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ENVIRONMENTAL PROTECTION AGENCY NONSTRUCTURAL PLANS FOR YAZOO BACKWATER AREA AND VICKSBURG DISTRICT REVIEW

YAZOO BACKWATER AREA REFORMULATION

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AN APPROACH FOR EVALUATING NONSTRUCTURAL ACTIONS WITH APPLICATIONS TO THE YAZOO RIVER BACKWATER AREA

BY
LEONARD SHABMAN
AND
LAURA ZEPP

Abstract

An Approach for Evaluating Nonstructural Actions with Application to the Yazoo River (Mississippi) Backwater Area

Leonard Shabman and Laura Zepp

A protocol was developed for estimating the economic benefits and costs of nonstructural actions on frequently flooded farmlands. A computer model using the best available data was developed and used to apply the protocol to evaluation of nonstructural actions for the Yazoo backwater (MS) area. Nonstructural actions included reforestation of approximately 70% of the acres inundated during the 2-year flood event, participation in an income insurance program for farms outside the 2-year flood plain and relocation with local flood protection measures for the limited number of structures in the watershed. A review also was completed of the US Army Corps of Engineers preliminary agricultural benefit estimates for a Yazoo area pumping plant.

Positive national economic development (NED) benefits are expected from implementation of nonstructural actions in the Yazoo study area. Included in the NED analysis are benefits for carbon sequestration and nutrient load reduction. Without these benefit categories NED is negative. However, nonstructural actions also were justified by documenting that significant environmental results are secured for a modest cost to the nation. While nonstructural actions may be warranted, agricultural flood protection benefits for a pump project appear insufficient to justify costs. Also, if the problems and opportunities of the watershed area are to be addressed with federal funds, nonstructural actions can be implemented for budget cost significantly lower than the cost for a pump.

The report concludes that the calculation of economic returns from continued agricultural production on frequently flooded land is critical to an analysis of both structural and nonstructural actions. Therefore, the logic and databases used to calculate agricultural returns under the new protocol and by the Corps in its pump evaluation should be reviewed by the Office of Management and Budget.

The report also concludes that a federal interagency committee should be chartered to refine the proposed evaluation protocol for NED and environmental analysis and to employ the procedures to establish a reforestation/restoration target for the Yazoo backwater area. As part of its work the interagency committee should design an implementation plan to provide incentives for voluntary adoption of reforestation actions for the watershed, to provide farm income assurance and to secure justified local protection and relocation for properties at risk. The implementation plan would involve linkages with state, non-governmental organizations (NGOs) and private sector participants.

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Thanks to the assistance of these people and many others during the course of this study, we believe that the resulting analyses are as representative as possible of the study area economic conditions. Nonetheless, we bear the full responsibility for the work reported here. Any inaccuracies found in this report are the sole responsibility of the authors.

Extended Report Summary

An Approach for Evaluating Nonstructural Actions with Application to the Yazoo River (Mississippi) Backwater Area

Leonard Shabman and Laura Zepp

Study Background and Objectives

Areas throughout the Yazoo River (MS) watershed were cleared for crop production early in the century. While little residential or industrial development has occurred in the backwater area, protection from flooding provided by interior channelization, cutoffs and levees, combined with favorable agricultural prices and agricultural and tax policy encouraged the clearing of most of that area's original forest cover for agricultural production. Today, much of the study area remains subject to flooding; by most estimates farming occurs on over 100,000 acres of land that has a 50% chance of being flooded each year (the 2-year flood plain).

A levee and gate structure surrounds the backwater area in the southern reaches of the watershed. The gate is opened after the early spring flows of the Mississippi and Yazoo Rivers diminish. Before the gate is opened, flooding limits the ability of farm operators to plant all their fields at times that allow for maximum crop growth. However, once the water leaves a field the farm operator can employ intensive production practices. In lower elevations, short season soybeans are planted to accommodate the heavy soils and limited growing season. This flooding motivated a Corps of Engineers proposal to build a large capacity pump to transfer water trapped in the enclosed backwater area into the Mississippi.

Critics questioned the justification of a pump as a fully funded federal expenditure and called for nonstructural measures such as expanded crop insurance and removing agricultural activity and structures from flood prone areas. However, no protocol existed for evaluating such nonstructural measures in this watershed or elsewhere in the nation. In response, researchers at Virginia Tech received grant assistance from EPA to

1) adapt existing economic analysis protocols for evaluating non- structural alternatives,

2) demonstrate the analytical protocol with an evaluation of nonstructural actions for the Yazoo River backwater area, and

3) describe an implementation plan that would provide incentives for landowner adoption of nonstructural actions.

A fourth objective emerged during the course of the study when information provided by the Corps made it possible to review the agency's preliminary estimates of agricultural benefits for a pump.

Economic Evaluation

A *nonstructural action* was any action taken to address watershed problems and opportunities that results in no significant change in watershed hydrology. After careful consideration of watershed problems, opportunities and economic conditions in the Yazoo Backwater Area, a nonstructural watershed action scenario was developed. The scenario included: i) voluntary reforestation of approximately 70% of the acres inundated during the 2-year return frequency flood event; ii) farmer participation in an insurance program to compensate for flood damages on land remaining in crop production, and iii) relocation of structures subjected to frequent flood damages or construction of small-scale, localized flood protection works. In the Yazoo study area, reforestation of frequently flooded agricultural lands with native bottomland hardwood tree species has been described as a "nonstructural action" for addressing agricultural flood damage problems and has received particular attention for its ecological restoration values.

Nonstructural actions must be undertaken by private landowners and businesses. A *non- structural plan* was defined as a combination of agency authorities and programs to create financial incentives for landowners to initiate reforestation efforts and to participate in the insurance program. The plan also would include initiatives to reduce the flood risk for the limited number of structures in the backwater area.

The National Economic Development (NED) criterion of the *U.S. Water Resources Council's Principles and Guidelines for Water and Related Land Resources Planning, (P&G)* was adapted to evaluate the economic consequences of the watershed action scenario. The NED analysis included the value of goods and services produced, regardless of whether a market for the service currently existed. The NED evaluation of the watershed action scenario served two purposes for this study: i) to determine whether a nonstructural incentives program to encourage adoption of nonstructural actions would benefit the nation's economy and ii) to provide information for the design of an incentives program.

Justification of the Watershed Action Scenario

Net NED benefits (benefits minus costs) were calculated as the difference between NED returns from the land use in Yazoo Backwater Area with and without implementation of the watershed action scenario. The NED consequences of landowners participating in an insurance program were not evaluated; instead, a subsidized insurance program was treated as a transfer payment that has no NED consequences. Also, it was assumed for the NED analysis that relocation and localized protection actions will be taken until NED costs will be equal to the NED benefits. Therefore, the net NED from residential, commercial and infrastructure protection was set at zero.

The NED results were calculated for the reforestation actions within the watershed action scenario. When evaluating the NED consequences of reforestation actions, NED costs are the market prices paid for the seedlings, labor, machinery and other inputs used in reforestation. NED costs also include the NED value of the forgone agricultural production on the reforested land.

Once costs are incurred, the NED benefits are the money valuation of the services provided by restored forested land. One benefit is the value to the nation of the pulpwood and saw timber that could be harvested in future years. Forests also provide superior wildlife habitat, sequester carbon (carbon dioxide is the primary greenhouse gas), are less likely to contribute to nutrient enrichment of estuaries and sediment loads. Some of these environmental services were calculated as NED benefits.

The watershed action scenario was determined to be NED justified. The calculated net benefits for the watershed action scenario were over $20 million. Specifically, forgone farm income was $ 30.6 M as an NED cost of reforestation. Timber benefits, net of costs, had a negative NED value of $9.5 million. Other reforestation benefits were positive including habitat for hunting ($6.9 million), sequestered carbon ($9.8 million), nutrient control ($32.2 million), and avoided on-farm non-crop damages ($13.7 million).

Included in the NED analysis are benefits for carbon sequestration and nutrient load reduction. Without these benefit categories NED is negative; however, nonstructural actions also were justified by documenting that significant environmental results are secured for a modest cost to the nation.

Agricultural Returns - A Comparison of Approaches and Results

Estimates of agricultural returns are critical to calculating the NED cost of nonstructural actions. Agricultural returns analysis also is central to the estimates of benefits for structural measures such as the pump project. A comparison of the agricultural returns calculations uncovered significant differences between this study and the preliminary results of the Corps; in addition we identified areas where the Corps benefit analysis may be flawed. Therefore, in the absence of a formal Corps report on the pump, used the agricultural returns model developed for the nonstructural research to estimate the maximum potential flood protection NED benefits from operation of a pump. While nonstructural actions may be warranted, agricultural flood protection benefits for a pump project appear insufficient to justify costs.

Findings and Implications

Because a Yazoo Backwater area project has been authorized the requirement for Office of Management and Budget review of NED analyses under Executive Order 12322 does not apply. Therefore the EPA should make a special request that OMB review the procedures, data and logic used for agricultural returns calculations.

The administration should seek authorization in WRDA 2000 for a federal interagency committee of equal partners (Corps, FEMA, USDA, EPA, CEQ, FWS, and OMB) to address the problems and opportunities in the Yazoo backwater study area. This federal agency partnership should develop formal linkages with state, non-governmental organizations (NGOs) and private sector participants. Congressional direction for the effort should affirm that implementation, as with the pumps, will be a full federal responsibility.

The interagency committee should refine the proposed evaluation protocol for NED and environmental analysis and employ the procedures to establish a reforestation/restoration target for the Yazoo backwater area.

The interagency committee should develop a coordinated approach with FEMA, USDA and the FCIC to provide farm income assurance for lands above the 2 year flood plain and to secure justified local protection and relocation for structures at risk throughout the watershed.

The interagency committee should design an implementation plan to supplement the Wetlands Reserve Program (WRP) incentives for voluntary adoption of reforestation actions for the watershed. The new program should rely on government easement payments offering landowners the opportunity to earn an up-front payment or predictable annual payment for switching land use from farming to forest production. The payment might be necessary to compensate the landowner for the increased variability in cash flow from forest product sales relative to annual agricultural sales, to address landowner unease over uncertain future timber yields and prices and/or to bridge any gap between forestry returns and the forgone returns from crop production.

If the problems and opportunities of the watershed area are to be addressed with federal funds, nonstructural actions can be implemented for budget cost significantly lower than the cost for a pump. If easement payments to landowners were a full federal responsibility, the budget cost in excess of the existing Wetlands Reserve Program payments would be $26 million, at $650 per acre. To the extent that other sources of funds are secured this budget cost will be reduced. The cost of the income assurance program was estimated at $11.5 million. However, this estimate includes those payments made as disaster aid and crop insurance indemnities, in the absence of the proposed program. The costs that would be incurred in planning and administering these programs were not estimated. The cost for flood protection for structures was not calculated but a perspective on the possible costs can be provided. The Corps reports that there are 1544 structures in the 100 year flood plain. The total market value of those structures was less than $40 million. From this perspective the market value property in the watershed, the full cost of the insurance program and the full cost of the easement program are approximately 1/2 the cost of a $150 million pump.

Section 1. Introduction

1A. Origin and Scope of the Study

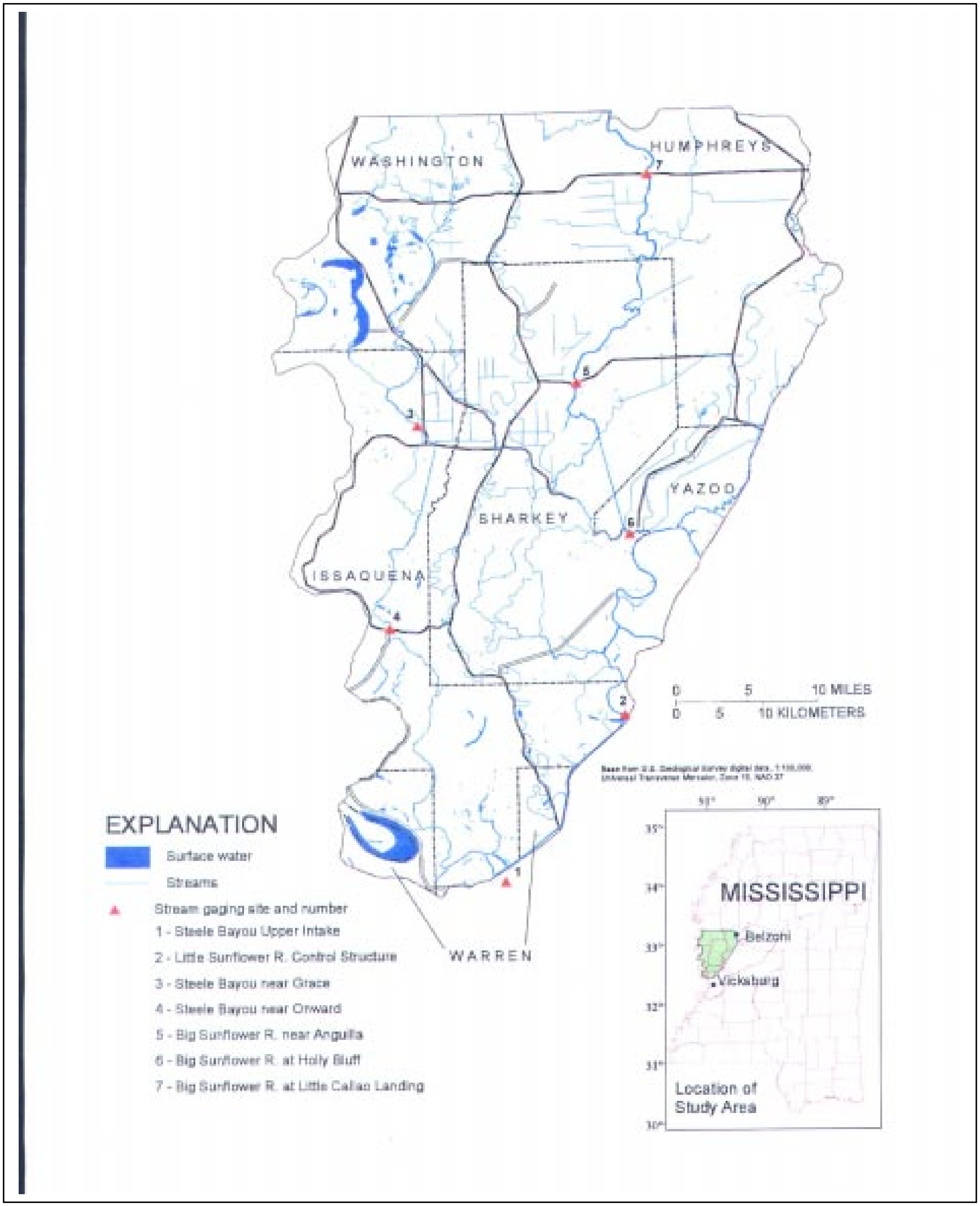
In 1928 the Corps of Engineers was authorized to begin studies and develop plans for flood hazard reduction throughout the lower Mississippi River watershed. The 1941 Flood Control Act instructed the Corps to develop a plan to address flood hazards in the Yazoo River watershed. Following Corps recommendations, the executive branch sought and received Congressional appropriations for implementing levee and channel projects that have protected the Yazoo River Backwater area from flooding originating in both the Yazoo and Mississippi Rivers. Today, the area has a levee on the west along the Mississippi River (the mainline levee) and a levee to the east (the Yazoo River levee). (See Figure 1-1) At the southern end of the area, where the two levees meet, a gate at Steele Bayou can be closed during high river flows in late winter and in the spring to protect the area from the two rivers.

The portion of the Yazoo Backwater Area considered in this study consists of approximately 540,00 acres that make up the southern most tip of the larger Yazoo River watershed. It is in the shape of an inverted triangle, bordered on the east by the Yazoo River and on the west by the Mississippi. It stretches southwards from approximately the latitude of Belzoni Mississippi to its southern-most tip at Vicksburg, Mississippi. (USACE, 1982)

Areas of the Yazoo watershed were cleared for crop production early in the century. While little residential or industrial development has occurred in the backwater area, protection from flooding provided by interior channelization, cutoffs and levees, combined with favorable agricultural prices and agricultural and tax policy encouraged the clearing of most of the watershed's original forest cover for agricultural production. Because water cannot escape until the gate is opened after the early spring Mississippi River flows diminish, the area remains subject to flooding from winter rainfall and runoff from the upper reaches of the watershed. In some years this internal flooding limits the ability of farm operators to plant all their fields at a time that would allow for maximum crop growth. Once the water leaves the field, there is only a small likelihood of flooding later in the growing season. Therefore, while planting may be delayed for a crop, the farm operator can employ intensive production practices once the water is off the field. As a result, in lower elevations short season soybeans are planted to accommodate the heavy soils and limited growing season. Other crops are found in the higher elevations of the watershed.

In 1982, the Corps proposed a project to reduce the duration of this "internal" flooding, citing the 1941 Flood Control Act authorizing language. (USACE, 1982) The agency proposed pumping water collected in the backwater area back into the Mississippi. The pump, if effective, would make an area that has always flooded better suited to agricultural production.

Figure 1-1: Study Area



*(DOI USGS, 1999) Preliminary figure subject to revision as of February 7, 2000

A sequence of congressional and administrative actions followed the Corps' 1982 proposal, creating the conditions under which the pumps proposal is currently being considered. In 1986, Congress adopted generic cost sharing reforms that had the effect of increasing the local sponsors financial responsibility for the proposed pump project [Section 103 (e)(1) of the Water Resources Development Act of 1986 - 33U.S.C.2213 (e) (1)]. Then in 1988, the Secretary of the Army requested a reanalysis of the unconstructed features of the 1941 authorized project for the whole watershed. In 1989, the Office of Management and Budget instructed the Corps to develop a plan for the backwater area that was justified by national economic development (NED) criteria. As the revised plan for the backwater area was being developed, the local project sponsor (the area levee board) advised the Corps that they could not meet the cost-sharing obligation established in 1986. As a result, Section 337 of the Water Resources Development Act of 1996 made flood damage reduction actions a full federal financial responsibility, as it had been in the original authorization.

Critics of a pump as a fully funded federal expenditure agree that the pump will result in a reduction in agricultural flood damages. However, they still have questioned the justification for a pump. In recent years federal policy toward agricultural flooding has shifted from the structural projects to insurance and removing agricultural activity from flood prone areas in the interests of environmental restoration.

It was suggested that, if federal expenditures are warranted in the study area, spending should be for nonstructural actions designed to protect landowner income, while encouraging environmental restoration. The Corps Vicksburg district, while not formally rejecting nonstructural actions, led the federal and state agencies and the project sponsors to believe that such an approach would be economically unjustified, would be inconsistent with the authorization language and could not be budgeted for by the agency.

However, there is no formal protocol comparable to planning procedures established by the Corps for reviewing structural projects exists for evaluating nonstructural actions. In response researchers at Virginia Tech received grant assistance from the USEPA to develop protocols for the economic evaluation of nonstructural actions. The resulting procedures would rely to the maximum extent appropriate on the conceptual and policy logic in the governing document for water planning in the Federal government, the *Economic and Environmental Principles Guidelines for Water and Related Land Resources Implementation Studies* (P&G). The Yazoo backwater study area would then be used as a case study to illustrate how the framework could be implemented. The specific objectives of the study were:

1. to adapt the existing economic analysis protocol for evaluating a non-structural alternative,

2. to demonstrate the analytical protocol with an evaluation of nonstructural actions for the Yazoo River backwater area, and

3. to describe an implementation plan that would provide incentives for landowner adoption of nonstructural actions.

While the study was underway, the Corps District offices in Vicksburg requested the results of the evaluation of reforestation actions. The Corps planned to use these results for justifying a plan that combined reforestation with a pump.[1] At this time, no revised report on a pump alternative is available for review. However, an information exchange with the Corps was initiated to permit a comparison of the agricultural returns analysis common to both the pump and the nonstructural evaluation. The text of the 1982 pump report (USACE, 1982), and preliminary agricultural net returns calculations provided by the Corps district and division offices in response to questions, made it possible to review the agricultural benefits analysis that apparently will be offered for a pump. A comparison of approaches for measuring agricultural net returns became a fourth objective of the study.

1B. Nonstructural Actions and Plans

Traditionally, the response to agricultural flooding has been to build structural water control measures to enhance the economic value of farming in flood prone areas. An alternative is to create attractive insurance programs that provide landowners with monetary compensation whenever flood damages are incurred. The goal of this approach is to protect income from farming, but not to reduce flood damages that are incurred. This means that if the insurance premiums are actuarially sound, and landowners pay the premiums, then landowners would have an incentive to alter land use and damages would fall to the national level. Another alternative encourages landowners to remove agricultural activity from flood prone areas. A combination of governmental payments with sales of services from the new land use (ex. hunting leases might be sold) could enhance landowner income and achieve ecological restoration of the previously farmed land.

Through the middle of the 20th century, structural water control measures were promoted to expand the farming opportunities on poorly drained and flood prone soils. By mid century, in the face of farm surpluses, water policy reviews began to question the economic rationale for expanding the land base (NWC, 1973). By the 1990s the argument was made that water control projects had diminished the ecosystem's capacity to provide terrestrial and aquatic wildlife habitat, sediment and nutrient trapping functions and mediation of hydrologic extremes of flood and drought. Recognition of the possible environmental consequences of the nation's water management approaches led to calls for ecological "restoration" (National Research Council, 1993; FIFMTF, 1992) and to Congressional legislation encouraging restoration actions in watersheds. Restoration is a loosely defined concept, but is generally thought of as the return of a watershed to some previous condition [2] (National Research Council, 1993).

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1 As a result of this request a memorandum was distributed on June 22, 1999 that cautioned against misuse of the work from this study when evaluating a proposal that includes a pump. A copy of that memorandum is included in Appendix G.

2 It is not the case that restoration can only occur through a nonstructural approach. Changes from current hydrology might be needed to restore a historical condition and such changes might be achieved through structural measures. However, such consideration was beyond the scope of this study.

Restoration that involves large scale hydrologic change may be too costly (in both financial terms and through its displacement of existing land and water uses) to be justified. However, in the Yazoo backwater study area, the flooding regime in the lower elevations remains largely as it was at the time of the last significant land clearing. In this area, planting trees to bring back the original forest cover may be equated with restoration.[3] Today farming occurs on over 121,000 acres of land that has a 50% chance of being flooded in any year (the 2-year flood plain). As prices for farm commodities have fallen relative to costs and as public policy has sought to discourage farming these areas through such programs as the Wetlands Reserve Program, reforestation of areas subject to flooding is advocated as both "restoration" and as a "nonstructural approach" to addressing agricultural flood control problems.

While reforestation in the Yazoo backwater area has been equated with a nonstructural approach, nonstructural actions can address all of the problems and opportunities in a watershed. For this study, a *nonstructural action* was defined as any action taken to address watershed problems and opportunities that results in no significant change in watershed hydrology.[4] Nonstructural actions might include relocation of structures, expansion of insurance programs to compensate for the economic losses from flooding and reforesting farmland in the flood plain. In the Yazoo study area, reforestation of frequently flooded agricultural lands with bottomland hardwood tree species has received particular attention for its ecological restoration potential.

Regardless of their environmental or national economic merits, nonstructural actions must be undertaken *voluntarily* by private landowners and businesses, perhaps in response to direct subsidies and tax advantages. A *non- structural plan* is a combination of programs to create financial incentives for landowners to voluntarily implement nonstructural actions. In fact, recommendations to modify agency programs already are permitted as a part of recommended federal water resources plans. The governing document for water planning in the Federal government, the *Economic and*

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3 The term "restoration" is used in this study as it is defined by the US Army Corps of Engineers as part of their "restoration and ecosystem approach" to environmental issues. A definition is provided in EP 1165-2-1, "Digest of Water Resources Policies and Authorities", July 30, 1999, Chapter 19: "Restoration is the process of implementing measures to return a degraded ecosystem's functions and values, including its hydrology, plant and animal communities, and/or portions thereof, to a less degraded ecological condition. The goal of restoration is to return the study area to as near a desired natural condition as is justified and technically feasible."

[4] The term "nonstructural" has been defined in different ways in Federal reports. For example, the P&G in Section 2.1.4 defines nonstructural measures as follows: "A modification in public policy, an alteration in management practice, a regulatory change, or a modification in pricing policy that provides a complete or partial alternative for addressing water resource problems and opportunities." The Interagency Floodplain Management Review Committee that evaluated the experience of the 1993 midwest flood (IFMRC,1994) adopted the definition of nonstructural measures prepared by the Federal Interagency Floodplain Management Task Force in 1992 (FIFMTF,1992). "The term nonstructural" measures is used to describe techniques that modify susceptibility to flooding (such as regulation, floodplain acquisition and flood proofing techniques). Both groups considered insurance programs to be compensation for losses that would modify the impact of flooding and also as financial incentives to avoid flood plain locations. Without a clear definition in use, we adopted a definition of nonstructural actions that best characterized the difference between the pump project and what was being considered in this study; that is, the effect of the action on watershed hydrology.

Environmental Principles Guidelines for Water and Related Land Resources Implementation Studies (P&G) states:

> "Plans may be formulated which require changes in existing statutes, administrative regulations and established common law; such required changes are to be identified."

1C. The Case Study Application

Using the Yazoo Backwater area as a case study for implementing a nonstructural evaluation protocol involved a sequence of steps.

