each of the Measures were provided by Cost Engineering and Specifications Section, Design Branch, Wilmington District, with input from other Product Development Team (PDT) members. Interest during construction (IDC) for each alternative was calculated based on the total first cost for each Measure, the starting and completion dates for each phase, assumed equal monthly expenditures during each phase, and the FY15 Federal interest rate of 3.375 percent. Appropriate funding was assumed available for each phase. Total first cost for each Measure includes the estimated construction cost, cost for lands, easements and rights of way, preliminary engineering and design cost, supervision and administration cost, and contingencies. Interest during construction calculated for each Measure was then added to the total first cost to derive the economic cost of each alternative. The economic cost was then annualized based on a 50-year life and a 3.375% interest rate. Table 4-4 contains the total cost associated with project implementation, given the above criteria, for the considered alternatives.

Table 4-4: Average Annual Costs of the Combined Measures in 2013* Dollars, 3.375 Discount Rate

Cost/Impact Assessment							
	No Action	Increment 1	Increment 2	Increment 3	Increment 4	Increment 5	Increment 6
Average Annual Damages Prevented	$0	$ 340,360	$ 423,760	$ 442,320	$ 470,260	$ 476,470	$ 491,340
Emergency Costs Avoided	$0	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Recreation	$0	NA	NA	NA	NA	NA	NA
Total Beneficial Impacts	$0	$ 340,360	$ 423,760	$ 442,320	$ 470,260	$ 476,470	$ 491,340
Adverse Impacts							
Project Costs , Includes Real Estate*	NA	$ 772,000	$5,696,000	$5,953,000	$22,039,000	$54,970,000	$56,228,000
Interest During Construction	NA	$ 3,000	$ 234,848	$ 245,445	$ 2,314,152	$ 2,266,000	$ 2,318,000
Economic Costs For BCR	NA	$ 775,000	$5,930,848	$6,198,445	$24,353,152	$57,236,000	$58,546,000
Average Annual First Cost	NA	$ 33,000	$ 253,000	$ 264,000	$ 1,014,972	$ 2,440,000	$ 2,496,000
Annual O&M	NA	$ 1,000	$ 10,000	$ 11,000	$ 57,760	$ 98,000	$ 100,000
Total Avg Annual Costs	NA	$ 34,000	$ 263,000	$ 275,000	$ 1,072,732	$ 2,538,000	$ 2,596,000

*Increment 4 is the selected plan, and uses updated (2016) costs for the selected plan only. Additional plans analyzed employ 2013 costs, due to project budgeting and time constraints.

5.0 Project Benefits

5.1 Project NED Benefits

The project benefits are measured in terms of reduced damage at each (building) structure, for use in the economic analysis. For each combination of measures, the issue of primary concern is the difference between damage occurring with the measures in place, compared to the damage occurring without the measures. This comparison can be obtained by determining the flood damage for all structures in a damage reach, and then aggregating over the damage reaches to get expected damages for the project on an annual basis. Finally, after all aggregation is complete the project benefits can be defined by calculating the difference in damages with, and without, the measures in place. An alternative to this method is to consider the project benefits structure by structure, and then to aggregate those benefits over the project.

5.2 Net Benefits

Net benefits are measured as the difference between benefits and costs, where benefits are defined as the reduction in flood damage resulting from the project. Assessment of economic performance builds upon hydrologic, hydraulic, and geotechnical factors that enter into the assessment of engineering performance, plus the computation of flood damage to structures or other activity in the floodplain. While engineering performance is focused on risk at each damage reach, economic assessment is more complex, involving the integration of information at several spatial scales. In the case of Princeville there are three spatial scales of analysis. These are:

- Project scale at which all the economic analysis is summarized,
- Damage reach scales used for most analysis in HEC-FDA (flood damage assessment model), and
- Structure scale where the assessment of damage to structures is made.

The project is divided into 2 damage segments (Upper and Lower) and 3 hydrological reaches), containing 1016 structures, with most of the structures concentrated in the lower reach. The Lower reach begins at cross section 137307, approximately 1.25 miles south of where US 64 crosses the river and extends to cross section 140680. The Index location of Lower 1 reach is cross section 137307. The Upper 1 reach begins at this point and continues upstream to cross section 149028. The Index location of Upper reach is cross section 141231. The Upper 2 reach continues to cross section 157851. The Index location of Upper 2 reach is cross section 252004. The End reach begins at cross section 252004 and designates the upstream boundary for this analysis at cross section 258478. The index location of the End reach is cross section 149556. HEC-FDA conducts a distribution based Monte Carlo probability simulation, in which 100 iterations of damaging flows are re-created to best ascertain damages to those structures. Four variables will be randomized for each structure: first-floor elevation, value of the structure, value of the contents, and other values of the facility. The results of these simulations are aggregated by damage category (e.g., single-family residential, commercial, agricultural and public). A “Without Project” run was also conducted through FDA to establish simulated project performance against existing conditions. For the purposes of this analysis, the damages will be represented as an aggregate number. This aggregated figure has then been

compared to a “Without Project” condition to establish a benefit of project implementation. The costs used in this analysis are represented as an average annual cost (see Table 5-1), as are the benefits. These two figures, when compared, produce a benefit/cost ratio. For NED projects, the benefit-cost ratio is the typical indicator of project performance. Plans with higher benefit-cost ratios indicate that a greater return is received for the investment. Table 5-1 displays these results. Additionally, Table 5-1 displays the results of an incremental analysis, using the NED plan as the base, to demonstrate the additional cost and benefits of implementing plans that deviate from the NED plan.