- defining water and related land resources problems and opportunities
- formulating (describing) nonstructural actions that would address the problems and opportunities
- evaluating how well the actions contribute to national economic development
- proposing an implementation strategy to encourage implementation of the nonstructural actions were undertaken

At each step, the research relied on insights from different disciplines and synthesized data, study results, meeting minutes and interview notes from academic sources, government reports and experts on agriculture, forestry and the environment.

After careful consideration of watershed problems, opportunities and economic conditions in the Yazoo Backwater Area, a set of three nonstructural actions were considered. These included: i) voluntary reforestation of approximately 70% of the acres inundated during the 2-year return frequency flood event, ii) relocation of structures subjected to frequent flood damages or construction of small-scale, localized flood control structures, and iii) expanded farmer participation in a program to compensate for income losses due to flood damage on land remaining in crop production. Then, using a combination of these three nonstructural actions, a scenario was created for the Backwater Area, termed *the "watershed action scenario"*.

A protocol for evaluating the economic consequences of the watershed action scenario was developed and applied. The results from that work are included in the following sections of this report. The evaluation of the nonstructural outcomes scenario served two purposes: i) to determine whether a nonstructural incentives program to encourage adoption of nonstructural actions would benefit the nation's economy; ii) to provide information for the design of an incentives program.

Each of the three specific actions included in the watershed action scenario were to be voluntary actions undertaken by landowners and communities in the Yazoo Backwater Area. Therefore, a nonstructural plan had to identify policies and programs that would create incentives for landowners to implement actions such as those included in the watershed action scenario. Upon concluding that there was justification for nonstructural actions, a nonstructural plan was suggested that would provide incentives for landowners to either reforest or purchase insurance. In the last section of the report we use the results from the analysis of the watershed action scenario, a reconsideration of the history of the area and a policy review to propose a possible incentive package that could constitute a nonstructural plan.

Section 2. A Historical Context for The Evaluation

2A. Land Clearing and Drainage: Water Programs, Market Prices, and Agricultural Policy

Prior to extensive human settlement, the dominant features of the Mississippi Alluvial Plain were swampland and bottomland hardwood forests located in sumps and basins formed among the waterways and tributaries of the Mississippi. At that time in the nation's history the agricultural potential of the fertile, alluvial soils motivated the clearing and drainage of these lands. However, features of these agricultural lands that carried over from their wetlands state—low elevation, proximity to waterways and heavy, slow-to-dry, clay soils—made them particularly susceptible to flooding and soil saturation during spring and early summer.

Floodwater control structures and channel enlargement to facilitate the effectiveness of on-farm drainage systems became essential to realizing the agricultural potential of many bottomlands. Local drainage districts were initially responsible for the flood control and channel modifications. However, entering the 1930s the United States Army Corps of Engineers was assigned a leading national role in water management. Projects were developed to prevent flood damage to existing agricultural activity and to aid in the conversion of wetlands to agricultural production. Over time, a network of levees, floodgates, diversion channels and other flood control structures were constructed. This complex system prevented the inundation of agricultural lands when possible, and prevented prolonged periods of soil saturation by minimizing flood elevation and expediting the drainage of flooded fields.

This water control development program reached the Yazoo River area in 1960s. Authorized by the Flood Control Act of 1941, the Vicksburg District began construction on the Yazoo Backwater Project in 1961 for the purpose of providing relief from flooding. At the end of construction in late 1977, the Yazoo Backwater Project consisted of four major drainage structures and a series of levees intended to minimize flooding from the Mississippi and Yazoo Rivers. With the completion of these projects the purposes of the 1941 Act nearly had been achieved. At the southern end of the area, where the two levees meet, a gate at Steele Bayou can be closed during high river flows in late winter and in the spring to protect the area from the two rivers. Agricultural production areas were protected from the overflow of the Mississippi and Yazoo Rivers by levees on the west and east sides of the watershed (See Figure 1-1) and land that had previously been forested could be economically cleared and planted to farm crops, principally soybeans.

While water control structures provided partial protection to some lands in the Yazoo River basin, the flooding regime in the lower elevations was not significantly altered by structural water control works. Nonetheless, further clearing of land for agricultural cultivation occurred in the area, even on the most flood prone lands. In large part, this clearing was encouraged by market conditions and government agricultural policies in the late 1960s and early 1970s. To appreciate the market conditions that encouraged the clearing of this land, consider the price of soybeans. In 1998, the US price for soybeans was $5.33/bu. Around 20 years ago, in 1976, the average annual price was $6.81 per bushel. At other times prices were even higher: $10.00 per bushel in June 1973, $8.99 per bushel in Aug. 1973, $9.05, $9.24 and $8.13 per bushel in April, May and June of 1977, respectively. (data from the National Agricultural Statistical Service's (NASS) database of historical crop prices found at http://usda.mannlib.cornell.edu/data-sets/crops/92152/) Considering that the annual price of $6.81 in 1976 would be $17.75 in 1998 dollars (using GNP implicit price deflator forecasts from WEFA, 1996), suggests why there was a flurry of land clearing in the early 1970s as landowners sought to benefit from the unusually high prices in the soybean market.

In addition to high crop prices, federal agricultural policies of the 1960s and '70s further encouraged the clearing and cultivation of wet land with heavy soils. Agricultural policy of the 1960s and 1970s provided price and income supports that put a floor under the minimum income (income insurance) from farming these lands. Research now shows that favorable tax treatment of land clearing expenses, available technical assistance from USDA for land clearing and the income that could be earned from the sale of the pulp and saw timber from the cleared lands all encouraged land clearing activity. [5] (Kramer and Shabman, 1993)

2B. Times of Change

From the late 1970s to the present time, there have been significant changes in agricultural market conditions, national agricultural policy and the goals of water development analysis. Together these changes called for reconsidering the dedication of frequently flooded lands to agricultural production, in this area and in the nation.

2B1. The Farm Economy

For most of the 20th century the nation has had a conscious policy of supporting farm income and development of the agricultural economy. The national irrigation and drainage programs that pre-dated the Corps flood control activities in the 1920s were all seeking to expand the land base available for food and fiber production. Over time, technological change in agriculture related to mechanization, chemical fertilizer and pest controls, new management information systems and now biotechnology have raised yields per acre for virtually all crops at a significant and consistent rate (Ahearn et al. 1998). At the same time real farm income in the US has not risen as productivity has increased because, worldwide, food supply has outpaced world demand (FAPRI, 1999).

Consider one simple index of the shrinking profitability of agricultural production that is routinely published by the US Department of Agriculture (USDA). The index of farm product prices received to farm input prices paid declined from 138 in 1973 to 130 in 1974 to 113 in 1975, and by 1985 equaled 79 (Kramer and Shabman, 1993). In 1998 that index was 87 (USDA, 1999). Faced with a price/ cost squeeze farm numbers fell,

[5] One landowner in an interview with the authors suggested that the expectation that a pump would be built encouraged clearing of the bottomland areas in the Yazoo study area.

land in farms declined and farms were consolidated to include more acres. In the US and in the Delta there are fewer and larger farms today than there were as recently as 20 years ago. Market conditions, combined with explicit policy goals (see below), have reduced land dedicated to food and fiber production in the United States. Projections of prices for the future made by the USDA do not promise significant improvement in farm profitability and certainly no immediate return to the 1970s profit levels (FAPRI, 1999).

2B2. Agricultural Income Policy

The nation has always sought to have a low cost and abundant food supply; however, another goal of United States agricultural policy is to enhance the income of farm operators. At various times farm, policy has sought to support farm income by making payments to farmers if prices fell below a certain level, by (in effect) buying crops when prices fell and by programs to encourage or require farmers to retire land from production. As the international market for United States crops grew the enhancement of export demand was also seen as means to support farm income (For a comprehensive history and assessment of possible farm policy futures see: Orden, Paarlberg and Roe, 1999l)

After years of experiments with different forms of price intervention, the United States adopted a new farm policy in 1996, the Federal Agricultural Improvement and Reform Act of 1996 (FAIR). Payments to farmers were "decoupled" from any production requirements; these "production flexibility" payments were based on historical production but are to be phased out as the farm economy made a transition to producing for the world market. Recent declines in world demand coupled with increased competition for market share from other nations with expanding production of the major grain and oilseed crops has made the future for this reform uncertain. In fact, in the past two years the Congress has appropriated significant "emergency payments" to bolster farm income. In 1999 total US farm income was comprised of over 40% government payments (USDA ERS, 1999).

A central feature of farm programs has been land set aside requirements intended to reduce the land base in farming, reduce supply of certain crops and increase prices and farm income. Continuously increasing yields made such land retirement an imperative. Today the Conservation Reserve Program (CRP), and to a lesser extent the Wetlands Reserve Program (WRP), are a legacy of the supply control efforts. The CRP began with the 1985 farm bill and was promoted as a program to limit production, but primarily on fragile lands (steep slopes and highly erodible soils). Payments were made to landowners who voluntarily removed land from production of certain crops in certain locations. Supply control was to be achieved, along with environmental improvements as ecologically sensitive lands were targeted for retirement from production.

When FAIR was passed, the policy goal was to release agricultural producers to the opportunities in the world market. There was to be an end to programs intended to the restrict supply; nonetheless CRP was continued as an "environmental protection" program. Over time the CRP has been preserved and the WRP has been introduced to makes cash payments to farm operators who plant trees or otherwise restore wetlands. Agricultural policy analysts differ over whether the CRP/WRP programs are environmental protection programs or supply reduction programs.[6] Regardless of whether environmental protection or supply control is the primary objective, the fact is that since 1986 these two programs have paid over $19.7 billion in technical and financial assistance to remove farmland from production (Personal correspondence from David L. Faulkner, Virginia State Office, NRCS).

Another program of significance for bolstering farm income, without increasing production has been the federal crop insurance program. The Federal Crop Insurance Corporation (FCIC) administers a program that encourages farm operators to pay a premium that purchases insurance coverage against yield losses to natural hazards. Aspects of the program design also provide income insurance. To encourage farm operators' participation in the program, premiums are subsidized and the Administration and Congress are considering increasing the subsidy. (Grunwald, 1999) Also, there is a provision for making a nominal payment that provides more limited coverage.

2B3. Environmental Goals and Federal Water Development

Today, the remaining forested bottomlands in the nation are recognized for their roles in terrestrial and aquatic wildlife habitat, water quality maintenance, carbon sequestration and floodwater retention. Additionally, the recognition that vast tracts of forested wetlands were cleared and drained for cultivation has motivated an interest in restoring these areas to their former forested condition. (National Research Council, 1993; FIFMTF, 1992).

For the Corps a change in public attitude towards wetlands was reflected in the Water Resources Development Act of 1990. Sections 306 and 307 of the Water Resources Development Act (WRDA) 1990 authorized the Secretary of the Army to include environmental protection as a primary mission of the Corps, setting out a specific goal for the Corps Water Resource Development Program of increasing the quantity and quality of the nation's wetlands. In June of 1990, the Assistant Secretary of the Army for Civil Works issued a "Statement of Environmental Approaches" defining the path to be taken towards integrating the newly articulated objective of environmental stewardship with the traditional economic development goal of Corps projects. In 1995 guidance on ecosystem restoration, Corps offices were encouraged to formulate projects principally to secure opportunities for environmental restoration.

Existing Corps guidelines required evaluating projects following the P&G definition of the "Federal Objective": A project need to make a positive contribution to the national output of goods and services after complying with all applicable environmental laws and programs. (See P&G at http://www.wrsc.usace.army.mil/iwr/Planning/PLGuidance.htm) The value of outputs was to be represented in monetary terms within the "National Economic Development" (NED) account. However, the requirement to have positive

[6] Further details on the history and objectives of the WRP and CRP programs can be found at http://www.nrcs.usda.gov/NRCSProg.html

NED does not now apply for restoration projects. With Corps Circular "Ecosystem Restoration in the Civil Works Program" (EC 1105-2-210) first issued in June 1994, it was established that Corps planning should explicitly recognize opportunities for environmental restoration. In addition, the EC established that reductions in measured economic (NED) benefits could be justified in the pursuit of environmental restoration.[7] The agency leadership considered but rejected a requirement for placing monetary (NED) values on the environmental services produced by natural resources such as forested wetlands. Monetary values can be estimated and reported as supplemental information. With the release of the restoration guidelines, the responsibility of the Corps expanded to include not only the enhancement of economic activity, but also the protection and restoration of the nation's natural resource base.

2C. The Yazoo Backwater Area: Viewed with a Contemporary Policy Perspective

Today, the lower elevations of the Yazoo backwater area that was cleared for cropland when prices were favorable, when agricultural policy was supportive and when levees were built, remains subject to flooding. The levee and gate structure that surrounds the backwater area means that winter rainfall and runoff from the upper reaches of the watershed can not escape until the gate is opened after the early spring Mississippi River flows diminish. This flooding regime in the two year flood plain approximates historical flooding patterns and conditions remain suitable for supporting the bottomland hardwood forests that originally covered the area.

Three decades ago, the last remaining source of floodwater was the motivation for the Corps to formulate a project for pumping water from the now enclosed backwater area back into the Mississippi. This large capacity pump, which would be fully paid for by the federal government, would make an area that has always flooded better suited to agricultural production.

Today, the Corps restoration policy would encourage the agency to consider nonstructural actions such as reforestation in the interests of restoration. In fact, the agency is now considering adding a reforestation (restoration) component to the plan for a pump. However, the agency has felt bound by the original project authorization language and has maintained that the planning objective for the area remains flood damage reduction paid for at 100% federal expense. In fact, the agency believes that making restoration a planning objective might trigger new cost sharing obligations for the project sponsor. As a result, the Corps maintains that any actions it takes in the watershed must meet the Federal Objective of positive NED with full compliance with applicable environmental laws and requirements. Therefore, each separable element in the plan should pass an NED justification test. As a result the Corps must demonstrate that the measured NED benefits for restoration actions within the plan are positive, the Corps own restoration policy notwithstanding. Of course, the pump must also be NED justified.

[7] A decision rule that was not exclusively dependent on monetary benefit assessment was endorsed by the IFMRC, 1994.

In light of the evolving national policies toward agricultural production, flood damage reduction and environmental restoration, it is not surprising that critics have questioned the inclusion of a pump, especially as a fully funded federal expenditure, in any plan. During the re-study process the Corps has been encouraged to consider a nonstructural approach. For example, in 1997, the Fish and Wildlife Service Vicksburg Office, after consideration of the problems in the area, prepared a paper titled "A Draft Flood Damage Reduction Strategy for the Yazoo Backwater Area (July 1997, co-sponsored by USEPA) (USFWS, 1997). In the conclusion of that paper the agency stated that a nonstructural approach would be an application of "… state-of-the-art flood damage reduction techniques to meet the contemporary needs of the American public." At the same time a nonstructural approach would secure the natural system values of wetlands and floodplains and limit spending to conform with the reality of Federal budget limits (IFMRC, 1994).

The Corps restoration policy, if restoration became a planning objective, would not require that all the services from a nonstructural plan be NED valued. However, in this study and in consideration of the confusion over this requirement, the research first sought to explore ways to measure NED benefits and costs of nonstructural actions. In Section 6A1b. we will apply the logic of the ecosystem guidelines to the watershed action scenario, without using the NED benefits measured in Section 4.

Section 3. Problems, Opportunities and Nonstructural Actions for the Yazoo Backwater Study Area

The Yazoo Backwater study area covers about 540,000 acres. The area is characterized by large farms and scattered small towns. Land use is predominately agriculture with scattered forest cover most often associated with wildlife management areas. The hydric soils and landscape are a reminder that this land was an extensive natural wetlands prior to human settlement (DOI USGS, draft paper currently in review).

Even in recent times, this was an area that included more forest cover than now exists, especially in the lower elevations where the area was subject to flooding from the Mississippi and Yazoo Rivers. As with other areas of the Delta, the most flood prone lands were not cleared until the latter years of the 20th century and these lands in the lower elevations retain flooding regimes similar to the flood pattern at the time the land was cleared.

The Yazoo backwater study area has always been sparsely populated, but an overall decline in farm employment opportunities has resulted in a continuing exodus of people from the area. Issaquena and Sharkey Counties comprise a significant part of the study area. From 1980 to 1997 population in Sharkey County feel by 17% to 6,615 people. Over the same period the population of Issaquena county fell by 35% to 1637. In the period from 1990 to 1997 only 4 new building permits issued in both counties taken together. The 1996 unemployment rate was near 18% in both counties. Meanwhile, of those who did work over 60% worked outside of the two counties. Many of those who remain in the area are poor, with the poverty level in the are over 60%. A significant part of the population is black. (Data can be found at http://www.census.gov/datamap/www/28.html).

The regional economy still relies on the agricultural sector for much of its earnings, but even the significant public investment in water control projects started in the 1960s has not been adequate to offset the larger market and policy forces that have reduced the economic contribution of agriculture in the area. US Census Bureau, Bureau of Economic Analysis data tabulated by the Corps indicate that farm and related agricultural services sales were $14.4 million dollars in 1969) in 1982 dollars for the counties that include the backwater area. This was 43% of total sales for the area. By 1990 the Corps reports that agricultural sales had fallen to $11.6 million (1982 dollars) and were 24% of total sales in the area.

3A. Problems Addressed by Nonstructural Actions

Agricultural production is on alluvial soils, with mainly heavy (hydric) soils in most parts of the study area (DOI USGS, draft paper currently in review). Whether many areas now farmed might be technically defined as “wetlands” using rules from the federal regulatory program remains a matter under consideration, however the soils and hydrology are akin to a wetlands area.

The watershed landscape now is dominated by the levees and a gate that ponds water for a variable number of days early in the growing season. While this flooding can now be attributed to the levee and gate system, historically similar flooding was occurring from the overbank flows of the Yazoo and Mississippi into the backwater area. The flooding occurs on over 121,000 acres that are in the 2-year flood plain.

Most of the flooding is predictable in its seasonal occurrence. Once the water leaves the field, there is little likelihood of flooding later in the growing season. As a result, in lower elevations soybeans predominate due to heavy soils and shortened growing season due to later winter/early spring flood regime. Other crops are found in the higher elevations of the watershed on lands with the better soils where planting delays are few. However, while planting may be delayed for a crop, the farm operator can employ intensive production practices once the water is off the field.

Within the study area, the *agricultural flooding problem* for the nation is whether and how to assist farm operators to increase farm income. The income increase need not come through increased agricultural production.

A second problem of national concern is the possible *flooding of residences and businesses*, although most of the possible damages are from low probability flood events – the 50 year or less frequent flood event (Table 3-1). While this study was not able to complete a comprehensive analysis of relocation and localized protection, the suggested nonstructural plan includes a recommendation that such actions be considered and undertaken. Such a plan can be warranted because of the limited number of structures involved (Table 3-2) and the concentration of those structures in a few small towns.

Table 3-1: Flood Damages to Structures (Summary for all reaches)

FREQUENCY	TOTAL DAMAGE
1 Year	$500
2 Year	$50,000
5 Year	$828,000
10 Year	$2,828,000
25 Year	$6,540,000
50 Year	$10,082,000
100 Year	$26,517,000
Average Annual Expected Damage	$1,202,310

Source: Computed from data provided by Corps of Engineers

A third problem of national concern is the *degraded water quality* in the watershed. In addition, the nutrient loads from the Yazoo contribute to water quality problems in the Mississippi River and the Gulf of Mexico. Many waters of the Lower Yazoo River are listed as impaired under Section 303 (d) of the Clean Water Act's state reporting requirements (Source: http://www.epa.gov/iwi/303d/08030208_303d.html) Pollutants such as sediment, pesticides and nutrients that are associated with the intensive agriculture are the sources of impairment.

Of special note, the Yazoo is among the many tributaries to the Mississippi River that contribute to the main river's nutrient loads suspected as a cause of the hypoxic area in the Gulf of Mexico. While the Yazoo is not the most significant source of nutrients, each watershed throughout the river basin makes some contribution. The following short description characterizes the problem.

Table 3-2: Yazoo Backwater Structures Inundated by the 100-Year

	# Affected	Total Value	Average Value
Trailers	396	$4,266,000	$10,773
Residential 1 story	795	$17,812,000	$22,405
Residential 2 story	76	$5,067,000	$66,671
Sub-total	1267	$27,145,000	$21,425
Commercial	50	$4,107,000	$82,140
Professional	4	$162,000	$40,500
Semi-Public	17	$600,000	$35,294
Public	5	$186,000	$37,200
Recreational	85	$892,000	$10,494
Warehouse	113	$2,040,000	$18,053
Industrial	3	$3,475,000	$1,158,333
Totals	1,544	$38,607,000	$25,005

Source: U.S. Army Corps of Engineers, Vicksburg District.

"On the Gulf of Mexico's Texas-Louisiana Shelf, an area of hypoxia (low dissolved oxygen levels) forms during the summer months covering 6,000 to 7,000 square miles, an area that has doubled in size since 1993. This condition is believed to be caused by a complicated interaction of excessive nutrients transported to the Gulf of Mexico by the Mississippi River; physical changes to the river, such as channelization and loss of natural wetlands and vegetation along the banks; and the interaction of freshwater from the river with the saltwater of the Gulf.

A significant portion of the nutrients entering the Gulf from the Mississippi River comes from a variety of human activities, including discharges from sewage treatment plants, storm water runoff from city streets, and non-point source pollution from farms. In addition, some nutrients from automobile exhaust and fossil fueled power plants may enter the waterways and the Gulf directly through air deposition." (http://www.epa.gov/surf/surf98/Mississippi/backgrda.html)

3B. Opportunities Offered by Nonstructural Actions

3B1. Reforestation for Commercial Production of Pulpwood and Saw Timber

The forest cover today is found for the most part in natural and wildlife management areas (DOI USGS, draft paper currently in review). Commercial forestry has a limited history in the area and much of the timber production was associated with the land clearing process. Pulp and saw mill processing capacity exists within cost-efficient transportation distance from the watershed, although for most species the harvesting will be several years in the future. Reforestation of the less productive agricultural soils in the area may provide opportunities for enhancement of national economic development and landowner income from the market value of the wood products produced as markets for the wood products develop.

3B2. Reforestation for Wildlife Habitat and Recreational Values

Soybean production offers cover and a growing season food source for deer and small mammals. Reforestation will increase and improve cover, nesting sites and brood-rearing habitat (Wesley et al. 1981). Also, newly established forests can act as corridors connecting existing forest habitat, increase edge and eventually forest interior habitat (Peterken and Hughes 1995). However, variation in stand composition associated with different reforestation scenarios will affect relative habitat suitability for different game and non-game species. Cottonwood plantations show rapid growth resulting in rapid stand closure, thereby quickly providing interior habitat. Oak plantings, unlike cottonwood, produce potentially large quantities of hard mast in the form of acorns in stands aged 20 years and greater. Hard mast is a preferred food source for both wild turkey and deer (Wesley et al. 1981). For the above reasons, bottomland hardwood forests in the Yazoo basin can provide habitat for a variety of game species, including whitetail deer, wild turkey, rabbit, bobwhite quail, mourning dove, squirrel and waterfowl (Woolfolk, 1997).

Recreational hunting is a popular pastime in Mississippi. In 1996, 433,000 recreational hunters spent an estimated $576.3M on hunting (DOI, 1997). With a demand for suitable hunting sites, the sale of hunting lease offers landowners an alternative, non-timber source of income from reforested land. A 1997 survey of private landowners in 66 Mississippi counties reports an average annual hunting lease value of $31 per acre. (Jones, 1999) In general, wetland areas that are well suited for waterfowl draw significantly higher lease values, ranging from $49 – 98 / acre (Jones, 1999). “All-purpose” hunting leases can range from $1.50 to $25/acre annually (Woolfolk, 1997). Fallow agricultural fields tend to be the least desirable for most game, with the exception of northern bobwhite quail and mourning dove. Higher valued sites tend to be mature, bottomland hardwood stands or mature hardwood stands intermixed with agricultural fields, providing excellent habitat for whitetail deer, wild turkey and rabbit. Younger, immature tree stands provide less cover and food for wildlife and thus tend to earn lower lease prices, but exceed the lease prices for agricultural fields.

3B3. Reforestation for Water Quality Enhancement

The benefits of wetland forests to water quality occur not only because forestry practices are less land disturbing than agricultural production, but also because forests have been shown to remove sediment and agricultural residues, reduce turbidity and stabilize water temperatures (CENR, 1999). Three specific water quality effects are discussed below: sediment, nutrients and pesticides.

Sediment

While cropping systems vary in terms of sediment loss, any agricultural system will usually result in larger sediment yields than will a forested system. Post-harvest tilling, bedding and residue shredding contribute to sediment load increases during winter flooding (McDowell et al. 1981). Sediment removal from cropland has a direct effect on water quality in terms of increasing turbidity. Indirect effects include acting as a transport mechanism for nutrients and pesticides. Sediment yield was found to be a function of rainfall and runoff with maximum values achieved during the period between final tillage and early spring. In most cases, erosion losses from forestland are between one and ten percent of the losses from agricultural land. In some cases, forestlands have no net erosional losses of sediment and, instead, may act as a sediment sink, removing more suspended soil particles from floodwater and runoff than they contribute.

Pesticides

Much of the Delta is planted in crops using high pesticide inputs. Forestry-related activities have considerably fewer chemical inputs than most agricultural systems. Most forest cropping systems rely on herbicides for weed control only during the first growing season of the rotation. In contrast, row crop agriculture usually involves applications of several chemicals throughout the growing season every year. Insecticide is applied to forest crops only rarely and under the most intensive management scenarios. Cottonwood is the most chemical intensive of the forest crops proposed here due to its sensitivity to weeds and short rotation length. Assuming one application per rotation, cottonwood may require as many as 5 applications per 100 years while other species would require only 2 or three, depending on rotation length. Lower application rates are possible for oak and other hardwood species. Intensity of weed competition will dictate actual application rates (See the discussion of production practices in Section 4E3a1.).

Nutrients

Riparian forests and streamside management zones have been shown to remove nutrients applied to adjacent agricultural lands, reducing their influx to rivers. High denitrification rates in functioning wetlands results in removed nitrate conversion to gaseous nitrogen, the primary constituent of the atmosphere. Denitrification is carried out by microorganisms that thrive under conditions of high soil carbon and high nitrate availability. One of the consequences of forest growth is increased soil organic matter content due to leaf, twig and fine root accumulation, facilitating high nitrification rates throughout the life of the stand. Forest vegetation utilizes agricultural nutrients including nitrates and phosphorus (CENR, 1999).

3B4. Reforestation for Carbon Sequestration

Carbon is sequestered by a plant community, including an agricultural field or in a forest, when atmospheric carbon dioxide is converted to plant material. According to estimates made for several forest types, the mass of carbon in annual wood production typically equals or exceeds that found in agricultural fields. In forest stands, carbon fixed in merchantable products increases, then decreases with stand age as the age of maximum merchantable biomass increment is passed. Conversion of land from agricultural use to forestry typically results in a doubling of soil organic carbon. Although carbon content remains at a steady state in an intact forest, estimates across a range of different forest types suggest that the time and value of this steady state vary greatly.

The value of carbon sequestration has been growing as a variety of potentially damaging changes in global and regional climate are being predicted as a consequence of increased concentrations of carbon dioxide and other greenhouse gasses. One policy aimed at reducing atmospheric carbon dioxide concentration is reforestation to sequester atmospheric carbon in tree biomass. When incorporated in wood, carbon is climatologically inert and lends itself to a wide range of uses, both as standing trees and wood products.

To accomplish a reduction in atmospheric carbon through reforestation, decomposition of biomass and subsequent release of carbon to the atmosphere must be delayed. It must be "tied up" in a form where decomposition is slowed or stopped. In the case of soybeans, which are used as food or fuel, most carbon is returned to the atmosphere as carbon dioxide through respiration and combustion. Little carbon is kept in an inert form on a long-term basis. In contrast, woody material used for construction purposes, recycling paper and paper stored in landfills will retain carbon in an inert state for a considerable period of time. According to one estimate, 60% and 37% of wood-based carbon is in an inert form 5 and 100 years following harvest, respectively (Row and Phelps 1990).

3B5. Income Assurance for Agricultural Production

Landowners are interested in securing the income potential of their land. For lands that remain in farm production, the opportunity to participate in a crop loss insurance program would benefit the nation by promoting more efficient land uses, by protecting farm income while not increasing farm production and putting downward pressure on farm prices.

3B6. Residential and Commercial Flood Hazard Management

Individuals and communities seek to have the losses from flood inundation reduced or compensated. Federal Emergency Management Agency (FEMA) interest in relocation programs and the Challenge 21 program of the Corps of Engineers authorized in the Water Resources Development Act of 1999 suggest that relocation and localized protection (individual protective actions against flooding) may be accepted as a programmatic approach for flood damage reduction.

3C. Planning Objectives for the Yazoo Backwater Area

The frequently flooded agricultural lands located in the Yazoo Backwater Area present a variety of problems and opportunities that should be considered when planning an investment in water resource management measures. An assessment of the problems and opportunities present in the Yazoo Area suggests three planning objectives:

1. To improve the income of landowners who incur losses in farm income due to flood damages

2. To diminish the economic and social costs caused by flood damage to residential and commercial structures in the study area

3. To restore the capacity of the watershed environment to provide carbon sequestration, nutrient reduction and recreational opportunities.

3D. A Watershed Action Scenario for the Yazoo Area

Nonstructural actions that address each of the problems and opportunities in the Yazoo Area would require changes in land use and business practices to include reforesting farmed land, purchasing insurance and taking individual protective actions against flooding. A nonstructural plan is the package of financial incentive payments to encourage such changes. However, due to study time and resource limitations, no effort was made to predict how an incentive program would affect landowner decisions. Instead, we formulated and then evaluated a package of nonstructural actions that we termed the “watershed action scenario”; the presumption was that a well-structured financial incentive program would encourage landowners to undertake nonstructural actions similar to those in the watershed action scenario.

After careful consideration of watershed problems, opportunities and economic conditions in the Yazoo Backwater Area, a set of three nonstructural actions were selected for the watershed action scenario:

- voluntary reforestation of 88,000 acres of land with a 2-year return frequency of flooding [8];

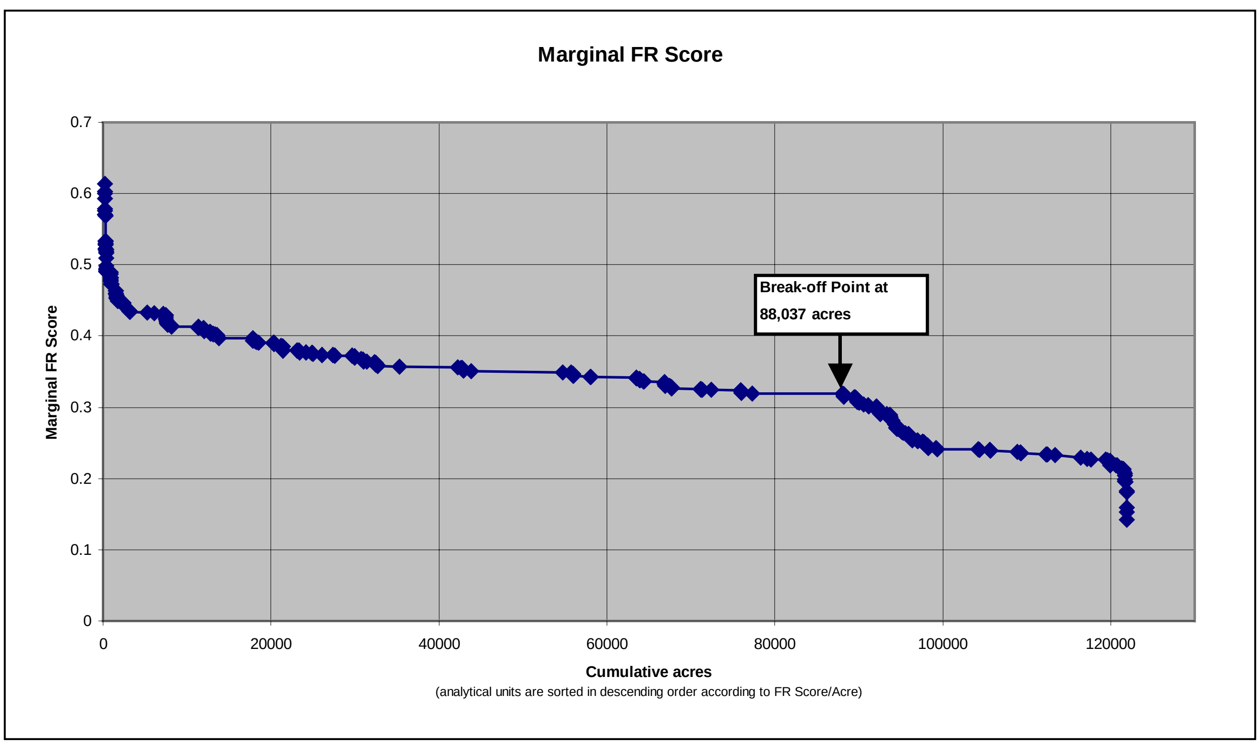
[8] The 88,000-acre increase in forested land is above the current forestland use. In fact, trends in land use suggest that without any action there will continue to be reforestation in the watershed, so long as the Wetlands Reserve Program remains viable. (USFWS, 1999). This WRP induced trend will be considered later in the report when discussing the study results and policy implications.

- expanded farmer participation in an income assurance program to offset agricultural flood damage losses of landowners who choose not to reforest; however, the program only would be available for land above the 2-year floodplain; and,
- relocation of structures subjected to frequent flood damages or construction of small-scale, localized flood control structures to address the flood risk for the limited number of structures in the backwater area.

The 88,000 acres of land to be reforested in the 2-year flood plain were selected as one possible reforestation scenario for the study area. The acres selected are assumed to be soybean land. Parcels of land were selected for reforestation in the order of their suitability to support a successful reforestation effort. A "functional restoration" (FR) scoring system developed by the USGS offices in Pearl, Mississippi was used to rank land areas in the study area according to how suitable they are for reforestation. The scoring system is based on four themes, restorability, existing hydrologic regime, water quality and habitat. Every acre of land receives a score for each of the four themes. The sum of the four scores then equals the total "FR score" for the acre (DOI USGS, draft paper currently in review).

In order to select the acres to be reforested in Watershed Action Scenario, all land areas (called analytical units – see Section 4D3) in the two-year flood plain were sorted in descending order by their per acre FR scores.

Figure 3-1: Selecting Acreage to be Reforested by Identifying Breakpoint in Marginal FR Score



Working from the highest to the lowest FR score per acre, a tally of cumulative acres and cumulative FR points was taken. Then, moving from the highest to the lowest ranked analytical unit, the “marginal FR score” was calculated by dividing the change in total FR score by the change in total acreage with the addition of an each analytical unit. The marginal FR scores were then plotted against cumulative acres to produce a marginal FR score curve. The marginal FR score curve was examined to find significant break-off points, that is, points where the marginal FR score dropped of significantly; indicating that with each additional analytical unit acquired, a significantly larger number of acres must be acquired to attain each additional point in the cumulative FR score. A significant break point was identified at a total of 88,000 acres, as shown in Figure 3-1. This amount of acreage represents approximately 70% of the cleared land that could be reforested in the two year flood plain.

Section 4. Evaluation of the Watershed Action Scenario

The watershed action scenario was evaluated using the National Economic Development (NED) criterion that is required by the P&G for water resource projects. If the watershed action scenario is economically justified then a nonstructural plan of incentive programs to encourage a similar, if not identical, set of nonstructural actions will be warranted. Thus, the economic analysis is conducted to establish a justification for the incentive polices and *not* to justify a particular set of land uses. Before providing a detailed description of the benefit categories and estimation techniques a brief overview of the NED criterion is offered.

4A. The National Economic Development (NED) Criterion

The *U.S. Water Resources Council's Economic and Environmental Principles Guidelines for Water and Related Land Resources Implementation Studies (P&G)* http://www.usace.army.mil/inet/functions/cw/cecwp/guidance.htm state that the Federal Objective "of water and related land resource project planning is to contribute to national economic development consistent with protecting the Nation's environment …". [9] The Principles section of the P&G defines NED as follows:

> "Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the Nation. Contributions to NED include increases in the net value of goods and services that are marketed, and also those that may not be marketed."

The NED analysis will include the value of goods and services produced, regardless of whether or not a market for the service exists. In the watershed action scenario, the environmental services provided by restored forested wetlands are included among the NED benefits. Environmental services such as carbon sequestration, improved wildlife habitat and increased nutrient uptake may or may not be traded in existing markets. Nonetheless, as long as these environmental functions can be related to an increase in the national output of goods and services, they are counted as part of the NED criterion.

In an NED analysis not all sources of income to landowners are measures of economic benefits. The NED criterion measures only the value of positive or negative changes in output of goods and services in the national economy and excludes taxpayer financed cash subsidies. NED benefits do not include payments to landowners such as conservation easement payments, reforestation cost share programs, disaster payments for flood losses, production flexibility contract payments and any other similar programs

[9] As was noted earlier, the P&G requires that a plan serve the Federal Objective of having positive net NED benefits consistent with meeting all applicable environmental laws. Because the Corps restoration policy provides an exemption from the positive NED test for actions formulated to achieve restoration, the watershed action scenario might be justified on this basis. Because the calculated NED benefits reported in this section might be viewed as experimental, the restoration policy guidelines were used in Section 6 to develop an alternative justification for the watershed action scenario.

that contribute to landowner's income. Such cash payments are a transfer from one part of the economy (taxpayers) to another (the recipient of the transfer) and do not result in an increase in the national output of goods and services.[10] Generally, NED analysis does not include revenues to landowners from government programs as NED benefits and does not include tax payments to governments as an NED cost.

4A1. Applying the NED Criterion for Evaluating Nonstructural Actions

Some of the services of nonstructural actions that were valued are not explicitly listed in the P&G – these included hunting on private lands, carbon sequestration and nutrient reduction. The P&G present a carefully constructed logic for measurement of a variety of services arising for management of water and related and related land resources actions. At Section VII, 1.7.2 (c)(11) is a list of these services that may be measured as benefits and an opportunity for consideration of other services if the service categories are documented. Because we have included benefit categories such as carbon sequestration and nutrient reduction as benefits we will justify their inclusion in accord with Section VII, 1.7.2 (c)(11) of the P&G, which allows for "Other categories of benefits for which procedures are documented in the planning report and which are in accordance with the general measurement standards in paragraph (b) of this section".

Throughout the text the P&G describes the evaluation standard of willingness to pay for each of the services and then leads the analyst through a step by step approach to valuing the services explicitly listed in Section VII, 1.7.2 (c)(11). When a service is not listed there then the user of the P&G is obligated to first make the argument that the service is one for which people would (in principle) be willing to pay – the measurement standard – and then is obligated to use a technique for measure of willingness to pay that would be professionally defensible and be consistent with approaches used for other P&G services. We will explain why our technique for the calculation of benefits for carbon sequestration and nutrient reduction conform with the P&G willingness to pay measurement standard. [11]

4B. The With and Without Evaluation Stance

The evaluation of the watershed action scenario compares the net benefits to the nation (NED) from different uses of flood prone lands initiated by landowners response to the nonstructural plan. The evaluation begins by describing the alternative land uses under a baseline, or without plan condition. For the Yazoo, with its agriculturally

[10] When evaluating the NED costs of an alternative, any expenditure is considered to be an NED cost if it results in resources being diverted from the private sector. In contrast, expenditures on payments to landowners through government programs such as disaster assistance payments or production flexibility contracts, are not considered NED costs because they do not remove resources directly from the private sector. Instead, such payments represent merely a redistribution of money from one government program to another.

[11] The NED values were ascribed to, for example, nutrient reduction for improved water quality and not to the services derived from the improved water quality like enhanced commercial and recreational fishing opportunities. This means that the recreation benefits from improved water quality were not directly measured using tools such as the travel cost method or the contingent valuation method.

dominated landscape and few forest areas, under the without plan condition all land will continue in agricultural production. The with plan condition is reforestation of some number of acres of flood plain cropland. The difference in acres of forest under the with and without action condition is the reforestation that might be attributed to the incentives in the nonstructural plan. [12]

The watershed action scenario consists of the three nonstructural actions of reforestation, a federally subsidized insurance program and localized protection or relocation of structures. Evaluating the watershed action scenario required determining the change in NED with implementation of each of these three actions. Net NED benefits (benefits minus costs) are calculated as the difference between NED returns from the land use in Yazoo Backwater Area with and without implementation of the watershed action scenario.

In this study we consider a future scenario that results in reforestation of 88,000 acres of cropland that is currently farmed in areas that have a 50% chance of flooding in any year (the 2-year flood plain). The initial assumption for the without action condition is that the current level of agricultural land use will prevail in the future. This means that the 88,000 reforested acres would be ascribed to the nonstructural plan and the financial costs and NED benefits for that change would be charged to the plan. However, there is reason to believe that significant reforestation will occur in the watershed in the absence of any nonstructural plan, as long as the WRP program remains in effect in the area. The Fish and Wildlife Service's (FWS) Planning Aid Report (USFWS, 1999) evaluated the recent history of land use in the area and concluded that a continuation of the existing Wetlands Reserve Program (WRP) easement purchase program would lead to over 40,000 acres of reforestation in the next decade. If the WRP does continue then, the incentives in the nonstructural plan would expand on and accelerate this reforestation trend. This possibility is considered in the implications section of the report.

4C. Categories of NED Benefits and Costs

The net NED for the Watershed Action Scenario includes the benefits and costs generated by the reforestation action. When evaluating the NED consequences of reforestation actions, NED costs are the market prices paid for the seedlings, labor, machinery and other inputs used in reforestation. NED costs also include the NED benefits sacrificed from the without action condition when reforestation occurs --- that is, the NED value of the forgone agricultural production on the reforested land..

Once these costs are incurred, the NED benefits are the money valuation of the services provided by forested land. One benefit is the value to the nation of the pulpwood and saw timber that could be harvested in future years. Forests also provide superior wildlife habitat, sequester carbon and are less likely to contribute to nutrient enrichment of estuaries and lakes and reduce sediment loads to streams. Under the NED criterion, these environmental services of forests can also be an NED benefit. Although landowners may not earn a cash income from the production of these services, as long as

[12] We do not project future changes in crop mix.

there is evidence that the services are of value to the national economy, they may be counted as NED benefits.

Table 4-1 provides a detailed listing of the benefit and cost categories that were used in the evaluation of the watershed action scenario. The reforestation benefits listed in Table 4-1 do not include agricultural flood damages avoided as a benefit category. To claim such benefits would be conceptually in error and inconsistent with the P&G. The logic follows. Reforestation results in an NED cost equal to the opportunity cost of the agricultural production forgone once reforestation takes place. The opportunity cost of the land no longer being farmed is measured as the net returns earned from the land in its current flood prone state. The estimate of forgone net return is already adjusted to account for flood damages. Because flood damages are accounted for by the flood-lowered estimates of net returns, the NED costs of forgone agricultural production is lower than it otherwise would be. This means that flood damages are already accounted for in the NED calculation as a lower cost for the reforestation action. To then include damages that no longer occur as a separate benefit category would double count flood damages avoided as a benefit of reforestation. The P&G instructs the analysts to measure the benefits of a removal of activity from the land as the benefits ascribed to the new land uses. This is what was done here.

The computed NED benefits for the watershed action scenario are only for the reforestation actions. This limitation on the NED analysis warrants explanation. First, the NED consequences of landowners participating in an insurance program were *not* evaluated. Such an evaluation only can be made if landowners are paying actuarial (unsubsidized) premiums for their insurance coverage and if ad-hoc disaster aid payments are no longer made. Under these conditions, the analysis first would predict how landowners would modify land use in accord with the insurance premium costs. The resulting NED from the with-insurance land use would be compared with the NED realized from the current use of the land. The benefits would be the NED difference to the nation with and without insurance. The NED costs would be the administrative costs of establishing and administering an insurance program. However, as will be explained, the nonstructural plan calls for subsidized insurance to encourage participation in the program. These subsidies were treated as a transfer payment that would not result in any land use change. The administrative costs of increased insurance coverage might be included as an NED cost, but because of its small anticipated magnitude, this cost was not part of the NED calculation.

Second, this research was *not* able to complete a comprehensive analysis of relocation and other nonstructural flood hazard mitigation actions. In order to recognize the NED consequences of localized flooding, the nonstructural plan does call for a detailed flood hazard reduction analysis for the limited number of structures in the study region. It is assumed for the NED analysis of the watershed action scenario that relocation and localized protection will be undertaken to the point where the total NED costs will be equal to the total NED benefits from avoided damages. In effect the net NED from residential, commercial and infrastructure protection is set at zero.

Table 4-1: NED Benefits and Costs

Benefit or Cost Category	Description
NED Cost – agricultural production	A cost of reforestation is the NED value of the forgone farm production. Following the P&G standard for calculating agricultural NED, the value of forgone production is calculated using projected yields adjusted for delayed planting due to flooding, projected agricultural market prices, and projected costs for production inputs.
NED Cost – timber stand	Expenditures made for land preparation, thinning, etc. necessary for assuring survival of the planted seedlings. Establishment costs also include expenditures for replanting if the seedlings are killed by extended inundation.
NED Benefit – timber harvest	NED benefits derived from reforestation include the sale of harvested trees for saw-timber and pulpwood. Timber returns depend upon the productivity of the site, the tree planted and future market conditions. For the watershed action scenario reforestation was a cottonwood oak interplant on all soils that would support cottonwood, seeding of nuttall oak and seedling planting for all other species.
NED Benefit – wildlife	Forests provide for more valued hunting experiences than agricultural fields. This increase in value is manifested in hunters increased willingness to pay for leases on forested land over agricultural land. The tree species producing the greatest quantities of mast and having the longest rotations (Nuttall, Nuttall/ Cottonwood interplant, Green Ash, Cherrybark Oak and Bald Cypress) receive the higher hunting benefits. For all tree species, the hunting value increases as the tree stand matures and with its proximity to a wildlife management area.
NED Benefit - Nutrient load reduction	Forested areas release less nitrogen and phosphorous to the water than farmed lands. Reduced nutrients from the change in land use from agriculture to forestry contribute to reducing nutrient loads to the hypoxic area in the Gulf of Mexico. The number of pounds of TN reduced by the change in land use was derived from a watershed simulation model prepared for the EPA TMDL process. Other water quality improvement results are possible, but were not considered for this analysis.
NED Benefit - Carbon Sequestered	Forested areas sequester more carbon (CO_2 is the primary greenhouse gas) than farmed lands. Increased carbon sequestration of forestland over farmland contributes to a reduction of greenhouse gases released to the atmosphere. Estimates of the metric tons of carbon sequestered were made for a study completed at the University of Maryland.
NED Benefit – Non-crop / on-farm damages avoided	Frequent flooding on agricultural lands damages farm equipment, stored supplies and drainage structures. Reforestation means that such agricultural infrastructure is no longer located in the flood prone areas and is not longer subject to flooding.

4D. Computing NED Costs and Benefits

The NED costs and benefits of the Watershed Action Scenario are calculated in three steps (equation 4-1). First, all acreage in the study area is broken down into 32 analytical units. Each analytical unit represents a unique combination of soil type and flooding frequency found in the study area. The development of analytical units is discussed further in 4D3.

Then, per acre estimates of all costs and benefits (show in Table 4-1) are made for each of the 32 analytical units. Sections 4E1 and 4E3 describe in detail the calculation of the per acre NED benefits from the production of wood products, the NED costs of reforestation and the NED costs of forgone agricultural production. Section 4E4 explains how per acre benefits were calculated for other, non-timber NED benefits associated with reforestation, such as the creation of wildlife habitat, nutrient load reduction and carbon sequestration. The calculation of per acre benefits for reduced non-crop, on-farm damages is described in Section 4F1.

Per acre estimates of benefits and costs are calculated for each year of a 120 planning period. All future per acre costs and benefits are discounted to present values at a 6-7/8% discount rate. The discounted future values are then summed over the 120 year period to produce the "net present value" (NPV) of the per acre results for each cost or benefit category. Section 4D1 describes the 120 year planning period.

In the final step, the number of acres in each analytical unit are multiplied by the per acre estimates made for the analytical unit of the NED benefit and cost categories. This step is referred to as the "Landscape Application" of the per acre results, and is described in detail in Section 4H.

Eq. 4-1

Change in NED under Watershed Action Scenario =

$$\sum_{i=1}^{32} Acres_i * (Timber_i - Establish_i - Ag_i + Wildlife_i + Nutrient_i + Carbon_i + Noncrop_i)$$

i= 1-32, indicating analytical units 1-32
Ag_i – NPV of costs of forgone agricultural production, per acre (See Eq. 4-2)
$Timber_i$ – NPV of benefits from the sale of harvested wood products, per acre (See Eq. 4-3)
$Establish_i$ – NPV of costs of establishing a timber stand, per acre
$Wildlife_i$ – NPV of benefits from hunting leases, per acre
$Nutrient_i$ – NPV of benefits from payments for reductions in nutrient loading rates, per acre
$Carbon_i$ – NPV of benefits from payment for carbon sequestration, per acre
$Non\text{-}crop_i$- NPV of benefits from avoided non-crop, on farm damages, per acre
$Acres_i$ = Number of acres in analytical unit i

Eq. 4-2

$$Ag_i = \sum_{Y=1}^{120} \sum_{a=1}^{7} [(Price_{ay} * Yield_{ay} * Reduc_{ay} - ProductionCost_{ay}) * Acres_a] / (1+r)^y$$

Ag_i – NPV of costs of forgone agricultural production, per acre
$Price_{ay}$ – Annual price of crop a in year y (see Section 4E1a3)
$Yield_{ay}$ – Annual flood free yield of crop a in year y (see Section 4E1a2)

$Reduc_{ay}$ – Yield reduction factor applied years in which flooding results in delayed plantings (see Section 4E1a4)
$ProductionCost_{ay}$ – Production Costs for crop a in year y (see Section 4E1a1)
$Acres_a$ – number of reforested acres previously planted to crop type a
a-crop types 1-7 (soybean, cotton, rice, sorghum, wheat, corn, pasture)
y- 1 – 120, number of years in planning horizon
r- discount rate of 6-7/8 %

Eq. 4-3

$$Timber_i = \sum_{y=1}^{120} \sum_{t=1}^{9} [(Yield_t * Price_t - Establish_t - \text{Consultant Fee}) * Acres_t] / (1+r)^y$$

$Yield_{ty}$ = amount of wood product produced (MBF for sawtimber and Cords for pulpwood)
$price_{ty}$ = stumpage price for wood product ($/MBF for sawtimber, $/cord for pulpwood). Stumpage price is net of harvest costs and taxes.
$Establish_t$ = cost of field activities in silvicultural regime specified for each species
consultant fee_t = fee paid for assistance in marketing and selling timber at time of harvest
t – reforestation regimes 1-9 (sycamore, green ash, sweet gum, nuttall, cottonwood, cottonwood-oak, seeded nuttall, cherrybark, bald cypress)
$Acres_t$ – number of acres reforested with tree type t
r- discount rate of 6-7/8 %

4D1. Time

The reforestation actions in the watershed action scenario would not occur immediately. Instead reforestation of 88,000 acres might take a period of 5-10 years, as landowners considered the incentives being offered to reforest in the context of their farm business situation (for example, they might wait to depreciate some piece of equipment before reforesting) and perhaps because funds might not be available to offer cash incentives all in one year. However, for simplicity we assumed immediate reforestation in 1997 (the first year of the analysis) and a stream of benefits for the next 120 years (two hardwood timber rotations).[13]

A comparison of NED between the with- and without- project conditions is made by simulating annual costs and benefits under both conditions over the length of a 120 year planning period. Because the annual values occur in future years, the future values are discounted at a 6-7/8% discount rate and summed to calculate the net present value (NPV) of all benefits and costs.[14] The NPV can be "annualized" and reported as an annual equivalent value.