Table 5-1: Project Performance and Incremental Assessment of Annualized Costs and Benefits, Princeville NC Flood Damage Reduction, 2016* Dollars, 3.125% Discount Rate

Alternative	AA Damages ($1,000)	AA Benefits ($1,000)	AA Cost ($1,000)	B/C Ratio ($1,000)	AA Net Benefits ($1,000)
Without Project	$504	--	--	--	--
W/Flap Gate (Increment 1)	$172	$332	$34	10.0	$298
W/ Flap Gate & Levee A (Increment 2)	$89	$415	$263	1.6	$152
Increment 3	$71	$433	$275	1.6	$158
*Increment 4	$44	$460	$998	0.5	-$538
Increment 5	$38	$4466	$2,538	0.2	-$2,072
Increment 6	$25	$480	$2,596	0.2	-$2,116

*Increment 4 is the selected plan, and uses updated (2016) costs for the selected plan only. Additional plans analyzed employ 2013 costs, due to project budgeting and time constraints

5.3 Identification of NED Plan

Because the project is located in a flood-prone area, the resulting Benefit-to-Cost Ratios of the plans constituted by the combined (levee alternative with flap gates) alternatives range from 10.0 to 0.2. Wilmington District has therefore approached this project from the standpoint that its justification would depend heavily upon Other Social Effects, and as such, may not result in an NED Plan. Possible results are that the least-cost alternative, or the alternative with the highest Benefit-to-Cost ratio, would serve as a tentatively-selected plan. Table 5-2 contains a cost and benefit summary of the selected plan, Increment 4.

5.4 Selected Plan

The local stakeholders, including the Town of Princeville and the County of Edgecombe, have recently expressed that their preferred alternative would be Increment 4 of the combined alternatives. This Combined Measure results in a Benefit/Cost Ratio of 0.5, at the lower end of the range of B/C Ratios for Combined Measures. Discussion will continue

with the stakeholders, including the State of North Carolina, as to additional cost contribution effects to the Sponsor which would result from selection of this alternative.

Table 5-2: Cost and Benefit Summary of the Selected Plan, Princeville NC Flood Damage Reduction, 2016 Dollars

Selected Plan Cost & Benefit Summary	
Initial Cost	$21,540,000
Price Level	2016
Construction Period	72 Months
Project Life	50 Years
Discount Rate	3.125%
Interest During Construction	$2,086,387
Total Economic Costs	$23,626,387
Average Annual Cost	$940,164
Annual Operation and Maintenance	$57,760
Total Average Annual Cost	$997,924
Average Annual Benefits	$459,870
Benefit Year	2016
Net Benefits	-$538,054
Benefit Cost Ratio	0.5

6.0 Selected Plan

6.1 Plan Description

The selected plan will require realignment or abandonment of the southern segments of the existing levee system due to realignment of U.S. Highway 64. These segments were previously called “Dike B” and U.S. Highway 64. Additionally, the existing levee system will be extended to the north and south to tie to high ground. The realignment and levee

extensions will require the addition of flapgates at ungated culverts at eight (8) locations, addressing a low spot in the existing embankment height of U.S. Highway 64, addressing the existing U.S. Highway 33 underpass, through which floodflows can enter Town, and construction of levee segments in specific portions of and Shiloh Farms Road to prevent overtopping.

6.2 Structural Features

Segment 1

The existing project terminates on ground that is approximately 4 feet lower than the top of levee. Segment 1 of the RECOMMENDED PLAN is an extension of the existing southern levee segment (or southern extension) downstream to high ground. 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

Segment 2

Segment 2 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 a project feature.

Segment 3

Segment 3 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.

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.

7.0 Regional Economic Development

7.1 Regional Economic Development Benefit Evaluation

The Regional Economic Development (RED) account is represented by employment created during construction, Employment created after construction, Agricultural Production and Local Farm Tax Revenues. While not quantified for this report, it is assumed that improvements to the flood risk will benefit employment by maintaining

business activities, where before they may be slowed by flooding. Detrimental agricultural impacts may be minimized by more robust flood fighting measures. Tax revenues will most likely remain more consistent in the absence of flooding. Additionally, The alternative with the highest construction will create the greatest regional multiplier impact, while the “no action” alternative creates no additional regional benefits. Employment after construction is based on O&M costs. Greater O&M efforts generally require more manpower.