The NPV calculation considers costs and benefits over 120 years. However, it is more common for analyses to be conducted over a shorter time horizon, generally 30-50 years. The 120 year time horizon used in this analysis was selected to facilitate the calculation of forestry returns for several reforestation regimes with differing rotation lengths. The

[13] If an assumption was made that (for example) some reforestation was undertaken in year 5 then the time horizon would be extend by five years to 125 years and there would be no costs for reforestation *or* for forgone agricultural returns for the first 5 years. The effect on the computations of extending the reforestation over a 5 year period (for example) would be to delay costs and benefits. The NPV results might differ slightly, but the overall result would not change.

[14] The 6-7/8% discount rate is the same rate used by the Corps in their ongoing analysis of the Yazoo Backwater Pumping plant.

forestry component of the model originally was designed to examine just timber returns and would accept discounts rates as low as 2.5%. Hence the 120-year planning horizon was selected to facilitate the calculation of forestry returns for several reforestation regimes with differing rotation lengths. When the model was adapted to this study we adopted the prevailing discount rate for water project evaluation. After 50 years, the value of all costs and revenues fall to near zero in present values terms at the 6-7/8 % discount rate. As a result, we were not concerned with the difference between the 120-year horizon we chose and the 50-year planning horizon commonly used in this type of analysis.

Also, while it is common for analyses to be conducted over a shorter time horizon, generally 30-50 years accurately predicting future market conditions or technical advances is difficult when an extended time horizon is used, regardless of whether the horizon is 30, 50 or 120 years. It is difficult to defend price and yield projections made so far into the future. Because of the significant uncertainties associated with projecting future economic and technical conditions so far into the future, this analysis does not attempt to make any price, yield or cost projections any further than 10 years into the future. Beyond the 11th year, all values are held constant.

4D2. Calculating the effects of flooding using a Monte Carlo Simulation

The flooding that is endemic to the area limits the ability of agricultural producers to achieve maximum net returns. Backwater flooding lasting into early and mid spring delays the timely planting of agricultural crops, sometimes preventing planting altogether. Delayed plantings result in reduced yields or the substitution of a lower value crop with a later planting date.

Additionally, flooding can interfere with the successful establishment of a timber stand. Flooding that overtops seedlings for a sufficient period of time can result in high mortality rates, requiring the landowner to incur the costs of replacing seedlings lost to flooding.

The timing, depth and duration of flooding vary from year to year. This means that the effects of flooding on NED forestry and agricultural returns in any given year are a random event. In order to include the effects of flooding in the calculation of agricultural and forestry returns, Monte Carlo simulation modeling is used to calculate the NPV of agricultural and forestry returns. Two separate simulations are used to calculate agricultural and forestry returns. Sections 4E1a4 and 4E3a5 describe in greater detail the operation of the two simulations, hereafter referred to as the “agricultural module” and the “forestry module”. While the agricultural and forestry modules are structured somewhat differently, both operate under the same general principles of a Monte Carlo simulation.

In a Monte Carlo simulation model, all stochastic variables (i.e. variables with values that vary with unpredictable flooding events) are identified. Each stochastic variable is then represented by a probability distribution that describes the range and likelihood of the possible values the variable can take on, depending upon flooding conditions. For example, soybeans yields can range from zero to 30 bushels depending on the flooding regime during the growing season.

For both the agricultural and forestry models the simulation model draws a single value for each stochastic variable from the probability distribution used to represent that variable. This is done for each year in the 120 year planning horizon and the selected variables are used in calculating the NPV of returns for the 120-year period. The process is repeated with the stochastic variables chosen by a different random draw. The calculation process is repeated many times (the total number of iterations differs for the agricultural and forestry modules). Each time the NPV is recalculated using new values of the stochastic variables drawn for each probability distribution; each repetition is referred to as an "iteration" of the model.

As the simulation runs through multiple iterations, the results of each iteration are consolidated to produce a probability distribution (range and likelihood) of NPV results. The mean of this probability distribution equals the expected value of the NPV results. The expected value is the NPV of agricultural or forestry returns that arises, on average, given the variable effects of flooding on the stochastic variables. The expected value is reported as the simulation solution.

4D3. Defining Analytical Units

Per acre NED benefits and costs vary from one site to the next in the study area, depending upon the characteristics of a site. The frequency and timing of flooding on a site, for example, plays a significant role in determining the net returns of agricultural and forestry production, as well as the extent of structural flood damages. The type of soils on a site also affects net forestry returns.

In order to account for the effects of these differing physical attributes on NED benefits and costs, land in the study area was broken down into 32 analytical units. Each analytical unit is defined by a unique combination of the three site characteristics defined in Table 4-2, below. Each analytical unit is made up of a different combination of these three site characteristics and is comprised of all land in the study area sharing the same combination.

Analytical units do not necessarily represent geographically contiguous parcels of land. A single analytical unit may consist of acreage scattered across the entire study area. Any parcel of land sharing the same attributes that define a given analytical unit, will be included in that analytical unit, regardless of its geographic location.

Table 4-2: Parameters Defining Analytical Units

Site Attribute	Defined	NED Benefits / Costs Affected
Study Reach	The Corps breaks the study area down into four study reaches. Stage frequency data, used to describe flooding frequency in the basin, differs between study reach 1 and reaches 2-4. Since reaches 2–4 share the same stage frequency data, they are treated as a single reach, "Reach Two".	Agriculture Forest Products Non-crop/ On-farm damages Hunting Nutrient Retention Carbon Sequestration
Elevation Range	Eight elevation ranges were delineated to estimate how many acres of land are flooded at different threshold river stages. Moving from Elevation Range One to Elevation Range Eight, the acres counted in an elevation range equal the number of additional acres flooded when the Mississippi reaches the next threshold stage at the Steele Bayou gage.	Agriculture Forest Products Non-crop/ On-farm damages Hunting Nutrient Retention Carbon Sequestration
Soil Type	All soils in the study area were classified as either hydric or non-hydric soils.	Forest products Hunting Nutrient Retention Carbon Sequestration

With two study reaches, eight elevation ranges and two soils types, there were 32 possible combinations of these three site characteristics. The per acre NED benefits and costs were calculated for each of these analytical units under both the with- and without-project conditions. The USGS office in Pearl, Mississippi developed a digital elevation model of the Yazoo study area to identify how many acres of land in the study area fall into each analytical unit (DOI USGS, draft paper currently in review). The per acre NPV estimates of benefits and costs were calculated for each analytical unit (Equation 4-1). The per acre returns were then multiplied by the total number of acres in the unit that were selected for reforestation under the Watershed Action Scenario. Finally, the total NED benefits and costs in each analytical unit were summed to calculate the aggregate change in NED for the entire study area, under the reforestation plan specified by the Watershed Action Scenario. It should be noted that the model developed by USGS is not limited to evaluating only the Watershed Action Scenario. It could be used to calculate the NED consequences of reforestation anywhere within the study area.

4D4. Estimating Flooded Acres

In order to represent the difference in flooding conditions at different elevations, eight elevation ranges were defined using eight different river stage readings on the Corps gage at Steel Bayou (see Table 4-3). The stages selected corresponded with stage frequency data provided by the Corps. The Corps stage frequency data identified the stage readings on the Steele Bayou gage that correspond with 1-year, 2-year, 5-year, 10-year, 20-year, 50-year and 100-year flood events. Every acre of land in the study area is assigned to one of the elevation ranges, depending upon what stage the river must reach, before the land is flooded. For example, all acres in Elevation Range One are flooded once the river stage reaches 87' (87.6' in reaches 2 – 4) at the Steele Bayou gage. Acres assigned to Elevation Range Two include all *additional* acres that are flooded when the river stage reaches 91' (91.8' in reaches 2-4). [15]

Several different methods for determining the number of acres in each of the eight elevation ranges were considered, including the use of digital elevation models, satellite images of flood scenes, and flood scenes used along with topographic data. The acreage estimates differed somewhat between different methods that have been used by the Corps and other agencies during their study of the Yazoo backwater area (DOI USGS, draft paper currently in review).

For this study, an experimental technique developed by USGS called HydroGrow was used to determine the number of acres inundated in each elevation. The HydroGrow technique estimates areas inundated at different flood stages measured at the Steel Bayou gage by interpolating from satellite images of flood scenes, along with topographic data (DOI USGS, draft paper currently in review).

Table 4-3: Elevation Ranges

Elevation Range Number	Stage (ft.) at upper limit of elevation range	
	Reach One	Reaches Two - Four
Range One	87'	87.8'
Range Two	91'	91.8'
Range Three	94.6'	95.3'
Range Four	96.3'	96.8'
Range Five	97.6'	98.1'
Range Six	99.2'	99.5'
Range Seven	100.3'	100.3'
Range Eight	> 100.3'	>100.3'

4E. Calculating Net NED Benefits from Reforestation

As shown in equation 4-1, the costs of reforestation are the expenditures made to establish trees and the agricultural income (NED) no longer earned on the reforested sites in the watershed. The benefits of reforestation accrue from timber sales and from the other services of reforestation listed in Table 4-1.

[15] Not including those acres already flooded at 87', which comprise the acreage in elevation range one.

4E1. Forgone Net Agricultural Returns

The market price for farmland (or for easements) is one possible measure of the present value of the forgone agricultural returns to the nation. However, land or easements prices will not measure the NED cost of forgone agriculture if the prices incorporate factors other than the capitalized value of future agricultural returns. Pump expectations, crop insurance subsidies and farm program activities might all affect land prices. The demand for hunting leases might also be capitalized into the price. We would expect that the dominant factor determining land prices would be agricultural returns. Nonetheless, we chose to measure the NED opportunity costs of forgone agricultural returns by using a simulation model to calculate the present value of net returns, rather than using agricultural land prices.[16] The modeled calculation of NED returns combines agricultural crop price information and prices for production inputs with yields to get a measure of the value to landowners and to the nation of the crop production. If the prices are "subsidy free", the price received by farmers represents consumers' willingness to pay for the agricultural output. In fact, such simulation modeling is a standard technique for calculating agricultural returns and agricultural flood damages. The P&G recommends simulation modeling for measuring agricultural flood damage reduction benefits.

4E1a. The Per Acre Calculation

The principal crops found in the Yazoo Basin are soybeans, cotton and rice. Some corn, wheat and sorghum are also grown. The NPV of per acre net returns to land were calculated for each of these six crop types. In the final evaluation of the watershed action scenario it was assumed that the reforested land would all be soybean land. The other crop return calculations were used in calculating the costs of an income assurance program. As shown in equation 4-2, the estimation of net returns requires estimates of prices, yields and costs in the current and future years. The future net returns are discounted back to present value.

4E1a1. Production Costs

Delta 1998 Planning Budgets were the primary source of information used for production practices and costs.[17] The Delta crop budgets are prepared annually by researchers and extension agents associated with Mississippi State University. Researchers utilize survey information collected from producers in the Delta region, along with published data and expert opinion to develop budgets that are representative of production practices and costs typical to the Delta area. (Budgets, 1997) Although production activities on individual farms in the Delta might differ somewhat from those represented in the Delta budgets; for the basin-wide scale of this analysis, the Delta budgets provide the best available representation of crop production in the Yazoo Basin.

[16] We do use the land prices from the area as a test of the validity of the computer modeled agricultural returns in Section 5. Also, we use easement purchase costs in Section 6.

[17] December 1997, Agricultural Economics Report 90, Mississippi State University

Detailed budgets for all crops can be found in Appendix A.[18] Costs considered were production costs (Table 4-4), replanting costs (Table 4-5) incurred to replace a crop killed by a flood event and fixed costs (Table 4-6) for years in which flooding prevents planting altogether (see equation 4-4).

Eq 4-4

$ProductionCost_{ay} = VarProdCosts_{ay} + ReplantCosts_{ay} + FixedCosts_{ay}$
$VarProdCosts_{ay}$ = annual variable production costs
$ReplantCosts_{ay}$ = replanting costs incurred for years in which flooding requires replant
$FixedCosts_{ay}$ = fixed costs incurred for years in which flooding prevents planting altogether
a-crop types 1-7 (soybean, cotton, rice, sorghum, wheat, corn, pasture)
y- 1 – 120, number of years in planning horizon

To reflect future changes in market conditions projected production costs were used for the first ten years of the simulation. The ten years of projected productions costs were determined by adjusting the 1997 production costs found in the Delta Planning Budgets according to projected rates of change in production costs for each crop type in the Delta region. Nominal projections of production costs in the Delta region (i.e. future costs including inflation) were provided by FAPRI (Food and Agricultural Policy Research Institute). [19] The FAPRI projections were adjusted for inflation and expressed in 1997 dollars.[20] The real rate of change in production costs was then calculated and used to adjust the base year costs taken from the Delta Planning Budgets. Projected production costs for the first ten years are reported in Table 4-4. It is assumed that production costs remain constant from the 11th year forward.

Table 4-4: Projected Production Cost per Acre by Crop Type (in 1997 dollars)

	Year 1 (1997)	Year 2 (1998)	Year 3 (1999)	Year 4 (2000)	Year 5 (2001)	Year 6 (2002)	Year 7 (2003)	Year 8 (2004)	Year 9 (2005)	Year 10 (2006)	Year 11 (2007)	Year 12 - 120
Soybeans	138.72	133.85	129.80	128.85	128.03	126.64	125.38	124.13	122.94	121.61	120.20	120.20
Cotton lint	541.42	512.84	504.76	500.47	497.27	492.21	487.12	482.60	478.26	473.45	468.33	468.33
Cottonseed	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Rice	431.87	416.39	404.17	401.60	398.82	394.44	390.17	386.48	382.96	379.29	375.35	375.35
Sorg	165.53	155.16	149.18	148.42	147.32	145.22	143.40	141.65	139.95	138.13	136.24	136.24
Wheat	136.11	125.98	120.71	120.55	120.32	118.80	117.55	116.42	115.31	114.12	112.85	112.85
Corn	250.19	238.82	230.28	229.38	228.61	226.07	223.89	221.86	219.90	217.72	215.39	215.39

[18] Some overhead costs were not included in the budgets. Therefore the returns to land are overstated by some amount.

[19] The nominal projections of production costs were prepared as part of the FAPRI 1998 US Agricultural Outlook report that provides 10-year projections of domestic and international crop yields, prices and production costs. The FAPRI projections are used as a baseline in much of the policy analysis done by USDA and are based on an explicit set of assumptions about future macroeconomic, political and technological conditions. These assumptions will be described in greater detail in Section 4E1a3.

[20] January 1996 WEFA (Wharton Econometric Forecasting Associates) forecasts of the GNP implicit price deflator were used to adjust nominal prices for inflation.

Table 4-5: Projected Replanting Costs per Acre by Crop Type (in 1997 dollars)

	Year 1 (1997)	Year 2 (1998)	Year 3 (1999)	Year 4 (2000)	Year 5 (2001)	Year 6 (2002)	Year 7 (2003)	Year 8 (2004)	Year 9 (2005)	Year 10 (2006)	Year 11 (2007)	Year 12 - 120
Soybeans	27.44	26.47	25.68	25.49	25.33	25.05	24.80	24.55	24.32	24.05	23.78	23.78
Cotton lint	66.48	62.97	61.98	61.45	61.06	60.44	59.81	59.26	58.72	58.13	57.50	57.50
Cottonseed	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Rice	47.29	45.60	44.26	43.98	43.67	43.19	42.72	42.32	41.93	41.53	41.10	41.10
Sorg	43.70	40.96	39.38	39.18	38.89	38.34	37.86	37.40	36.95	36.47	35.97	35.97
Wheat	34.72	32.14	30.8	30.75	30.69	30.30	29.99	29.70	29.41	29.11	28.79	28.79
Corn	85.78	81.88	78.95	78.65	78.38	77.51	76.76	76.07	75.39	74.65	73.85	73.85

Table 4-6: Projected Fixed Costs per Acre by Crop Type (in 1997 dollars)

	Year 1 (1997)	Year 2 (1998)	Year 3 (1999)	Year 4 (2000)	Year 5 (2001)	Year 6 (2002)	Year 7 (2003)	Year 8 (2004)	Year 9 (2005)	Year 10 (2006)	Year 11 (2007)	Year 12 - 120
Soybeans	31.49	30.38	29.46	29.25	29.06	28.75	28.46	28.18	27.91	27.60	27.29	27.29
Cotton lint	83.08	78.70	77.50	76.80	76.30	75.523	74.75	74.05	73.39	72.65	71.86	71.86
Cottonseed	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Rice	86.57	83.47	81.01	80.50	79.95	79.06	78.21	77.47	76.77	76.03	75.24	75.24
Sorg	30.98	29.03	27.92	27.78	27.57	27.18	26.84	26.51	26.19	25.85	25.50	25.50
Wheat	22.12	20.47	19.62	19.59	19.55	19.30	19.10	18.92	18.74	18.55	18.34	18.34
Corn	53.98	51.52	49.68	49.49	49.33	48.78	48.31	47.87	47.44	46.97	46.47	46.47

4E1a2. Flood Free Yields

The inherent productivity of a site produces "flood-free" crop yields; that is, yields that would be expected in the absence of problems caused by flooding. Flood free yields depend on site attributes, such as soil quality, susceptibility to drought, pestilence and soil saturation / flooding unrelated to backwater flooding connected to the Yazoo hydrology. To achieve the flood-free yields farmers must use recommended production practices.[21] In some flood prone situations farmers might be reluctant to use the best management techniques because of a concern over seasonal flooding. However, because the backwater flooding that occurs in the Yazoo Basin is somewhat predictable, it may not have the same effect on landowner decision making. Once the water has left the field, farmers are likely to employ the best available management practices because late season flooding is unlikely. The backwater flooding may delay planting and reduce yields or even cause a switch of crops, but the flooding would not deter the farm operator from using the highest yielding farm production practices after the flooding has subsided. [22]

[21] We assume that recommended production practices are those described in the budgets.

[22] The Corps argues that farmers are discouraged from using high management practices because of the backwater flooding. The Corps then asserts that if the flooding were to be reduced these high management practices would be employed. We will discuss this further in Section 5B.

Flood free yields were initially based on Mississippi State University (MSU) 1998 planning budgets for the Delta area. Crop yields used in the budgets were derived from historical regional averages (MAFES, 1998). The budget yields for the three dominant crops, soybeans, cotton and rice, were then cross checked with a composite of yield information, including National Agricultural Statistical Service (NASS) County Data for 1997 and 1998, interviews with local extension agents and 1997 US Census data. Tables 4-7 and 4-8, below, record the yield estimates reported by each of these sources.

Table 4-7: National Agricultural Statistical Service County Yield Estimates (1997-1998)*

	Sharkey		*Issaquena*		*Washington*		*Yazoo*		*Warren*		*Humphreys*	
	1997	*1998*	*1997*	*1998*	*1997*	*1998*	*1997*	*1998*	*1997*	*1998*	*1997*	*1998*
Soybean (bu.)	30	25	28.8	24.7	34.8	27.5	28.3	24.5	27.8	23.6	29.6	24.5
Cotton (lb)	957	940	871	855	957	804	882	805	830	739	948	900
Rice (lb)	6071	6152	n.a.	n.a.	6105	5890	n.a.	n.a.	n.a.	n.a.	5449	5845

*NASS data available at: http://www.nass.usda.gov/ms/soyb9798.htm

Table 4-8: County Yield Estimates from 1997 US Census Data

	Sharkey	*Issaquena*	*Washington*	*Yazoo*	*Warren*	*Humphreys*
Soybean (bu.)	29.21	n.a.	34.8	27.54	27.12	27.69
Cotton (lb)	888	n.a.	907.2	835.2	787.2	892.8
Rice (lb)	5940	n.a.	5985	5670	5996	5355

*1997 Agricultural Census data can be found at http://www.census.gov/prod/ac97/ac97a-24.pdf

Upon examining each of the alternative data sources, it was determined that the MSU budgets yields accurately represented flood free yields for lands in the study area. The yields reported in the MSU budgets, the NASS tables and the Census statistics are not "flood-free" yields; rather they are average, countywide or regional yields. Nonetheless, they closely matched the "flood-free" yield estimates provided by the local extension specialists. From interviews with these experts, it was clear that flood free yields in the study area are lower than flood free yields elsewhere in the state. In fact, the experts' estimates of flood free yields in the study area closely approximated average regional and state yields. For this reason, the yields reported in the MSU agricultural budgets were deemed to be accurate representations of what a producer might expect to harvest in a flood-free year on fields in the study area.

Recognizing changing technology, flood free yields are projected ten years into the future using trends reported in the FAPRI (Food and Agricultural Policy Research Institute) 1998 US Agricultural Outlook report. FAPRI yield projections are based on the assumption that, in general, technological changes, including yield growth occurs at rates that are in line with those observed in recent history (FAPRI, 1998). After the tenth year, yields are assumed to remain constant for the remainder of the planning period, due to the uncertainty of future technologies. [23]

Table 4-9: Projected Food-Free Yields per Acre by Crop Type (in 1997 dollars)

	Year 1 (1997)	Year 2 (1998)	Year 3 (1999)	Year 4 (2000)	Year 5 (2001)	Year 6 (2002)	Year 7 (2003)	Year 8 (2004)	Year 9 (2005)	Year 10 (2006)	Year 11 (2007)	Year 12 - 120
Soybeans (bu)	30	29.61	30	30.3	30.59	30.99	30.99	31.18	31.48	31.78	32.07	32.07
Cotton lint (lb.)	825.00	762.43	766.28	772.05	777.83	782.64	782.64	788.42	793.23	798.05	803.82	803.82
Cottonseed (lb)	1369.5	1265.63	1272.02	1281.61	1291.2	1299.19	1299.19	1308.78	1316.77	1324.76	1334.34	1334.34
Rice (bu)	125.00	126.19	126.98	127.87	128.73	129.55	129.55	130.37	131.16	131.96	132.72	132.72
Sorg (bu)	70.00	69.07	69.81	70.47	71.12	71.86	71.86	72.51	73.16	73.72	74.38	74.38
Wheat (bu)	50.00	49.13	47.83	50.43	51.08	51.63	51.63	52.28	52.93	53.58	54.12	54.12
Corn (bu)	100	99.82	101.93	103.94	105.96	107.89	107.89	109.82	111.74	113.58	115.43	115.43

4E1a3. Prices

The P&G at Section III.2.3.3 (b) calls for the use of normalized prices issued by the USDA as the prices that will be used in the agricultural net returns analysis. The normalized prices are to be free of the influence of government programs and are to reflect expected market conditions. In developing the normalized prices for 1998 the USDA stated that recent agricultural reforms had reduced the influence of government programs (USDA, issue date unknown). The UDSA noted that they were no longer using simulation models for determining normalized prices and were now using a 5 year moving average of market prices for the normalized price series. For the year 1997, for example, normalized soybean prices were $6.04 per bushel and these prices were to be used by the Corps for the whole period of analysis.

The more general guidance for selecting prices for NED analysis is found in the P&G in Section 1.4.10. In 1.4.10.(a), the P&G calls for "the use of real exchange values expected to prevail over the period of analysis." The P&G allows for the use of prevailing prices *"unless specific considerations indicate that real exchange values are expected to change."* (emphasis not in original). We considered the current USDA approach to reporting normalized prices in relation to the broader based USDA effort to project exchange values for agricultural products for the next decade. We noted that the

[23] In fact, if yields are projected beyond ten years then so too must real production cost (that will likely rise) and real prices (that will likely fall). Rather than extend all the projections when there is much uncertainty prices, costs and yields were all held at 2007 levels.

USDA has made significant strides in accounting for considerations that will cause exchange values for farm products to change over the next decade. We also noted that the USDA price projections are based on specific considerations that will cause exchange values to change and that the projections are free of the influence of government programs because of recent reforms in US farm policy. From these projections FAPRI predicts (for the USDA) that soybean prices would not exceed $5.83 from 1998 through 2007.

We concluded that the by using a 5 year moving average for reporting normalized prices the USDA had ignored their own more sophisticated work on prices. We found the normalized prices report by USDA to be technically flawed, unresponsive to the intent of the P&G, and inconsistent with the federal government's own price projections used in the formulation of farm policy. For this reasons we used the FAPRI price projections in our modeling and not the normalized prices series.

Ten- year crop price projections for the Delta region were used for the net returns simulation.

Table 4-10: Projected Prices by Crop Type (in 1997 dollars)

	Year 1 (1997)	Year 2 (1998)	Year 3 (1999)	Year 4 (2000)	Year 5 (2001)	Year 6 (2002)	Year 7 (2003)	Year 8 (2004)	Year 9 (2005)	Year 10 (2006)	Year 11 (2007)	Year 12 - 120
Soybeans (bu)	6.66	5.35	4.99	4.97	4.96	4.91	4.82	4.78	4.72	4.68	4.59	4.59
Cotton lint (lb)	.72	.65	.55	.53	.54	.55	.55	.55	.56	.55	.55	.55
Cottonseed (lb)	.06	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
Rice (bu)	4.45	4.05	3.78	3.73	3.69	3.62	3.60	3.53	3.50	3.43	3.37	3.37
Sorg (bu)	2.21	1.62	1.73	1.75	1.76	1.78	1.80	1.80	1.79	1.78	1.77	1.77
Wheat (bu)	3.69	2.75	3.04	3.14	3.16	3.17	3.21	3.22	3.15	3.10	3.10	3.10
Corn (bu.)	2.54	1.91	1.94	1.96	1.94	1.95	1.97	1.96	1.97	1.95	1.93	1.93

As with the regional production costs projections, the commodity price projections used were FAPRI regional price projections made in developing the annual FAPRI Agricultural Outlook Report. FAPRI price projections serve as the baseline commonly used by USDA for its policy analyses (FAPRI, 1998). The FAPRI projections are based on a series of assumptions about future domestic and international macroeconomic and policy conditions (FAPRI, 1998). Major assumptions include:

- Federal agricultural policies outlined in the 1996 FAIR act and the Uruguay Round World Trade Organization agreement will continue throughout the 10-year projection period. This is significant because it means that the prices are "free of subsidy" as required by the P&G.
- Current agricultural policies in other trading nations will also continue.

- Current average weather conditions and historic rates of technological change will persist.
- No further growth of the European Union will occur and no changes will occur in the European Union's Common Agricultural Policy.[24] (FAPRI, 1998)

4E1a4. Flood Damages to Agricultural Production

As was described in Section 4D2, flooding can limit the ability of agricultural producers to achieve maximum net returns. Depending upon the timing and duration of flooding, spring backwaters can delay the timely planting of a crop or prevent planting altogether. Less frequently, flash flooding or spring rainstorms can produce localized flooding events that may inundate a field after an initial planting has been made. In this case, the producer incurs the additional costs of replanting the crop, or possibly, a substitute crop with a later planting date.

The effects of flooding on the NPV of agricultural returns was calculated by using a Monte Carlo simulation model (referred to as the "agricultural module") to calculate the NPV of the returns to agricultural production over the 120 year planning horizon. As was described in Section 4D2, each flood-impacted variable in Equation 4.2 is represented by a probability distribution that describes the range and likelihood of all possible values the variable could take on, depending upon flooding conditions. To complete a single iteration of the simulation, Equation 4.2 is recalculated 120 times to produce annual returns for each year of the 120 year planning horizon. Then, the annual returns are discounted and summed to produce an estimate of the NPV of agricultural returns for the first iteration.

The same process is repeated for 50 more iterations, producing 50 estimates of the NPV of agricultural returns earned over a 120 year period. The average of these 50 estimates equals the expected value of the NPV of agricultural returns earned over a 120 period, given the variable effects of flooding. The expected value is reported as the per acre NPV of agricultural returns for each crop type.

In the agricultural model (Eq. 4-2), the flood-impacted variables are:

a-crop types 1-7 (soybean, cotton, rice, sorghum, wheat, corn, pasture)
y- 1 – 120, number of years in planning horizon

1) $Reduc_{ay}$, the yield reduction factor applied years in which flooding results in delayed plantings,
2) $VarProdCosts_{ay}$, the annual variable production costs
3) $ReplantCosts_{ay}$, the replanting costs incurred for years in which flooding requires replant
4) $FixedCosts_{ay}$, the fixed costs incurred for years in which flooding prevents planting altogether

[24] See FAPRI 1998 report, pp 1 – 4, for a detailed explanation of policy and macroeconomic assumptions underlying FAPRI price projections.

Each of the flood-impacted variables is represented with probability distributions. Each distribution is described by a set of parameters based on the historical flooding patterns in the Yazoo Basin. The parameter values were determined using fifty years worth of historical gage readings (1943 – 1993) that provided a daily record of the river stage at Steele Bayou.

Two forms of agricultural flood damages are represented in the model, reduced yields due to delayed plantings and additional production expenses incurred to replant a damaged crop. For each crop, a REPLANT variable is used to indicate whether or not the crop has to be replanted in a given year. If replanting is necessary, the REPLANT variable equals one, otherwise it equals zero. With every iteration of the model, the REPLANT variable value is drawn from a discrete distribution that describes the annual probability that the crop will need to be replanted, given that an initial planting was possible. The discrete distribution is described by two parameters, the probability that a replant occurs P(replant) and the probability that a replant does not occur 1-P(replant).

A separate replant distribution is used for each crop at each elevation range. The Corps dataset of daily gage readings is scanned to determine the parameters for each distribution. Daily gage readings for every day of the cropping season are examined to determine whether or not (1) an initial planting of the crop was possible and (2) flooding occurred and receded in time to allow for replanting. After all fifty years have been examined, the number of years in which these conditions exist are tallied and then divided by the total number of years in the dataset to calculate the annual probability that a replanting will occur.

After calculating the parameters for the REPLANT variable for soybeans, it was apparent that the probability of replanting for soybeans was low, even in the lowest elevation ranges where flooding problems are most severe. In elevation range one, the probability of a replant was only 10-12%. In elevation range two, the probability of a replant was only 6%. Probabilities for each crop, reach and range are reported in Appendix B. A low probability of replant for soybeans is consistent with the type of flooding that occurs in the region. In general, once initial spring flooding recedes, it remains off the land for the remainder of the cropping season.

If planting is delayed, yields may be reduced or it may be necessary to substitute a lower-value crop with a later planting date. At every elevation range, a PLANTING DATE variable indicates the day on which the final planting of a crop will take place, given the timing of flooding. The final planting day is the last day within the cropping season that floodwaters recede from a field. It might represent the first opportunity to plant that season, or, it might mark the end of a flood event that destroyed a crop, making the final planting of the season a replanting.

Depending upon what date is drawn as the final planting date for the cropping season, one of four actions will be taken.

- Plant on time**—**The crop will be planted on time, if the final planting date occurs before the end of its optimal planting period.[25]
- Plant late **--** The crop is planted late if the final planting date occurs after the end of the optimal planting period and planting a substitute crop is not possible. Planting late will result in a reduced yield at harvest.
- Plant a substitute crop **--** When the final planting date occurs after the end of the optimal planting period for the original crop, another crop with a later planting period will be substituted, if possible.
- Fail to plant**—**Planting is prevented altogether when the final planting date occurs after the end of the planting period for a crop and it is too late in the season to plant a substitute crop. A prevented planting results in zero yield.

Table 4-11: Planting Substitutions for Summer Crops

PLANTING DATE	Soybeans	Cotton	Rice	Sorghum	Corn
< = 4/25	soybeans planted on time	cotton planted on time	rice planted on time	sorghum planted on time	corn planted on time
4/26 – 5/25	soybeans planted on time	cotton planted on time	rice planted on time	sorghum planted on time	soybeans substituted
5/26 – 6/1	soybeans planted on time	soybeans substituted	rice planted on time	sorghum planted on time	soybeans substituted
6/2 – 6/15*	reduced soybean yields	soybeans substituted	soybeans substituted	sorghum planted on time	soybeans substituted
6/16 – 6/20	reduced soybean yields	soybeans substituted (reduced yields)	soybeans substituted (reduced yields)	sorghum planted on time	soybeans substituted (reduced yields)
6/21 – 7/4	reduced soybean yields	soybeans substituted (reduced yields)	soybeans substituted (reduced yields)	sorghum planted late reduced sorghum yields	soybeans substituted (reduced yields)
7/5 – 7/24	prevented planting	prevented planting	prevented planting	reduced sorghum yields	prevented planting
> = 7/25	prevented planting	prevented planting	prevented planting	prevented planting	prevented planting

Source: (Eddleman, 1979)
Note: 6/15 is the only date that differs from Corps' tables. Corps indicated 6/30 is the date on which you begin to get reduced soy yields. Experts we spoke with indicated that 6/15 is the date on which soy yields begin to decline.

[25] The "optimal" planting period is the recommended planting dates for each crop. Although a crop can be planted after the "optimal" planting period, it is assumed that it will produce a lower yield and / or lower quality harvest. See Table 4-11 for the recommend planting periods of each crop type.

PLANTINGDATE is drawn from a triangular distribution that describes, for each day of the cropping season, the likelihood that the final possible planting date will fall on that day. The parameters used to describe the PLANTINGDATE distribution are the earliest, latest and most frequent day on which the final planting of the cropping season has historically occurred. For each elevation range, the Corps stage data was examined to determine the timing of flooding during the cropping season and the final planting date was identified in each of the fifty years. The earliest, latest and most frequent final planting dates from the Corps data set were used as the parameters for the PLANTINGDATE distribution.

4E2. NED Opportunity Costs under Supply Control

Production of soybeans, the crop that dominates the 2-year flood plain, is limited by the CRP and WRP programs that control aggregate supply. In concept, under supply control the national output of a crop would not change with an increase or decrease in production in the study area, Instead, if production were reduced in the study area then land that in other areas of the nation would be returned to production. In this case, the NED cost of removing land from production is the cost to produce the same amount of product elsewhere in the nation.

In a competitive market, any fallow soybean lands would be those fields with the highest cost of soybean production. However, supply control programs (as well as WRP and CRP) are market distortions. Limits are in place on number of acres that can be enrolled in each state and each county and, often, payments provided are in excess of true value of foregone agricultural production. Subsidy payments for land retirement are based on the local rental rates for farmland. Therefore it is plausible that land retired in one area of the nation might have lower production costs than land that remains in production in the frequently flooded areas of the delta. If this is the case then as delta land is taken out of production that production could be replaced by once again farming retired land elsewhere in the nation that may have with lower production costs.

The NED costs of forgone agricultural production were estimated under the assumption that the national CRP/WRP programs act as supply constraint programs. Agricultural production forgone in the Yazoo study area would be replaced by increased production elsewhere in the nation and the NED costs would be the difference in production costs in the two areas. Using the simulation model the per bushel soybean production costs in the Yazoo area were calculated to be $4.91, including the costs of flooding. For the nation as a whole, per bushel production costs are $3.67. This means that replacing Yazoo soybean production with production on an average acre elsewhere in the nation, would lower the nation’s cost of producing soybeans. Therefore, reducing soybean production of the frequently flooded areas of the Yazoo would increase NED because there would be a NED cost savings (benefit) of $1.24 per bushel. What appears as a cost of reforestation with the standard analysis is a benefit under the assumption of supply control

4E3. Forest Products

The model used in this study to calculate the revenues earned from forest products originated from a simulation model developed for a prior research effort examining the economic and policy implications of reforestation in the Mississippi Delta (documented in "Restoration of the Lower Mississippi Delta Bottomland Hardwood Forest: Economic and Policy Considerations" (Amacher et al., 1997)). At the outset of this research, the original model was subjected to a thorough review by forestry experts in Mississippi. A meeting was convened January 22, 1998 at Mississippi State University for the purpose of bringing together forestry experts from NRCS, the Forestry department at Mississippi State University, members of the forest products industry and others to review the original forestry model and, when necessary provide specific recommendations for changes. During the course of this meeting, every aspect of the model was reviewed, including the choice of tree species and reforestation regimes, assumptions about growth rates and mortality rates, price projections, and the costs of reforestation. In all cases, unless otherwise noted in the text of this report, the recommendations provided by the forestry experts present at this meeting were adopted.

4E3a. The Per Acre Calculation

NED benefits derived from reforestation include the sale of harvested trees for timber and pulpwood. In this sense reforestation is conceived of as a commercial operation. Because it is a commercial system, significant up-front investments in establishment are made in an effort to secure better future yields and profits. This means that high production costs are incurred in the first few years of reforestation.

The costs of reforestation include all financial outlays made by landowners to establish and maintain forest stands on former agricultural fields. For the purposes of approximating the financial returns to reforestation in the study area, the eight reforestation scenarios identified in Table 4-12 below were selected as a representative subset of the reforestation options.

Table 4-12: Tree Species Selected for Analysis

Pulpwood Species	Sawtimber Species	Mixed Species
Sycamore	Green Ash	Cottonwood - interplanted with Nuttall Oak
Sweetgum	Nuttall Oak	
Cottonwood	Cherrybark Oak	

The timber returns generated under each of the reforestation options modeled depend upon the inherent productivity of the site, management decisions and future market conditions. The NPV of returns to each of the six reforestation scenarios selected are calculated as shown in Equation 4-3.

Rotation lengths differ from one tree species to another and across soil types. In order to make a comparison of returns across all tree species, a common time horizon of 120 years was established. The NPV of returns over the 120-year period is calculated in three steps. First, the NPV of returns over a single rotation are determined. Then, the annual equivalent value of the NPV estimate is calculated. The annual equivalent value equals the constant dollar value that, if received every year of the rotation, would equal the NPV estimate (once discounted and summed). Finally, the annual equivalent value is treated as annual payments in order to determine the NPV of returns over 120 years. The NPV of per acre returns for each tree species on a representative soil are reported in Appendix D

4E3a1. Establishment and Other Costs

Silvicultural regimes were developed for each of the reforestation scenarios and are presented in Appendix C, along with the associated production costs. All costs are expressed in 1997 dollars[26]. Because the majority of cleared lands eligible for reforestation are former agricultural lands, mechanical site preparation requirements were minimal, involving only one pass of a subsoiler and two passes with a disk harrow. In fact, use of a subsoiler may not be necessary for recently cultivated fields; however, the cost of one pass was included to account for the additional site preparation required for fallow fields (Allen, 1989). All regimes call for a clear-cut and replant at the end of the rotation.

Estimates of planting costs are based on cost share payments provided through the Forest Resource Development Program administered by the Mississippi Forestry Commission.[27]

Based on the results of a statewide survey of forest landowners conducted by Mississippi State University, forest owners paid an average consulting fee of 8.5% of gross revenues for assistance in the marketing and sale of their timber. In the calculation of timber returns, an 8.5% consulting fee is included as a cost in the final year of the rotation.

4E3a2. Flood Free Yields

Assessing the potential productivity of a site in timber production requires knowing its physical and topographic characteristics. The productivity of sites in the study area was characterized according the characteristics of the soils identified in the basin. Soil type, texture, moisture, drainage, structure and pH all determine the suitability of a site for a given tree species. Additionally, the rotation length, rate of tree growth and ultimately the harvested yield expected from a given tree species are all determined by the suitability of the soils found on a site for a particular reforestation regime.

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[26] January 1996 WEFA (Wharton Econometric Forecasting Associates) forecasts of the GNP implicit price deflator were used to adjust nominal prices for inflation.

[27] Some overhead expenses are not included as production costs in the model.

Soils in the study area were identified by NRCS soil series classifications. Using STATSGO data, fourteen major soil series were identified in the study area.[28] The fourteen soils series were then grouped into three general categories ("Dry", Moderately Wet and Wet soils) according to their internal drainage capacity and permeability (See Table 4-13).

Table 4-13: Soils Categories

"Dry" Soils	Robinsonville, Bosket, Beulah
	Dundee, Dubbs
	Commerce, Adler
Moderately Wet Soils	Tunica
	Forestdale, Bowdre
Wet Soils	Alligator
	Sharkey, Mhoon, Iberia

For the fourteen soils series identified in the study area, site indices published by Broadfoot (1976) were used as measures of the productivity of different tree species on each of the soil types.[29] In cases where several soils shared similar site index estimates for all tree species, one soil was selected to represent the group. Table 4-14 records which soils were grouped according to their productivity. The soil selected to represent the group is listed in bold. Grouping the soil series narrowed the analysis down to considering eight reforestation regimes on seven different soils. The site index estimates for the seven soils used in the analysis are recorded in Table 4-15.[30]

Table 4-14: Soil Series Grouped by Productivity Estimates

"Dry" Soils	**Robinsonville**, Bosket, Beulah
	Dundee, Dubbs
	Commerce, Adler
Moderately Wet Soils	Tunica
	Forestdale, Bowdre
Wet Soils	Alligator
	Sharkey, Mhoon, Iberia

Cottonwood yields were based on estimates provided in Amacher et al., (1997). Amacher, et al. simulated cottonwood yields from growth and yield data collected through a collaborative research project between Crown Vantage and the U.S. Forest Service. The model developed in Cao and Durand (1991) was used to simulate yields.

[28] Soils data provided by Terry Baldridge from STATSGO data and scanned county soils surveys.

[29] A site index is the height of a particular species of tree will reach at a given age (often age 50) on the soil type.

[30] Broadfoot provides a range of site index estimates for each soil type / tree species combination. The upper bound of each range of site indices was used in the analysis.

Table 4-16 presents the cottonwood yields calculated for a ten-year rotation for all soils on which cottonwood regeneration was considered feasible.

Table 4-15: Site Index Estimates for Each Tree Species / Soil Type Combination, Measured in Feet at Year 50

	Sycamore	Green Ash	Sweetgum	Nuttall Oak	Cherrybark Oak	Bald Cypress
Alligator	95	90	95	100	100	95
Robinsonville	125	90	115	105	110	n.a.
Forestdale	105	90	105	100	105	95
Sharkey	100	95	100	100	95	95
Tunica	110	90	105	110	105	n.a.
Commerce	120	95	120	105	110	110
Dundee	115	90	110	105	110	n.a.

Table 4-16: Cottonwood Yields

Soil Types	Volume in cords/ac. at Rotation Age (year 10)*
Heavy Soils	
Alligator	4.56
Sharkey	11.93
Tunica	10.47
Light Soils	
Dundee	22.46

Because growth and yield information for bottomland hardwoods in the Mississippi Delta is limited, yields for Nuttall oak and the other bottomland hardwoods were calculated using the site index estimates found in Broadfoot (1976) along with annual growth equations derived from unpublished work done by Putnam and Broadfoot, at the Southern Hardwoods Laboratory in Stoneville, Mississippi.

Both rotation lengths and yields at rotation age and thinning are based on site index estimates (see Table 4-17 and 4-18). Rotation and thinning ages for a given tree species are 10-15% longer for less suitable sites with lower site indices. Bald Cypress and Nuttall Oak rotation lengths were reduced by 10% on high quality sites. Rotation lengths for Green Ash, Sycamore and Sweetgum were reduced by 15% for soils with high site indices.

Site index estimates were then used in annual growth equations derived from Putnam and Broadfoot's work to determine volumes harvested at each thinning and the total volume at final harvest. The equations estimate a linear growth rate that approximates the average annual increase in volume per acre of trees, taking into account thinnings.

Table 4-17: Rotation Ages in Years

	Sycamore	*Green Ash*	*Sweet-gum*	*Nuttall Oak*	*Cotton-wood*	*Cottonwood -Oak*	*Cherrybark Oak*	*Bald Cypress*
Alligator	20	75	20	80	10	63	n.a.	80
Robinsonville	17	75	17	80	n.a.	n.a.	65	n.a.
Forestdale	20	75	20	80	n.a.	n.a.	n.a.	80
Sharkey	20	75	20	80	10	63	n.a.	80
Tunica	20	75	20	72	10	63	n.a.	n.a.
Commerce	17	64	17	80	10	63	65	72
Dundee	20	75	20	80	10	63	65	0

Table 4-18: Age (in years) of First and Second Thinning for Sawtimber Species

	Green Ash		Nuttall Oak		Cherrybark Oak		Bald Cypress	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Alligator	30	55	30	55	n.a.	n.a.	30	55
Robinsonville	30	55	30	55	25	45	n.a.	n.a.
Forestdale	30	55	30	55	n.a.	n.a.	30	55
Sharkey	30	55	30	55	n.a.	n.a.	30	55
Tunica	30	55	24	48	n.a.	n.a.	n.a.	n.a.
Commerce	22	42	30	55	25	45	24	48
Dundee	30	55	30	55	25	45	n.a.	n.a.

Table 4-19: Equations for Cumulative Volume (ft^3/acre/yr) by Tree Species

Tree Species	Cumulative Volume (ft^3/acre/yr)
Green Ash, Cherrybark Oak and Bald Cypress	ft^3/ac/yr = -50.09341+1.2291209*Site Index
Nuttall Oak	ft^3/ac/yr = -60.87912+1.4505495*Site Index
Sycamore	ft^3/ac/yr = -84.58242+1.910989* Site Index
Sweetgum	ft^3/ac/yr = -180+3*Site Index

For this analysis, both sycamore and sweetgum are assumed to be grown exclusively for pulpwood. Neither will be thinned during the course of the rotation. The only yield realized from a pulpwood rotation is the yield at final harvest. The final yield is calculated by multiplying the annual volume growth, as determined by the appropriate cumulative volume equation, times the number of years in the rotation. The resulting volume measurement in cubic feet is converted to cords of pulpwood by dividing by 90.

Green Ash, Nuttall Oak, Cherrybark Oak and Bald Cypress are all considered to be species grown for sawtimber in this analysis. Sawtimber rotations are thinned twice to improve stand quality and generate some revenues for the landowner early in the rotation.

This means that, for these four tree species, yields are calculated for a first and second thinning, as well as at the final harvest.

Yields at the first thinning equal 25% of the total volume of the stand at the time of the first thinning. Volume in cubic feet is converted to cords by dividing by 90.

Eq. 4-5

Yield at 1st thinning in ft^3 = annual growth rate (ft^3/ac/yr) * age of stand at 1st thinning * 25%

Eq. 4-6

Yield at 1st thinning in cords = Yield at thinning in ft^3 / 90

For the second thinning, it was assumed that 1/3 of the stand volume at the time of the second thinning would be removed. Total volume at second thinning equals the 75% of total volume remaining after the first thinning, plus the total volume growth from the date of the first thinning to the time of the second thinning. Volume in cubic feet is converted to cords by dividing by 90.

Eq. 4-7

Yield at 2nd thinning in ft^3 = annual growth rate (ft^3/ac/yr) * (number of years between 1st and 2nd thinning) + 75% of total yield at age of first thinning

Eq. 4-8

Yield at 2nd thinning in cords = Yield at 2nd thinning in ft^3 / 90

Volume at final harvest is then calculated as 2/3 of the total volume remaining after the first thinning, plus the total volume growth from the date of the second thinning to the time of the final harvest. The total volume at harvest in cubic feet is then converted to board feet by multiplying the volume in cubic feet by a conversion factor of 4 (Doyle) for Cherrybark Oak and 3.9 (Doyle) for all other sawtimber species.

Yield information does not exist for mixed oak-cottonwood stands more than three 3 years old. Therefore, yields for the Nuttall oak / cottonwood plantation were simulated according to initial planting densities. It was assumed that the oak was interplanted at a 50 percent stocking among a fully stocked cottonwood plantation, in accordance with the recommendations of Crown Vantage and the US Forest Service. This means that, in year three, 157 Nuttall oak seedlings are interplanted among 304 already established cottonwoods. Therefore, the yield at final harvest age for the oaks is estimated to be 50 percent of the yield computed for the pure Nuttall oak plantation, and the cottonwood yields are the same as those calculated for the pure cottonwood plantation. An important assumption for the mixed reforestation regimes is that the effects of established cottonwood on oak yields are insignificant. (Amacher et al.,1997) This is a reasonable assumption given the established tolerance and slow growth of Nuttall oak seedlings. (Amacher et al., 1997)

4E3a3. Prices

Prices for bottomland hardwoods vary widely according to wood quality, the time of year harvesting takes place, species mixes, and other characteristics of the forest site that affect ease of harvesting, such as soil drainage and size of the tract. For this analysis, Timber Mart South (TMS) data reported in Amacher et al., (1997) was used to determine current prices. Timber Mart South prices are averaged by state for "hard hardwoods" and "soft hardwoods" and are reported net of logging costs and state harvest taxes (Amacher et al., 1997). Amacher et al., further averages hardwood prices across the months in which harvesting in the Mississippi Delta bottomlands is likely to occur (July-October). Table 4-20 contains the estimates of current pulpwood and timber prices.

Forestry experts at Mississippi State recommended a 1% annual increase throughout the life of the tree rotations.[31] To allow for uncertainties about future conditions in the market for wood products, a more conservative price projection estimate was used in the model. For each tree species, sawtimber prices were assumed to increase by 1% annually (above inflation), from current prices through the first ten years. Prices remain constant through the rest of the rotation.

Table 4-20: Current (1997) Sawtimber and Pulpwood Prices in Mississippi

Pulpwood (per cord)	$16.70
Oak, Sawtimber (per MBF)	$228.00
Other Hardwoods, Sawtimber (per MBF)	$154.00

4E3a4. Consolidating Per Acre Returns

Specific tree species were selected for the acres included in the Watershed Action scenario. USGS provided a "tree-translator" which determined which tree species were best suited for an area based on the soil type, geomorphology and hydrologic conditions. Tree species were selected from cottonwood, sycamore, cherrybark oak, sweetgum, nuttall oak, green ash and bald cypress.

In selecting the reforestation regimes consideration was given to the uncertainties concerning future policy and market conditions that might affect the profitability of forestry. As a result, two changes were made to the recommendations made by the tree-translator. On sites recommended by the tree-translator as most suitable for cottonwood, a more profitable regime involving interplanted cottonwood and nuttall oak trees was used. Additionally, a seeded nuttall-oak regime, rather than a regime using nuttall seedlings, was applied to all site recommended for nuttall oak. The seeded nuttall oak regime has lower up-front establishment costs than does a regime using seedlings. Furthermore, old soybean planters can often be converted to acorn planters, further reducing the capital costs of converting from agriculture to a seeded nuttall oak regime.

Per acre returns were calculated for every possible combination of the seven soil types and eight reforestation regimes. In the analytical units used to break down the

[31] Growth rates based on recommendations made at a January 22, 1998 meeting organized by Dr. Steve Bullard at Mississippi State University for the purposes of reviewing and refining the forestry module.

study area, however, soils are identified only as hydric or non-hydric. Therefore, the per acre returns calculated for all seven soil types were consolidated into returns on hydric and non-hydric soils. The net returns for each tree species on hydric soils is calculated as the average of the returns earned by that tree type on each of the hydric soils, Alligator, Robinsonville, Forestdale, Sharkey, Tunica and Commerce. The net returns for each tree species on nonhydric soils equals the net returns earned by that tree type on Dundee soils. ("Hydric soils of Mississippi", http://www.statslab.iastate.edu/soils/hydric/ms.html)

4E3a5. Flood Effects

As was described in Section 4D2, flooding can interfere with the successful establishment of a tree stand. Two effects of flooding are represented in the simulation model. Flooding can result in higher seedling mortality rates than would otherwise be observed. With the expectation that some proportion of a tree stand will be lost to flooding during the course of a rotation, landowners often plant at higher densities than they hope to harvest. In the model, costs are incurred for planting at a 10x10 density (i.e. approx. 435 trees per acre). Harvested yields, however, are based on a 12x12 density (i.e. 304 trees per acre). In effect, this assumes a 28% mortality rate.[32]

A second effect of flooding represented in the model is the loss of young tree stands from floods that overtop the seedlings for an extended period of time. In the model, if a stand of trees is lost to flooding once, the landowner will attempt to replant and incur establishment costs twice in one rotation. If the stand is lost a second time in the same rotation, it is assumed that the landowner will abandon his attempts to reforest and walk away from the land for the remainder of the rotation.

A Monte Carlo simulation model (referred to as the "forestry module) is used to calculate the variable effects of flooding of forestry returns. As was described in Section 4D2, all stochastic variables in Equation 4.3 are identified and represented by a probability distribution. Equation 4.3 is repeatedly recalculated for 100 iterations, with each iteration producing an estimate of the NPV of forestry returns over a 120 year time

[32] It should be noted that significant uncertainty exists concerning the long-term effects of flooding on mortality rates for hardwoods. Both in the literature and through interviews with foresters at NRCS, we have found that the results of many studies reporting high mortality rates were later found to be premature. Studies that calculate mortality rates over the first 2-3 years often significantly underestimate the true survival rate because they fail to account for the natural, annual fluctuations in the survival of the above-the-ground tree shoots that is expected when establishing a bottomland hardwood species. A 1999 article in Restoration Ecology evaluating bottomland hardwood reforestation efforts in the Lower Mississippi River Alluvial Valley reports: "In several cases.. initial estimates of seedling densities at 2-3 years after planting were as much as 10-15 times lower than actual survival at 5 or more years after planting, because of natural regeneration on the site and resprouting of seedlings following herbivore damage in the first few years." (King, 1999)

It is not unusual to see significant losses in tree shoots in a given year due to flooding or herbivory, with re-sprouting in the following year. This cycle of shoot loss and resprouting serves a valuable function in allowing seedlings to devote energy towards developing underground root system sufficiently to attain a desirable "root to shoot" ratio.

period. After the simulation is completed, the results of each iteration are consolidated to produce another probability distribution, this one describing the range and likelihood of all possible NED results. The mean of this probability distribution represents the expected value of the NED results for the simulation.   The expected value of the simulation is the forestry returns that arise, on average, given the variability of flooding conditions.

The DEPTH-DURATION variable is the stochastic variable used in the forestry module to indicate when a tree state is overtopped for a period of time long enough to substantially damage the trees. If damage is incurred, the model requires that replanting costs be incurred for 80% of the tree stand. This assumes that 20% of the tree stand will survive the flooding or will naturally regenerate. It is assumed that the landowner will only attempt to replant once. If a second flooding event occurs, it is assumed that the landowner will cut his losses and abandon the land altogether. In this case, although the tree stand may eventually naturally re-establish itself, the landowner will neither receive revenues from a harvest, nor spend any additional money on maintaining the stand.

The value of the DEPTH-DURATION variable is drawn from a discrete distribution that describes the probability in any given year that “critical depth / critical duration” flooding will occur. A critical depth / critical duration flood is defined as flooding that overtops the trees for at least two weeks in the summer or four weeks in the winter.

The parameters for the DEPTH-DURATION distribution are 1) the probability that a critical depth / critical duration event does occur P(DEPTH-DURATION event occurs), and 2) the probability that such an event does not occur 1-P(DEPTH-DURATION event occurs). As a tree stand grows, flooding must occur at increasingly greater depths in order to qualify as a “critical depth” flood. Annual DEPTH-DURATION distributions are evaluated for floods occurring from 1 to 12 feet above the base elevation.[33] For the first 21 years of the simulation, a draw is made from all twelve DEPTH-DURATION distributions. To determine whether or not critical depth flooding has occurred in a particular year, the current height of the tree stand is first determined (see Section 4E3a2 for discussion of tree growth rates). Then, the DEPTH-DURATION distribution that describes flooding deep enough to overtop the trees at their current height is used to determine whether or not the tree stand incurred damage.

4E4. Other Benefits of Reforestation

In addition to simulating the net returns from timber and pulpwood, the forestry module was used to calculate the NPV of NED benefits associated with functions provided by the reforested acreage, including hunting benefits on private land, reduced nutrient runoff and carbon sequestration.   The value of hunting and the amount of carbon sequestered varied between tree species and throughout the length of a rotation.

[33] Base elevation is the elevation at which flooding first occurs in a given elevation range. For example, the base elevation for elevation range two is 91’.

Appendix E reports the NPV of per acre benefits resulting from carbon sequestration and the NPV of per acre returns from the hunting on private lands.

4E4a. Hunting Benefits on Private Lands

Improved wildlife habitat can yield what the economics literature refers to as non-use and use values. [34] When the potential benefits of habitat improvement include sustained populations of unique or endangered species, these services are valued primarily for their existence rather than the direct viewing or consumption of the wildlife. In this case, these services represent non-use values.[35] Beyond non-use benefits from improved habitat, reforestation can improve the uses of hunting and fishing.[36]

Available study time and resources limited the estimation of NED benefits for wildlife to hunting on private lands. The fact that hunting lease sales are made through an established market in the Delta (often these services are sold through established brokerage firms) is evidence for the presence of these use values in the general economy. Whether any given site has such values will depend on that site and the demand for and supply of leases in the market.

The benefits for hunting on reforested land were calculated for each of the different reforestation regimes. The proper measure of benefits is hunters' willingness to pay for the improved hunting opportunities on private land. This willingness to pay can be measured by the difference in sales prices of hunting leases between agricultural lands and forested lands. This estimate of willingness to pay for each of the different reforestation regimes was based, in part, on survey results reporting average annual hunting lease sales for counties in the study area (Jones, 1999). Additionally, a review of

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[34] The distinction between use and nonuse values should not be confused with the distinction between on-site and off-site values of reforestation. On site values are those occurring directly on the site. An examples of on-site values are improved wildlife habitat, while an example of off-site values are improved downstream water quality.

[35] Estimation of willingness to pay for wildlife habitat non-use values is difficult and expensive due to the need to rely on detailed survey methods. Thus, there are few studies that attempt to determine the non-use value of wildlife habitat improvement, and fewer still that could be used to infer values for reforestation. None are specific to the Delta. The most relevant studies are Stavins (1990), Bergstrom (1989), and Farber (1988). Stavins determines that the value to households of all of the ecological services of wetlands are $80-100 per acre per household, while Farber finds that the value of wetland recreation (both use and non-use values) is $36-111 per acre. Bergstrom determines the value of *all* wetland services to be $330 per acre per user, where users are assumed to engage in a variety of recreational activities.

[36] Recent work has been conducted to establish the willingness to pay for use value, primarily of hunting and fishing in forested wetlands. Some of this work is applicable to the Delta since forested wetlands will be created if bottomland hardwood establishment is undertaken. Marsinko et al. (1994), Pope et al. (1984), Pope and Still (1985), and Bishop and Herberlein (1979) all have studied the values of hunting in wetland habitats. Values for hunting services range from $2 to $600 per hunter per year, where the higher number is associated with high quality duck habitat. There is evidence of economic use value for bird watching in areas of the country such as Hawks Mountain, Pennsylvania, and the Platte rivers of Nebraska. In these areas, rough estimates of willingness to pay based on gross expenditures incurred traveling to the sites are $10 to $40 million per 100,000 visitors (Kerlinger 1993). In the Delta, the main attraction would be bird watching of winter waterfowl, but there is little evidence of the demand for this service.

the literature and interviews with area experts were used to identify appropriate hunting lease values for the analysis.

"All purpose" hunting leases that allow hunting of multiple species can range from $1.50 to $25/acre annually, depending upon the quality of habitat, the terms of the lease and whether or not capital improvements have been provided to accommodate hunters (i.e. deer blinds, hunting lodges, etc.) (Woolfolk,1997). Higher values sites are mature stands of bottomland hardwoods and bottomland hardwoods intermingled with agricultural fields. Lower value sites are young tree stands and agricultural fields not located in close proximity to a wooded area.

In estimating willingness to pay, it was assumed that a $5/acre hunting lease can be sold for an agricultural field. Since this $5 hunting lease is the willingness to pay for hunting on an agricultural field all private hunting NED benefits are the increase in willingness to pay above the $5/acre for agricultural land. For all tree species, the hunting benefits increases as the tree stand matures. The tree species producing the greatest quantities of mast and having the longest rotations (Nuttall, Nuttall/ Cottonwood interplant, Green Ash, Cherrybark Oak and Bald Cypress.) receive the higher hunting lease values, while the shorter rotation species (Cottonwood, Sycamore and Sweetgum) generate lower benefits (See Tables 4-21- 4-23).

Additionally, the USGS's functional restoration scoring system is used to identify analytical units that provide the best habitat. The USGS FR scoring system includes a habitat index that measures the quality of wildlife habitat based on proximity to existing wildlife areas, permanent water bodies and distance from primary and secondary roads (DOI USGS, draft paper currently in review). Analytical units that receive a per acre FR Habitat score above a threshold level are assigned high-value hunting leases. All other analytical units are assigned standard-value leases.

Table 4-21: Nuttall, Nuttall/Cottonwood-interplant, Green Ash, Cherry Bark, Bald Cypress Annual Hunting Lease Values / Acre

Number of years into the rotation	Standard-Value ($)	High-Value($)
1-15	0	5
16 - 20	5	10
21 – end of rotation	10	15

Table 4-22: Sycamore, Sweetgum Annual Hunting Lease Values / Acre

Number of years into the rotation	Standard-Value ($)	High-Value($)
1-10	0	5
10 – end of rotation	5	10

Table 4-23: Cottonwood Annual Hunting Lease Values / Acre

Number of years into the rotation	Standard-Value ($)	High-Value($)
1-end of rotation	0	5

Total hunting benefits on lands reforested under the Watershed Action scenario were calculated by first identifying the total number of acres reforested with each species. Then, the total acres planted to each species are multiplied by the per acre hunting lease values for that species.

4E4b. Benefits from Nutrient Reduction and Carbon Sequestration

4E4b1. Nutrient Reduction and Carbon Sequestration Are Services Permitted by the P&G

The P&G in Section VII, 1.7.2 (c) lists the services that may be valued in an NED analysis. That list is not restrictive and Section VII, 1.7.2 (c) (11) allows for "Other categories of benefits for which procedures are documented in the planning report and which are in accordance with the general measurement standards in paragraph (b) of this section." In fact, the explicit list of categories in the P&G is inadequate for describing environmental services that arise for restoration actions. This limitation should not be surprising because the P&G was conceived and published principally as a guide for evaluation of structural projects like reservoirs.[37] If NED evaluation is to be expanded to environmental restoration actions then services other than those explicitly listed in the current document must be recognized and section VII, 1.7.2 (c) (11) allows for expanding the list.

An immediate question is whether the services should include nutrient reduction and carbon sequestration. We argue for including these as services by referring to the simple materials balance model found in environmental economics textbooks (Pearce and Turner, 1990). The materials balance framework treats the environment d as a capital asset (natural capital) that provides a flow of services valued by people. The particular list of services vary with the particular assets physical, chemical and biological processes, but the environmental service of waste sink (receptacle) and waste assimilation is always among the listing of environmental services.

The waste service is used beyond the assimilative capacity of the environmental asset, when other services (for example, commercial fisheries and fish harvests) begin to decline. On the other hand, an action that increases the assimilative capacity of the environment increases the aggregate flow of all possible services from the environmental asset. Forested areas that sequester carbon increase the atmosphere's ability to provide the service of assimilating green house gases. In turn this reduces the rate of atmospheric warming and, therefore, increases the environments ability to maintain environmental

[37] This limitation of perspective consistently has been pointed out by the critics of the P&G such as the National Research Council Committee on Corps planning (NRC, 1999).

services that rely on a cooler climate. Forested areas that limit the nitrogen loads moving to an estuary are increasing the nitrogen assimilation capacity of that estuary and therefore the ability to provide other services such as the support of fish population for harvest.

The waste assimilation services of nutrient reduction and carbon sequestration have value to people and can be valued in a benefit cost analysis. However, it would be double counting to place a value on increasing assimilative service *and* on the added environmental services that result from that increase, but a careful analyst will avoid this double counting mistake.

4E4b2. Valuing Waste Assimilation Services of a Project

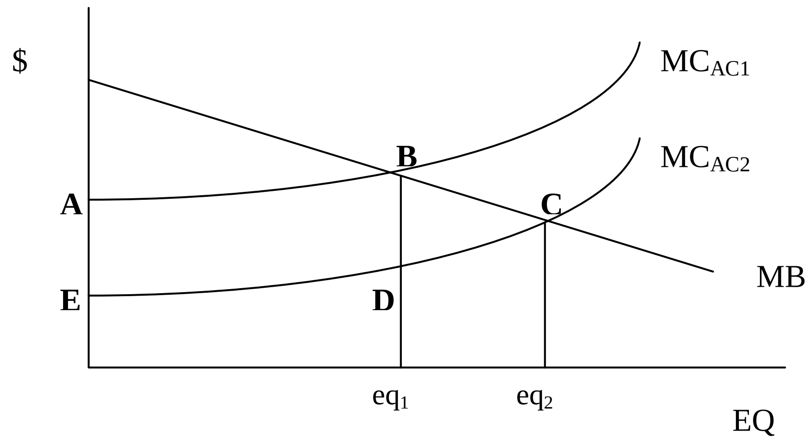
To understand one approach to valuing these services, begin with an economic analyst who defines her challenge as determining the "optimal" level of "environmental quality" without reference to any particular project. Environmental quality describes the level of non-waste assimilation services present in the environment, for example the level of fish population available for recreational and commercial harvest. The analyst realizes that the assimilative capacity of the environment provides a waste receptacle service, but at some point increased use of the environment for waste disposal degrades the other environmental services; that is, at some point use of the environment for waste disposal results in a loss of environmental quality.

Figure 4-1 represents the situation where reduced waste discharge results in increased environmental quality (EQ). In Figure 4-1, waste can be withheld (not released to the environment) by technological means, changes in the level of output or changes in production processes. In an elementary but standard diagram of this situation there is a marginal cost (MC) for waste withholding that rises from left to right; as increasing levels of waste are withheld EQ increases. Also depicted in Figure 4-1 is a marginal benefit function (MB) for each level of EQ associated with each unit of waste withheld. Beginning with AC1, the optimal level of environmental quality is eq1 where the marginal benefit of one added increment of EQ equals the marginal cost of waste withholding. This optimal point of eq1 might be translated into an ambient environmental standard.

Assimilative capacity 2 is greater than AC1. Therefore for the same amount of waste withheld a greater EQ is attained (AC2 compared with AC1) because of the higher assimilative capacity. To represent this result in Figure 4-1, the MC curve shifts from MC_{AC1} to MC_{AC2}. $MC_{AC\ 1}$ is the MC function when the waste assimilative capacity (AC) of the environment is at capacity 1. MC_{AC2} is the MC function when the waste assimilative capacity of the environment is at capacity 2.

Now suppose there is a restoration project (such as the watershed action scenario) that increases waste assimilative capacity to AC2. With the shift to MC_{AC2} the optimal level of EQ shifts from eq1 to eq2. From a strict analytical perspective, the benefits of the increased assimilative capacity are the area ABCE in Figure 4-1. ABDE is the saving in waste withholding cost associated with achieving eq1. DBC is the *net* benefit of increasing from eq1 to eq2.

Figure 4-1: NED Optimal Level of Environmental Quality



It is important to note, however, that two types of costs must be incurred in order to achieve the net benefits contained in area DBC. Costs are incurred for the project that was responsible for the enhanced assimilative capacity. Additionally, expenditures must be made to increase the level of waste withholding in order to reach the new optimal level of EQ (eq2). In the end eq2 replaces eq1 as the ambient environmental standard.

In reality an increase in standards and in waste withholding is not likely. In fact, ambient standards and allowable waste discharges are not governed by the precise analytical computations suggested by Figure 4-1. Economic benefit and cost analysis may inform the standard setting process, but environmental goals are a set by a mix of considerations and in the presence of less than complete information on benefits and costs. This type of judgment-based process led to the environmental standards and goals in the Committee on Environment and Natural Resources (CENR) report on the Gulf hypoxia problem (CENR, 1999) and in still-unsettled international negotiations on limiting greenhouse gas (GHG) emissions (See a discussion at http://www.ieta.org/kp.htm).

Environmental standards can be quantitative and legally enforceable (like a dissolved oxygen standard). Environmental standards may be a goal that takes on the force of a standard (like no net loss of wetlands). For our evaluation we treat ambient standards and goals as equal and call them "EQ targets". The EQ target is negotiated and does not change readily with new information. If there is an increase in assimilative capacity, eq1 is still the target to be met, but there can be savings in waste withholding costs because AC2 is able to absorb a greater amount of waste while not violating the standard. The benefit (value) of increasing the waste assimilative capacity is the saving in waste withholding costs (area ABDE). This is the logic that makes the case for alternative cost as a measure of the benefit of this waste assimilation service. [38]

In fact, the technique of alternative cost is an accepted method of estimating willingness to pay benefits for a service when these conditions exist. [39] In section VII, 1.7.2 (b) (11) the P&G states:

"Willingness to pay [can be] based on actual or simulated market price; change in net income; cost of the most likely alternative; and administratively established values."

The P&G goes on in section VII, 1.7.2 (b) (1) as follows:

"The cost of the most likely alternative may be used to estimate NED benefits for a particular output if non-Federal entities are likely to provide a similar output in the absences of any of the alternative plans under consideration and if NED benefits cannot be estimated from market prices or change in net income. This assumes, of course, that society would in fact undertake the alternative means. Estimates of benefit should be based on the cost of the most likely alternative only if there is evidence that the alternative would be implemented."

As is noted in the P&G, proper application of alternative cost technique requires the analyst to make certain arguments. In valuing nutrient reduction and carbon sequestration we were careful to assure that the following tests were met: 1) the increase in the assimilative capacity of the environment through reforestation must provide the same service as direct waste control measures, 2) the alternative the lowest cost implementable alternative, 3) there is evidence that there would be adequate willingness to pay for the service if it were sold at a price equal to the cost of the alternative.

The increase in the assimilative capacity of the environment through reforestation does provide the same service as direct waste control measures. Reductions in nitrogen loadings can be achieve either by end-of-the-pipe load reductions at a treatment plant, or reduced edge-of-field loads from runoff. Because the form of the N is same in both cases, both methods provide the same service. It is possible that in-stream attenuation

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[38] This might suggest that we are abandoning economic logic to political expediency. However, reverse the example to consider a project that violates an environmental target, say no net loss of wetlands. Suppose that a project would drain 1000 of acres of wetlands. We do not feel that the project would be acceptable (i.e. standards would be lowered) even if comprehensively measured benefits exceeded the costs. Our argument is the reverse of this case: as we increase AC we are not expecting the standard to be increased.

[39] Under some circumstances this approach is described as a cost-effectiveness (CE) analysis and not benefit cost analysis (BCA) a distinction made in OMB guidelines, "Economic Analysis for Regulations Under Executive Order 12866". The distinction between CE and BCA in the executive order may make sense *if* the action being evaluated only results in a single outcome (for example nutrient reduction). However, the reforestation action provides a vector of services (timber, hunting, nutrient reduction, carbon sequestration, reduced non farm flood damages). In the case of multiple outcomes from a single action, the analyst must find some way to value the multiple outcomes from that single action. The P&G recognizes this when it permits the use of alternative costs as a benefit measure from actions that have multiple outcomes.

will change the form or amount of N reaching the Gulf. Therefore the delivered load to the Gulf may differ by the location of the discharge. We were not able to assess this in this review. However, this point aside the services are the same. For carbon sequestration the removal of a metric ton of carbon by sequestration is equivalent to reduced CO2 emissions from mobile sources and from power and other production facilities. The location of the emission reduction or sequestration is not relevant to the global climate; therefore sequestration and reductions of emissions are providing the same service.

The analysis also took care to assure that the alternative for valuing the waste assimilation service was from the lowest cost implementable alternative. In both case this was accomplished by basing the value on a simulation of a market exchange (cap and trade) program that would identify the least cost waste control strategy. More description of this logic is included below.

Finally, we are confident that there would be adequate willingness to pay for the service if it were sold at a price equal to the cost of the waste control alternative. We can cite studies that suggest there is a WTP for nutrient reduction in the Gulf (CENR). [40]

For carbon sequestration we accept that the willingness to pay to reduce green house gas (GHG) is significant. We recognize the disputes over the presence of, causes of, significance of, and urgency of global warming. However, this administration has taken the position that the US will reduce net GHG emissions to the atmosphere, there are numerous bills in the Congress to encourage reduced emissions and there are significant commercial projects that are currently making payments to landowners who sequester carbon by reforestation or changes in agricultural production practices. [41] (There is an extended discussion of these activities in Section 6)

4E4b3. NED Benefits from Nutrient Load Reduction

The benefit calculation is limited to the reduction of nitrogen loads to the Gulf of Mexico, even though there are other water quality gains that will accrue from reforestation. In the case of nutrient retention, a national concern with hypoxia in the Gulf of Mexico served as evidence of a national target to improve water quality by reducing nutrient loads. While no single, official nutrient reduction goal has been established by the federal government, sufficient information exists to realize that a reduction goal will

[40] To complete such a benefit evaluation, even for one service (for example, commercial fish harvest), would require tracing the effect of a reduced pound of N from the Yazoo through the Mississippi River system to the Gulf. In the Gulf, the extent of the increase in DO due to the nitrogen reduction would need to be determined. Then, the effect of the increase in DO on fish populations would need to be established. Next, the effect of increased fish population on harvest rates would need to be set. Finally, the last step in the calculation would be to determine the change in net return to the harvest sector for the added harvest (considering the possibility of rent dissipation if the harvest sector is characterized by open access).

[41] There are some who dispute the significance of the increase in GHGs as an environmental concern. There are others who accept the need to reduce GHG emissions, but find the Kyoto protocol a flawed instrument. These two arguments must be kept separate. In fact many bills now in the Congress that would lead to United States reductions in GHG emissions are sponsored by opponents of the specific language of the still unratified Kyoto agreement.

be set. At present there is a 20% reduction goal stated in the sixth report of the series, "Evaluation of Economic Costs and Benefits of Methods for Reducing Nutrient Loads to the Gulf of Mexico, April 15, 1999).

Whatever the reduction goal, the result can be thought of as a load cap analogous to the Total Daily Maximum Load (TMDL) program developed under Section 303 (d) of the Clean Water Act. Thus the NED benefit calculation begins with an assumption that the nation has an implied target to cap the nutrient loads delivered to the Gulf of Mexico.[42] The target is a public policy affirmation that the water quality benefits from the cap on loads are warranted by environmental benefits received. In this sense the adoption of the goal is like the adoption of an ambient water quality standard.

The effect of the cap assumption is to make the opportunity ("right") to discharge nutrients to the watershed a scarce resource. This scarcity means that the rights to discharge would command a positive price if they were sold in a market because the quantity demanded for the discharge rights would exceed the quantity supplied at a zero price. It also means that any source that reduces its discharge from some baseline frees up discharge rights that they might sell. Any source that increases the assimilative capacity of the watershed for the pollutant also creates a valuable service (reduced nitrogen) that could be sold. At this time such a market is not in place. However, the P&G allows the use of simulated market prices in the absence of a market for the good or service as a measure of NED benefits; in this case the service is the nutrient assimilation capacity of reforestation in the Yazoo watershed. The NED analyst must either simulate a market for the assimilative service and discharge rights or may use the cost of the most likely alternative to reforestation as the value of the nutrient reduction from reforestation.

A thought-experiment will be useful for understanding the relationship between a simulated market for nutrient assimilation, the cost of an alternative to reforestation for nutrient reduction and the NED benefit calculation. Assume that a TMDL type logic has been applied to set a nutrient load cap. Also, assume all point and nonpoint sources of the pollutant have been allocated waste load limits so that 20% reduction in the watershed is achieved.[43] As a result the sources now have waste discharge allowances that entitle each source to discharge a fixed amount of the pollutant to the watershed. If the source wishes to discharge more they must purchase allowances from some other source that has reduced its discharge below the allowances held. In the case of reforestation, think of the landowner having a discharge allowance holding that assumes the land would continue in farming. By shifting the land use to forest the loads fall and the allowances that had been necessary for continued farming are now available for sale to others. The exchange of allowances would be in a market-like system analogous to market for allowances in the air quality program for sulfur dioxide.

[42] We also might assume that this leads to a cap on the loads leaving the Yazoo watershed, but this is not critical to the conceptual argument.

[43] For this discussion we assume that certification and enforcement of reductions for all sources has been addressed.

In principle the buyer of allowances when reforestation is the seller would not pay any more than the cost of making reductions themselves. This alternative control cost is an upper bound on willingness to pay for reductions achieved through reforestation. By considering the control costs at all sources – point and nonpoint – an estimate of a market price that might emerge for allowances is made. Hence, the computational challenge for a NED analysis is to identify the least cost alternative means of achieving reductions in ways other than reforestation.

The NED calculation begins with estimating the amount of nitrogen reduction achieved in pounds when forested land replaces farmed land. The amount reduced by reforestation is limited to what might be termed a replacement effect – that is, forested areas have less load than agricultural areas. The net reduction in nitrogen loads from replacing farmed land with forested lands was the basis for the nitrogen reduction estimates. Since much of that land would be in sinks and depressional areas there may be a trapping and buffering function for nutrients that continue to leave croplands that remain in production. The trapping and buffering effects on nutrient loads are not in this calculation, even though this can be a significant water quality improvement function of the forested areas.

Estimates of the edge of field loads from soybean and other cropped fields and from forested areas were provided from a Tetra Tech applications of the BASINS model to the Yazoo watershed. (Andrew Parker, Tetra Tech, Inc., personal communication, September 21, 1999). The estimates were based on a model calibration that estimated nonpoint source land contributions prior to in-stream routing. This corresponds to end of pipe loads from a POTW, prior the assimilative effects of the stream; in effect, this assumes that the in-stream process effects are equivalent among sources without regard to location. The calibrated data from BASINS work on Yazoo is shown in Table 4-24.

Table 4-24: Pollutant loads from the land uses in the Yazoo watershed

	TN	TP
	lb/acre-yr	lb/acre-yr
Aquaculture	39.45	2.37
Urban Impervious	9.52	4.98
Urban Pervious	8.40	2.60
Forest	1.32	0.28
Wetland	0.66	0.17
Pasture	5.18	0.72
Cropland - Cotton	13.07	3.16
Cropland - Soybean	11.17	2.99
Cropland - Other	13.90	3.37

The following calculation for nitrogen load reduction from reforestation was made for the 88,000 acres reforested under the watershed action scenario, where the assumption is that all reforested land was in soybeans.

Total TN pounds/acre/year reduced =
88,000 acres reforested * (11.17 TN lb/ac/yr $_{soybean}$ – 1.32 TN lb/ac/yr $_{forest}$ =
866,800 TN lb/ac/yr reduced.

The NED benefit was calculated as the product of the pounds reduced times the cost of reducing those pounds by the least cost alternative means in the watershed or in a nearby watershed. This yields an annual avoided cost for nutrient reduction made possible by the reforestation. For the estimate we assume point sources will retrofit their treatment plants to increase the nitrogen removal effectiveness of the plants. This cost is assumed to equal the price that would emerge in an allowance market.

The CENR study attempted to simulate a market price for allowances using a math programming model that based supply and demand functions on the cost for publicly owned treatment works (POTWs) to limit their nitrogen concentrations to 3mg/l using biological nutrient removal (BNR) plant retrofits.[44] This is a conceptually valid way to simulate a market outcome, but the simulation results suffer from two flaws. First, the POTW costs are out of date. Second, even the more current cost estimates are likely to overstate control costs in a true market, because behavioral responses are ignored. This second problem is common to analysts who try to estimate alternative costs (prices of bids) in cap and trade systems (Butraw,1996).

The data used in CENR report #6 was planning level data from 1988. These data were based on information from the Chesapeake Bay region. Since the time that report was issued there have been a number of waste water plant retrofits that have been implemented in the Bay region. Careful site specific engineering studies in that area have shown that removal cost estimates from 1988 exceed the results that have been realized to date. A range of operation (6-8 mg/l) would be a removal efficiency well in excess of the current discharge levels at plants in the lower Mississippi River watershed. For this analysis we assume that a year round average of 8mg/l would be achieved at each POTW. The Bay experience is that removal costs have ranged from $1 - $4/pound for this removal efficiency and at times were lower (A.P. Wiedeman, USEPA, Chesapeake Bay Program Office, letter to J. Adist , May 3, 1998; C. Randall, “Evaluation of Wastewater Treatment Plants for BNR Retrofits Using Advances in Technology, undated).

At $1/pound avoided removal costs avoided by reforestation are $866,800. At $4/pound the cost were $3,547,200. We use the average of $2.50/pound for the NED benefit estimate for a total avoided cost each year of $2,167,000. As with all other benefits, the annual dollar value of nitrogen reduction benefits is calculated and discounted in each year of the 120 year planning period. The discounted annual values are then summed to produce an NPV estimate of the benefits from reduced nitrogen loadings running off into the waterways.

[44] This analysis implies that a mass load limit would be imposed on each plants discharge.

4E4b4. NED Benefits from Carbon Sequestration

The conceptual logic behind the computation of the carbon sequestration NED benefits is the same as that used for the nutrient reduction benefit. We assume the presence of a cap and allowance trading system for carbon (and other greenhouse gas) emissions. We then consider what the equilibrium price for allowances would be in that system. The price that is simulated for allowances is the willingness of carbon emitters to pay for a reduction made elsewhere in the economy, in this case by reforestation that sequesters carbon in soils and forest biomass. This simulated market price times the amount of carbon sequestered in the reforested areas net of the carbon sequestered in agricultural activities is the NED benefit for the watershed action scenario.[45]

The amount of carbon sequestered is measured in metric tones per acre and the rate of sequestration depends upon the age of the stand. The annual rate of sequestration at different stages in the rotation is reported in Table 4-25 for each of the tree species modeled. The estimates were taken from a literature synthesis that the provided estimates for the southeastern United States and are the *net* additional carbon sequestered from replacing agricultural with forestland use. (King, et. al., 1999) [46]

Table 4-25: Metric Tons of Sequestered Carbon from Reforestation

Age of stand (years)	Carbon sequestered per acre (hardwood) (metric tons)	Carbon sequestered per acre (softwood) (metric tons)
1 – 15	.66	.67
16 – 50	.99	1.02
51 – end of longest rotation	.41	.43

The computation of per acre carbon sequestration NED benefits was done for every possible combination of reforestation regimes, soil types (hydric and non hydric) and elevation ranges. To calculate the total carbon sequestered by reforestation under the watershed action scenario, each of the per acre results were multiplied by the total number of acres reforested with the different tree species.

In every year, the metric tons of carbon sequestered were multiplied by a $14 per metric ton price. The price was simulated for an international allowance market in greenhouse gases by the US Council of Economic Advisors (CEA, 1998).[47] The CEA simulation estimate is consistent with the market information on carbon sequestration

[45] For this discussion we assume that certification and enforcement of sequestration or emission reductions from all sources has been addressed.

[46] These estimates do not account for the release of some of the sequestered carbon when the trees are harvested. Accounting for this release would be necessary if a fully refined benefit measure is to be developed.

[47] The simulated prices is found in a July 1998 publication, "The Kyoto Protocol and the President's Policies to Address Climate Change: Administration Economic Analysis." This report can be found at (http://www.whitehouse.gov/WH/New/html/kyoto.pdf)

payments that have been made to date.[48] The annual NED benefits are discounted and summed to produce a NPV estimate of returns from carbon sequestration over the 120 year period.

4F. Structural Damages

4F1. Non crop agricultural damages avoided

Agricultural producers equipment, drainage systems and other operating capital are subject to flooding and resulting flood damages. The Corps terms these damages non-crop on farm flood damages and ascribes benefits to the pump project for the reduction of such damages. The Corps contracted with researchers at Mississippi State University to help develop procedures for estimated the damages both with and without the pump project. Table 4-26 reports the estimated without pump average annual damages for this category.

Table 4-26: Non-Crop Damages per acre (1997 $) as Reported by the Corps

	Reach One	Reach Two- Four
2 year flood plain	$17.03	$18.02
3-100 year flood plain	$23.69	$26.43

Source: FAX communication, June 10, 1999 from M. Garton to L. Shabman ,Additional Questions VPI, Yazoo Basin Reformulation, Yazoo Backwater Area.

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The watershed action scenario will result in 88,000 acres of currently farmed land in the 2-year flood plain being reforested. The damages that would no longer exist on the reforested land can be considered a benefit of the reforestation. However, because the Corps has not released its report on the pump project, we have not been able to review the benefit category for its conceptual and computational validity. For example, we are unable to determine the degree to which the damage estimates are spatially distributed within the watershed. For this reason, we chose make a conservative estimate of this benefit category. For purposes of the watershed action scenario analysis we used only ½ of the $17.03 damage estimate as a non-crop on-farm damages reduced benefit estimate for each reforested acre in the watershed action scenario.

4F2. Residential and Other Flood Damages

The Corps reports that there are 1550 permanent structures in the 100-year flood plain. Table 4-27 indicates that these structures are of low value for the most part. It is also the case that a number of the structures are concentrated in a few developed areas. The damages associated with these structures is mostly for a recurrence of the 100-year

48 It is unlikely that prices for sequestered carbon would fall much below $14 per ton in the near future. For example, a soon to be initiated Department of Energy $15-18 million research program seeks to lower the cost of carbon sequestration to $10 per ton by 2010 (See: http://fetc-ip.fetc.doe.gov/publications/press/1999/tl_seq99.html)

event (the flood with a 1% chance of occurring in any year) and for the 50-year event (the flood with a 2 % chance of occurring in any year) (See Table 3-1) The NED evaluation for this study did not include an assessment of the benefits and costs of reducing flood risk to these properties by nonstructural actions. Instead we assume that nonstructural actions will be undertaken to the point where the benefits would just equal costs. In this way we assume that the net NED benefits for flood hazard reduction in the watershed action scenario are zero.

While there was no detailed evaluation of this problem for this study we can speculate that relocation programs for properties in the lower elevations will be justified because of the frequency of recurring damages and the low value of these properties. Specifically, we expect that the properties will be of lower value and the damages will be frequent. As a general rule relocation is more readily justified when properties have a low value. More detailed evaluation of localized protection and some relocation of properties in higher elevations would be part of the studies conducted under the nonstructural plan described in Section 6.

Table 4-27: Yazoo Backwater Structures Inundated in 100-Year Flood

	# Impacted	Total Value	Average Value
Trailers	396	$4,266,000	$10,773
Residential 1 story	795	$17,812,000	$22,405
Residential 2 story	76	$5,067,000	$66,671
Sub-total	1267	$27,145,000	$21,425
Commercial	50	$4,107,000	$82,140
Professional	4	$162,000	$40,500
Semi-Public	17	$600,000	$35,294
Public	5	$186,000	$37,200
Recreational	85	$892,000	$10,494
Warehouse	113	$2,040,000	$18,053
Industrial	3	$3,475,000	$1,158,333
Totals	1,544	$38,607,000	$25,005

Source: U.S. Army Corps of Engineers, Vicksburg District.

4G. Insurance and the NED Analysis

No NED analysis of the insurance program for the watershed action scenario was completed. See Section 4-C for an explanation.

4H. The Landscape Calculation

Evaluating the net NED benefits of the Watershed Action Scenario requires calculating the difference between the NED benefits generated on land reforested under the nonstructural alternative, and the NED costs that would be incurred on the same land under the without-action alternative.

In order to apply the per acre NED benefits calculated for each of the 32 analytical units identified in the study area, the total number of acres reforested in each analytical unit is determined. A Geographic Information System (GIS) model developed by USGS offices in Pearl Mississippi was used to produce a spreadsheet, referred to as a "parameter file" that identifies: within the study area, 1) the number of acres that are included in each of the 32 analytical units, 2) within each analytical unit, the number of acres that are reforested under the Watershed Action Scenario, and 3) the total number of acres reforested with each of the eight reforestation regimes (DOI USGS, draft paper currently in review).

The total forestry returns earned in each analytical unit are calculated by multiplying the number of acres reforested with each of the eight regimes by the appropriate per acre returns. Then, the forestry returns earned in each analytical unit are summed to determine the total forestry returns under the Watershed Action scenario. The total revenues earned for carbon and nutrient credits as well as hunting leases are determined similarly. The total number of acres reforested in each analytical unit is multiplied by the appropriate carbon, nutrient and hunting lease per acre returns. Then the total returns earned in each analytical unit are summed to determine the total revenues earned under the Watershed Action scenario for carbon, nutrients and hunting leases.

In the NED evaluation of the Watershed Action Scenario, it was assumed that all 88,000 acres selected for reforestation were planted to soybeans. This assumption was made because many of the same attributes that made these 88,000 acres the most valuable for reforestation (as indicated by the FR scoring system), such as hydric soils and frequent flooding, also make them unsuitable for crops other than soybeans, such as cotton, corn or rice. Calculating the total agricultural returns forgone under the Watershed Action Scenario involved multiplying the total number of acres to be reforested in each analytical unit by the per acre NPV of soybean returns for that unit. The total agricultural returns for each analytical unit are then summed to produce an estimate of the total agricultural returns designated for reforestation under the Watershed Action Scenario.

Even though it was assumed that all lands reforested under the Watershed Action Scenario were planted to soybeans, the model was used to evaluate net returns to agriculture over the whole watershed. This watershed wide net return calculation was used to estimate the cost of an income assurance program and to examine the agricultural flood damage reduction benefits of a pump. The specific results of these analyses are reported in the next two sections.

Calculating the total agricultural returns when there are multiple crops requires knowing how many acres of each crop type are grown on the land. In this case the model runs use two "composite" acres to represent the distribution of different crop types within and outside of the two-year flood plain. Both composite acres include all seven crop types present in the study area. The amount of land in each composite acre that is planted to each crop is proportionate to the actual distribution of crops within and outside of the two-year flood plain in the Yazoo Basin, as determined by the Corps. The two composite acres are used to calculate a weighted average of the per acre agricultural returns of all crop types in each analytical unit. Then, the total number of acres to be reforested in each analytical unit is multiplied by the weighted average of agricultural returns for that unit. The total agricultural returns for each analytical unit are then summed to produce an estimate of the total agricultural returns forgone on all land.

4I. Results for the Watershed Action Scenario

The net present value (NPV) of NED consequences for the watershed action scenario is reported in Table 4-28. [49] The watershed action scenario was determined to be NED justified with calculated net benefits over $20 million. Specifically, forgone farm income was $ 30.6 M as an NED cost of reforestation. Timber benefits, net of costs, had a negative NED value of $9.5 million. Other reforestation benefits were positive including habitat for hunting ($6.9 million), sequestered carbon ($9.8 million), nutrient control ($32.2 million), and avoided on-farm non-crop damages ($13.7 million).[50] In Table 4-28, these same results are also reported as average annual values.

Table 4-28 NED Results for the Watershed Action Scenario (million $)

NED Category	NPV of NED	Average Annual NED
Farm Income	- $ 30.6	- $ 2.1 M
Timber	- $ 9.5	-$ .65 M
Hunting	$ 6.9	$ .48 M
Sequestered Carbon	$ 9.8	$ .68 M
Avoided nutrient control costs	$ 32.2	$ 2.2 M
Avoided on farm non-crop damage	$ 13.7	$ .94 M
Net NED	$22.5	$1.55

[49] A number of sensitivity analyses were conducted on variables including prices, costs, yields, delayed plantings, etc. In all cases, the NED for the watershed action scenario remained positive.

[50] If the supply constraint perspective is taken, then a different result emerges. Using the simulation model the per bushel soybean production costs in the Yazoo area were calculated to be $4.91, including the costs of flooding. For the nation as a whole, per bushel production costs are $3.67. This means that replacing Yazoo soybean production with production on an average acre elsewhere in the nation would lower the nation's cost of producing soybeans. Therefore, reducing soybean production of the frequently flooded areas of the Yazoo would increase NED because there would be a NED cost savings (benefit) of $1.24 per bushel. What appears as a cost of reforestation with the standard analysis is a benefit under the assumption of supply control. A total of $47.6 M in *cost savings* (*benefits*) would be produced under the watershed action scenario, instead of a loss of NED of $30.6 million.

These results should be used with caution. First, the results should not be extrapolated beyond the 88,000 acre scenario, even within the 2 year flood plain. The FR score analysis suggests that the land in the 2 year that was not part of the reforestation was of lower ecological value (See Section 3). As a result the reforestation benefits that can be obtained on additional land may not be as high as the benefits reported in Table 4-28. In addition, the benefits also depend on the species of tress planted and these trees may change as new acres are added. Also, the opportunity cost of adding new land may be higher. As more of the land in the 2 year flood plain in added to a scenario crops other than soybeans may be displaced. While we have not been able to complete an analysis of adding more acres it is likely that the added acres that could be reforested in the 2 year flood plain would have lower net benefits that the acres in the watershed action scenario.

Second, in continuing of correspondence between the Corps and the FWS offices in Vicksburg, the Corps has indicated that they intend to include the benefits from reforestation as part of their evaluation of the pump. When completing an NED analysis, each action that is hydrologically and/or economically separable from other actions must be evaluated separately. In this case, the pump should be evaluated without the reforestation and the reforestation should be evaluated without the pump. If both are to be bundled into a combined plan, each separable action should be independently justified. If there is no separable justification, then one NED justified action might provide sufficient net benefits to mask the fact that an unjustified action is being “carried” by a justified action.

Section 5. Agricultural Returns - A Comparison of Approaches and Results

Agriculture is the dominant use of cleared lands in the study area. This means that the opportunity cost of forgone agricultural returns are a significant NED cost of any plan including reforestation. For this reason, several efforts were made in this study to ensure that the inputs to the agricultural module were reasonable representations of the agricultural practices and returns in the Yazoo backwater area. As was discussed at length in Section 4, model inputs were drawn from current and widely accepted data sources, such as FAPRI price projections and crop budgets for the Delta Region from Mississippi State University. Additionally, interviews with area extension agents and USDA specialists were conducted to cross check the data sources and ensure that the data was correctly interpreted and used appropriately in the model. Based on this work we were confident that the net returns calculations were based on sound data.

As the net returns analysis was being completed two tests of the reasonableness of the estimates were considered. One test was to compare the capitalized value of the net returns to land market prices in the area. Because the study area is dominated by agricultural land uses and there is little prospect of other forms of development, we anticipated a strong correlation between the NPV of NED returns and land market prices. More specifically, in making the comparison, the expectation was that if flood-free annual net returns were capitalized at a 6-7/8% rate, they would be close to, but still be less than current land market prices for cropland. In primarily farming areas like the Delta, capitalized farm returns will be close to market prices; however, there are other values that get capitalized into market prices that do not show up in the NED estimates of agricultural returns. Government transfer payments made through the crop insurance program, production flexibility contracts and expectations of "emergency aid" appropriations [51], as well as landowner expectations of the construction of a pump can all increase land market prices above the land market prices that would be predicted by the capitalized net agricultural returns. On the other hand there may be factors such as the lack of liquidity in land as an asset that would slightly depress land market prices.

A second test was to compare the results from our work with the preliminary agricultural returns results from the Corps study of the pump plan. During the course of this study, we were provided with a series of memos, e-mails, data tables and written documentation explaining the Corps methods and assumptions for calculating agricultural returns and flood damages in their analysis. We anticipated that the Corps agricultural net return results would be similar to those in this study. However, the Corps preliminary estimates did not correspond with our results. In this section we explore the causes of the differences and conclude that the results from this work are more reasonable than the preliminary net return results provided to us by the Corps. Because the Corps has not released its final report our concerns about their analysis are presented in general terms. In Section 6 we make a recommendation for the actions that should be taken once the final Corps analysis is released.

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[51] Recall from Section 3 that government payments currently comprise 40% of net farm income in the nation.

5A. Agricultural Returns and Land Prices: This Study

Table 5-1 reports the capitalized value of this study's net returns land prices for frequently flooded soybean land and for flood free returns to cotton land. In the second column of the table are the 1997 land prices for Sharkey County. The prices are similar in other counties. Consistent with expectations, the capitalized net returns for both soybeans and cotton were less than land market prices. This result is expected because the NED returns are subsidy free (no crop insurance or aid payments are considered, nor is the active hunting lease market). Cotton returns are well below cotton land prices, however government payments to cotton producers have been among the most generous government payment programs in the past (Glade, Meyer and MacDondald, 1995) and have continued in recent years (Grunwald, 1999). These payments are increasing the land market prices, but are included in NED returns. Overall the results reported in Table 5-1 increased confidence that the net returns calculations from the model were reasonable.

Table 5-1: Comparison of Capitalized Net Returns (this study) and Land Prices

Crop	Capitalized Net Returns** (this study)	Land Market Prices*
Soybeans	$ 372	$400/ acre for Class III and V, frequently flooded land
Cotton	$ 432	$750 Class III

*Source: Federal Land Bank Prices reported in Black, Unsworth and Ott, 1997)
** Based on net returns in Reach One

5B. Corps Methods of Estimating Agricultural Damages

Our second test for the reasonableness of our NED estimates was to compare our assumptions and techniques with those used by the Corps in developing their estimates of agricultural flood damages and net returns. We found several reasons why the agricultural flood damage reduction benefits computed for this analysis differ from the benefits likely to be reported by the Corps. Some of the significant differences are described here.

One important area of difference is that our estimates of the current flood-free net returns for some crops in this study are far less than the Corps' estimates. For example, the Corps reports annual flood-free net returns for soybeans in the "upper stratum" (i.e. above the two year flood plain) of $106.89/ ac under current conditions. In this study, soybeans earn a flood-free net return of $61.08 / ac in the first year of the simulation (1997). Similarly, the Corps reports a current day net return of $297.31/ac for cotton in the upper stratum, while this study reports a flood-free net return of $132/ac in the first year of the simulation. Having higher flood-free net returns estimates means that the Corps' calculations of flood damages begin with a higher potential income loss from flooding and so would yield greater flood reduction benefits.

The second important area of difference is the projection techniques used to account for the pump and future economic and technological change. The credibility of the Corps' projection methods with the pump in place and over time has been a source of concern among project reviewers for a number of years, so much so that the Corps has been required to report their results with and without such growth. It is also the case that a pump project has not been justified when the analysis relies on such projections. For example, USACE, 1982, page F-53 states "under the existing development analysis, excess benefits over costs are negative for all plans."

First, the Corps includes "intensification benefits" in their analysis of the pump.[52] Intensification benefits are those improvements in flood-free agricultural returns that occur with the pump for reasons other than reduced flood damages. The Corps argues that, in addition to reducing flood damages, the presence of a pump will enable producers to employ improved management practices. We did not accept this argument. As we reported in Section 4, once the water leaves the field there is little likelihood of return flooding. Therefore, farm operators will employ the best available production practices. We argue that effect of flooding is to delay planting or cause a shift in crop planted, not to discourage the best production practices for a given crop when planting is initiated.

Second, the Corps study projects agricultural benefits over the entire 50-year life of the project. The Corps projects with- and without- project net agricultural returns using historical and projected trends in crop sales per harvested acre in the Yazoo Basin. Historical and projected growth in crop sales does not provide any information about future changes in the *costs* of production, rather only describes change in agricultural revenues. The use of crop sales as the basis for projecting future net returns (i.e. revenues – production costs), may fail to adequately represent future changes in production costs that would diminish the growth rate of projected net returns. Furthermore, projected growth rates based on historical crop sales produces estimates of increasing growth rates that contradict present trends of falling real prices and increasing yields. The analysis in this study also projected agricultural net returns; however, because there is a significant amount of uncertainty associated with projections made 50 years into the future, the projections used in this study were based on 10-year FAPRI projections of yields, prices and productions costs for the Delta region.[53]

Figure 5-1 shows the growth in per acre soybean returns for the flood free condition using the Corps methods and preliminary data. Also included in Figure 5-1 for comparison are the projections made for the analysis of the Watershed Action Scenario in this study, again for the flood free condition. While, the Corps' preliminary net returns steadily increase over the ten-year period, the net returns analysis of the Watershed

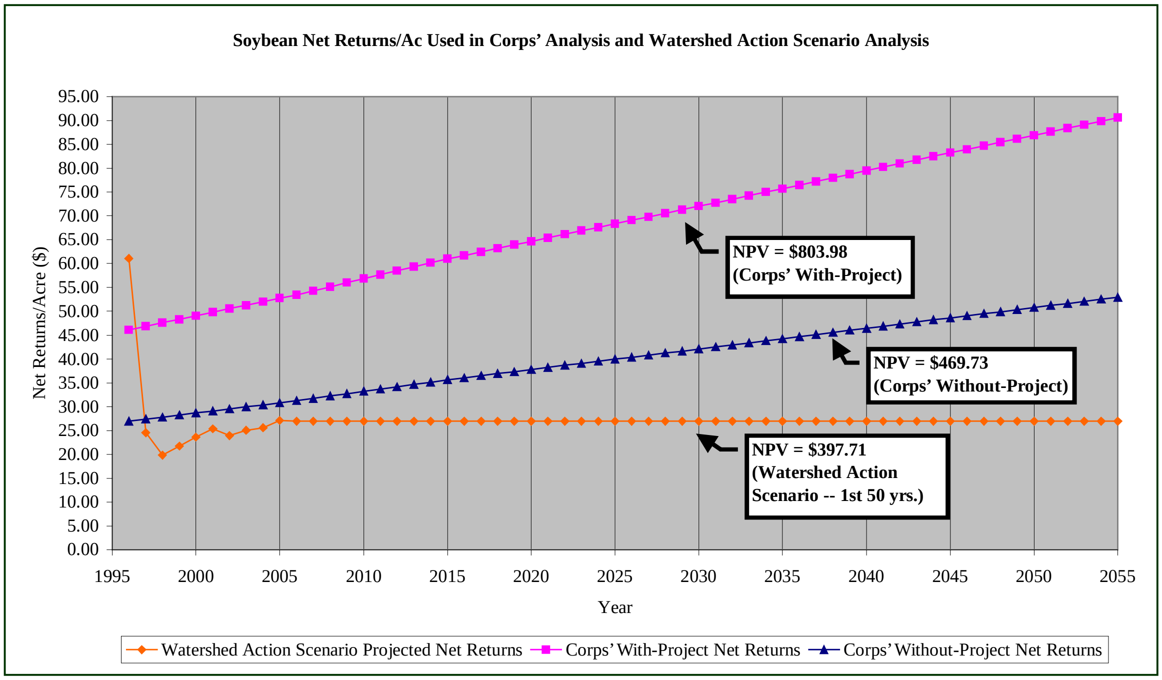
[52] Intensification benefits typically are represented in ways in the Corps' analysis: 1)flood-free yields with a project are higher than flood-free yields without a project, and 2) the distribution of crops changes with a project to include a larger proportion of high value crops than occur without the project.

[53] FAPRI projections are made only 10 years into the future and incorporate the effects of future changes in macro economic conditions and world demand growth.

Action Scenario decline in years 1998, 1999, 2003 and 2007, due to increases in the costs of production relative to revenues earned (projected yield and price growth).

Agricultural benefits provided by the pump equal the difference between agricultural returns, adjusted for flood damages, with- and without- the pump. The Corps' estimates allow agricultural benefits (prevented damages) to grow in three ways. Intensification in the first year (1996) results in an initial difference in flood-free returns with- and without- the pump project. This means that agricultural benefits are earned with the pump, even before the benefits of forgone flood damages are accounted for. As is shown in Figure 5-2, in year one (1996), an increase in flood-free returns with- versus without- the project of $19.17 is triggered by the presence of the pump. [54] This is a 71% increase in flood free net soybean returns attributable to intensification.

Figure 5-1: Projected Growth of Soybean Net Returns/Ac (Flood Free)



The gap between flood-free returns with- versus without- the project increases over time because the same projection factors are applied to the with- and without- project flood-free returns. This arithmetic result occurs because the initial with-project flood free returns are higher than the initial without-project returns. By applying the same growth rate to the different numbers the gap between the with and without project flood free net returns grows over time. As shown in Figure 5-2, applying the same growth factors to these initial amounts results in a difference of $37.67 between flood-free with- and without- project returns in year 50 (2055), as compared to the initial difference of $19.17 in 1996.

[54] Note that the Corps calculates total intensification benefits as 76.6% of the total difference between annual net returns with- and without- the project.

Figure 5-2: Projected Growth of Soybean Net Returns/Ac With- and Without-Project

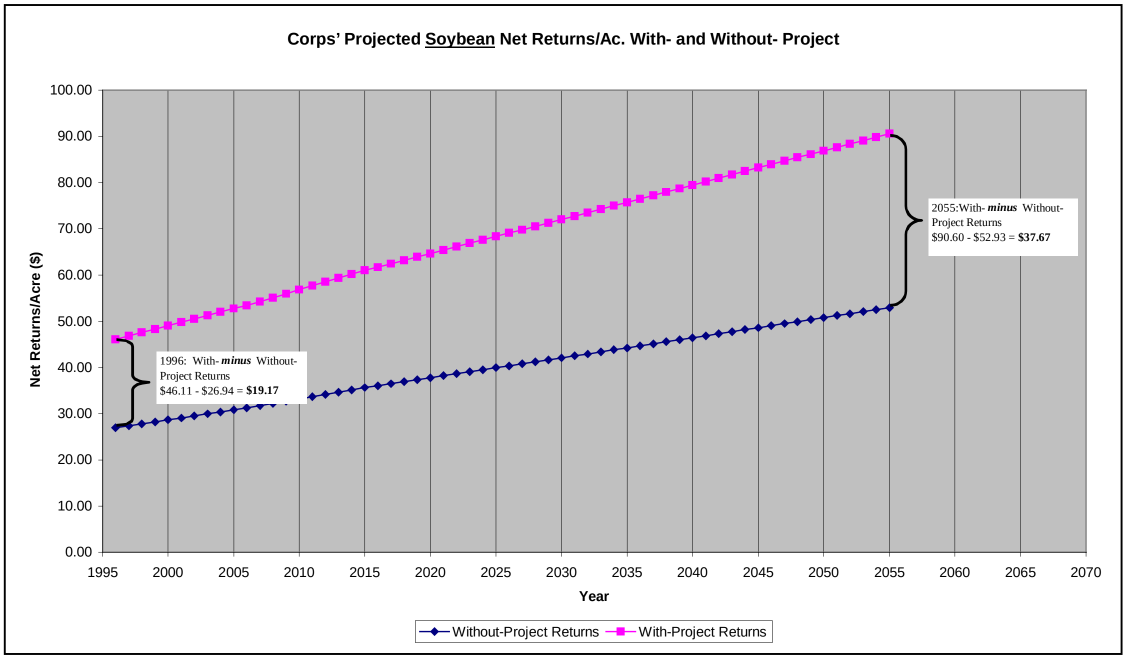
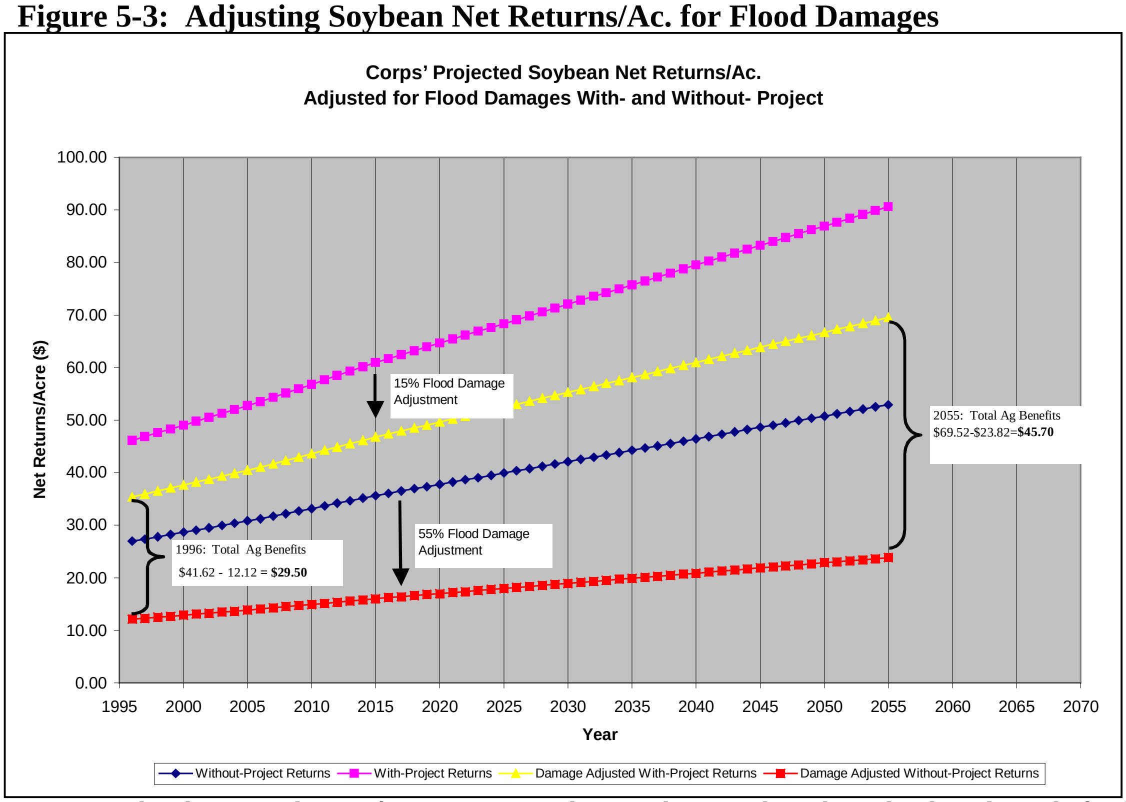


Figure 5-3: Adjusting Soybean Net Returns/Ac. for Flood Damages



* Note that damage reduction factors represented in Graph 5.4 are hypothetical, selected strictly for the purpose of demonstrating the Corps' methodology.

Finally, the difference between with- and without- project returns (i.e. the agricultural benefits of the pump) grows even more once adjusted for flood damages. The likelihood and severity of flood damages without a project will be greater than flood damages with a project. As a result, the without- project net returns are reduced a greater amount by flooding than the with-project returns. This result is illustrated by applying a hypothetical flood damage estimate (see Figure 5-3) to the with- and without project net returns reported in Figure 5-3. After subtracting out the effects of flooding, agricultural benefits for the pump (the difference in flood adjusted with- and without- project returns) is $29.50 in year one (1996) and $45.60 in year 50 (2055) for this illustration.

5C. Agricultural Returns and Land Prices: The Preliminary Corps Analysis

Differences in the starting estimates of net returns and in the projection methods were evident between the two analyses. We therefore applied the land market comparison test to the preliminary Corps estimates. Once again we would expect that the capitalized value of net NED returns would be less than the reported land market price for the same reasons described in Section 5A. In particular the Corps returns are expected to be subsidy free and so any subsidy effect on land prices should be missing. The results reported in Table 5-2 are for a range of values because the Corps reports different returns for the lower stratum (the 2 year flood plain) and an upper stratum (all land outside the 2 year flood plain).

First consider the soybean comparison. The capitalized returns include the effect of flooding in the lower and upper stratum. [55] With no projections, the capitalized soybean returns in both strata are greater than those reported for our model (Table 5-1). In the upper strata the capitalized land prices, contrary to expectations, exceed the market price for land. With projections the capitalized soybean returns exceed the land market price; in the upper strata by a significant amount. From this we conclude that the Corps preliminary soybean returns are greater than the returns we estimate, and can not be easily reconciled with the land price data.

Now consider the results for cotton. First recognize that these are the capitalized value of *flood free* returns taken directly from materials provided by the Corps. As with soybeans the capitalized returns varied by strata, but are comparable to the returns reported from our model in Table 5-1. The capitalized value of the Corps preliminary flood free cotton net returns in Table 5-2 greatly exceeds the returns we calculate for cotton. However, of more significance the capitalized values simply can not be reconciled with the land market prices. Cotton land prices of over $5,000 per acre are predicted using the Corps preliminary data while $1,300 is the highest land market price reported by the land bank in Sharkey County. [56]

[55] The flooding effect was estimated from our model.

[56] One response to this comparison might be to argue that factors such as lack of lack of liquidity in owning land might result in a lowering of land prices. If this were the case the capitalized net returns would *overstate* land market prices. This argument may have some merit but to later the conclusions of this comparison, these unspecified effects would have to be greater than the contribution of subsidies and hunting leases to land prices and then impose a huge and unrealistic penalty on land holding in the area.

Table 5-2: Comparison of Capitalized Net Returns Corps Soybeans Land Prices based on

Crop Type	Land Price based on Corps' Capitalized Net Returns (no projections)	Land Price based on Corps' Capitalized Net Returns (with projections)	Land Market Prices*
Soybeans	$ 354 - $1405	$ 432 - $1716	$400/ acre (Class III and IV, frequently flooded) - $600 (Class III and IV)
Cotton	$1486 - $4,325	$ 1815 -$ 5,281	$ 750 (class III) - $1,300 (class I)

*Source: Federal Land Bank Prices reported in Black, Unsworth and Ott, 1997)

5D. Implications for Corps Estimates of Agricultural Flood Damage

The net returns calculations and the projection methods used by the Corps to estimate current and future agricultural net returns, and agricultural flood damages, will produce higher estimates than the methods used in this study. However, the preliminary net returns results provided by the Corps can be questioned. We used a careful budget analysis (reported in Section 4) and prudent and realistic projection approach. The validity of our approach is certified by the land price comparison. Therefore the agricultural returns model developed for this research was used to evaluate the possible extent of agricultural flood damage reductions from construction of a pump as a separable element.

The agricultural returns model was used to compute the present value of the maximum agricultural crop flood damages in the watershed. This was accomplished by running the model to compute agricultural returns under both current and projected future economic conditions and under the assumption that all flood damages were eliminated. The difference of $25.6M is the maximum potential flood protection NED benefits from operation of a pump. If the pump reduced these damages, for example, by 75% of the maximum, then the NED benefits for this separable action would be $19.2M. These benefits are not adequate to NED justify a pump project that may cost approximately $150 M and other benefits of the pump would not be adequate to make the net benefits greater than zero. In contrast to these results, the Corps is likely to report benefits from reduced flood damages that are sufficient to produce positive NED benefits, with the majority of the benefits resulting from reductions in agricultural flood damages due to both the operation of the pump and from reforestation of currently cleared lands.

Section 6: Findings and Implications

Section 4 describes the nonstructural evaluation protocol and describes the application of the protocol to the Yazoo backwater study area. The estimated net NED benefits for the watershed action scenario are positive. Section 5 is focused on the agricultural returns analysis used in this study to measure one of the costs of reforestation. The section also reviews the preliminary agricultural damages prevented by a pump. The results from Sections 4 and 5 are elaborated on below. Possible criticisms of the results are anticipated and addressed. Then the implications of the results and of the possible criticisms lead to recommendations.

6A.Findings

6A1. The Nonstructural Approach Can Be Justified

Section 4 reports that NED benefits justify a plan to implement the watershed action scenario. These results were developed by applying the analytical logic encompassed in the P&G. However, two of the benefit categories – nutrient reduction and carbon sequestration – are not conventionally considered as benefit categories. The theoretical and P&G rationale for their inclusion is discussed in detail in Section 4. The critical assumption is that there are national goals for reducing greenhouse gas (GHG) releases to the atmosphere and for making reductions in nutrient loads to the Gulf of Mexico. The presence of these goals warrants the use of an alternative cost method for benefit assessment. In Section 6A1a. further arguments in support of this assumption are offered. If these arguments are rejected then the benefit category for an NED evaluation may be questioned.

In Section 6A1b., a justification for the watershed action scenario is offered *without* relying on the NED benefits from carbon sequestration and nutrient load reduction. Instead we apply the logic of the Corps ecosystem restoration evaluation guidelines. Those guidelines call for the analysis to demonstrate that the costs of a restoration action (here reforestation) are low in relation to significant environmental gains that will be realized. (See: http://144.3.144.209/corpusdata/usace/usace-docs/eng-regs/er1165-2-501/entire.pdf) The environmental gains and their significance need not be represented in NED terms. We conclude that whether the NED benefit category is accepted or not, the watershed action scenario is justified and a plan to secure implementation of the actions in the plan is warranted.

6A1a NED Benefits for Carbon Sequestration and Nutrient Reduction

The approach used to estimate the NED benefits for carbon sequestration and nutrient reduction presumes that there are goals in place that establish targets for reduced GHG emissions and for nutrient load reductions to the Gulf of Mexico. If such goals can be presumed then the alternative cost measurement technique is justified (See Section 4). We assert that evidence of national goals in these areas is adequate to justify the NED benefit calculation approach used.

First, consider the carbon sequestration services of reforestation. The premise of the NED analysis is that there is sufficient evidence of a national commitment to reducing GHG emissions to the atmosphere. It can be shown that the policy environment exists that will result in limits of GHG in the atmosphere and that will accept carbon sequestration in lieu of reductions in GHG emissions as a way to meet those limits.

Table 6-1 lists bills from the last session of the Congress. The bills are evidence of a national goal for reducing carbon atmospheric GHG and these same bills recognize that carbon sequestration can be a cost effective means of achieving these reductions. While the EPA has been instructed by the Congress in the Year 2000 appropriation bill language to avoid actions that would lead to implementation of the Kyoto protocol, this instruction is *not* analogous to a mandate that the agency ignore or avoid study or analysis of the GHG problem more generally. Opponents of Kyoto support finding ways "… government and private industry can work together in a responsible manner to reduce greenhouse gas emissions in ways not tied to the Kyoto treaty." (See: C. Hagel and F. Murkowski, "High Costs of Kyoto", Washington Post, Januarys 29, 2000, page A17 (available at http://search.washingtonpost.com). Agencies of the federal government have embarked on ambitious programs to improve the technologies for reducing green house gases and sequestration is one of the primary options being considered. See: http://fetc-ip.fetc.doe.gov/publications/press/1999/tl_seq99.html

Meanwhile, private sector activity to purchase sequestration credits as offsets for future emissions is expanding rapidly in recognition of the emerging national commitment to reduce GHGs and in recognition of the role sequestration will play in meeting this goal. An extensive inventory of private sector activity can be found at http://www.ieta.org/. For the above reasons we assert that there is a national commitment to GHG reductions in the atmosphere and that the NED benefit calculation for the watershed action scenario is defensible.

Next, consider NED nutrient reduction. The NED benefits for nitrogen load depend on a policy commitment to reduce the hypoxic area in the Gulf of Mexico. In the fall of 1997 EPA formed the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force. The task force requested that a study of the causes and effects of hypoxia in the Gulf be undertaken by the Committee on Environment and Natural Resources (CENR) of the White House Office of Science and Technology Policy. Then, at the end of the 105^{th} Congress, this request was written into law. Section 604a of PL 105-383 calls for an assessment of hypoxia in the Gulf and for the development of a plan for reducing, mitigating and controlling the hypoxia problem.

Six separate, but interrelated reports have been completed, each examining different aspects of hypoxia in the Gulf, including: the causes and distribution of hypoxia in the northern Gulf of Mexico, the ecological and economic consequences of hypoxia, the sources and loads of nutrients transported to the Gulf by the Mississippi River, the effects of reducing nutrient loads on hypoxia in the Gulf, and the social and economic benefits of methods used to reduce nutrient loads.

Table 6-1: Carbon Legislation

Bill #	***Short Title***	***Sponsor***	***Date Introduced***	***Current Status***	***Summary***
S. 547	Credit for Voluntary Reduction Act	Chafee	3/4/99	3/24/99 in Environment and Public Works	Authorizes the President to provide regulatory credits for voluntary reduction of emissions or sequestration of carbon. Establishes period of time in which credits can be accumulated. Allows for retroactive credit entitlements. Sets a 1:1 exchange rate, defines baseline, describes monitoring and measurement procedures. Allows for sale of credits among program participants and to non-participants.
HR 2520	Credit for Voluntary Actions Act	Lazio	7/14/99	7/30/99 in Energy & Power	Similar to Chafee bill. Authorizes the President to provide regulatory credits for early reductions in greenhouse gas emissions. Contains requirement that participants be entitled to receive reduction credit for "….permanent protection of carbon stocks in mature primary forests, reforestation and afforestation, and improved forest carbon stock management in forests that have merchantable timber." Note: number of credits allowed for increases in carbon stock is limited to no more than 20% of all credits allocated.
HR 2980	Clean Power Plant Act of 1999	Allen, Thomas	9/30/99	10/13/99 in Subcommittee on Energy & Environment	Establishes a cap and trade program for CO2 emissions among electric utilities. Also, authorizes the appropriation of $30M to EPA and USDA to "…carry out soil restoration, tree planting, wetland protection and other methods of biologically sequestering carbon dioxide." Authorizes the appropriation of $15M to EPA and DOE to finance R&D activities in support of the development of a carbon sequestration strategy.
S. 882	Energy & Climate Policy Act of 1999	Murkowski	4/27/99	4/27/99 in Committee on Energy & Natural Resources	Amends the Energy Policy Act of 1992 to establish an Office of Global Climate Change. One of the functions of this office will be to promote voluntary efforts to reduce or avoid greenhouse gases and to undertake research, development and demonstration projects to create new technologies and practices to remove and sequester greenhouse gases.
S. 1066	Carbon Cycle & Agricultural Best Practices Research Act	Roberts, Pat	5/18/99	5/18/99 in Agriculture Committee	Amends the National Ag. Research, Extension and Teaching Policy Act of 1977 to make USDA the lead agency in research relating to carbon and ag. practices to increase soil carbon storage. Directs the development of a carbon cycle remote sensing technology program. Authorizes appropriations for a nationwide carbon cycle monitoring system. Authorized Secretary of Ag. to make conservation premium payments to participants in conservation programs for related research activities, and to provide educational and technical assistance.
S. 1457	Forest Resources for the Environment & the Economy Act	Wyden, Ron	7/29/99	9/30/99 in Subcommittee on Forests & Public Lands, Committee on Energy & Nat. Resources. Hearings held.	Amends Energy Policy Act of 1992 to assess opportunities to increase carbon storage on national forests and to facilitate voluntary reporting of forest projects that sequester carbon. Establishes a Carbon Storage and Watershed Restoration Program. Secretary can enter into agreements with NIPFs or Indian tribes for the "…protection, restoration, and enhancement of fish and wildlife habitat and other resources on public land, Indian land or private land in a national forest watershed. Secretary of Energy and Commerce is directed to establish a revolving loan to fund Indian tribes and NIPFs efforts to undertake forestry carbon activities. Loan funds can be used to pay the costs of purchasing and planting tree seedlings and other forest management actions. An insurance provision is made waiving landowner liability for certain causes of loss of timber stand. Loan can be cancelled if owner donates a conservation easement to the land.
S. 935	National Sust. Fuels & Chemicals Act of 1999	Lugar	4/30/99	10/8/99 Placed on Senate Legislative Calendar	Amends Nation Agriculture, Extension, Research and Teaching Policy Act of 1977 to authorize research to promote the use of biobased industrial products. Includes research aimed at measuring and analyze carbon sequestration and carbon cycling related to the production of biomass feed stocks.
S. 1776	Climate Change Energy Policy Response Act	Craig, Larry	10/25/99	10/25/99 in Energy & Natural Resources	Authorizes appropriations for climate change research, including research pertaining to carbon sequestration through forests.
HR 2827	National Sust. Fuels & Chemicals Act of 1999	Ewing, Thomas	9/9/99	10/28/99 Hearings held Subcommitee on Energy & Environment	Similar to S. 935. Directs Secretary of Agriculture and Secretary of Energy to competitively award grants for research involving the measurement of carbon cycling in relation to the life cycles of biomass feedstocks (includes some forest products).

An Integrated Assessment Report is currently being prepared, based on the findings of the six reports described above and the public comments received on them. The draft of the Integrated Assessment Report is currently available for public comment. Upon completion, the report will be used by the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force as a source of information in developing a plan for addressing hypoxia concerns in the Gulf. See: http://www.nos.noaa.gov/pdflibrary/hypox_ia.pdf

The overall national problem of hypoxic conditions in estuaries is well recognized. (See: National Oceanic and Atmospheric Administration (NOAA), 1998, "Oxygen Depletion in Coastal Waters" by Nancy N. Rabalais. NOAA's State of the Coast Report. Silver Spring, MD: NOAA. http://state-of-coast.noaa.gov/bulletins/html/hyp_09/hyp.html). The Gulf of Mexico condition is the most recent to gain national recognition. In other areas where hypoxia has been identified (for example, Long Island Sound and the Chesapeake Bay) nitrogen load reduction goals have been established and programs have been initiated to reduce loads from all tributaries and from all sources within tributaries. It is reasonable to anticipate such load reduction goals for the Mississippi River discharge to the Gulf of Mexico.

The Mississippi drainage has a massive spatial scale compared with other areas that have hypoxia problems. Still, if the national model is applied in this case a watershed like the Yazoo will have goals that mirror those for the whole drainage. For example, if a 20% load reduction is needed to reverse the hypoxia problem, then each watershed initially might be expected to reduce loads by 20%. Further analysis might call for more reductions in some areas and less reduction in others, perhaps through an offset program that is anticipated by pending EPA rules (See: http://www.epa.gov/OWOW/tmdl/proprule.html). The reductions from reforestation in the Yazoo could contribute to reduced costs for load control either in the Yazoo or in other areas of the drainage. For the above reasons we assert that there is a national commitment to nutrient load reductions to the Gulf and that the NED benefit calculation for the watershed action scenario is defensible.

6A1b. Justification Using the Ecosystem Restoration Guidelines

Because the application of NED measurement to the services of carbon sequestration and nutrient reduction is a new one there may be a reluctance to adopt the NED measures as a definitive justification for the watershed action scenario. For that reason this section will apply the Corps Ecosystem Guidelines, that were introduced in Section 2, to the evaluation of the watershed action scenario. In the Corps guidelines an ecosystem restoration action does not need to be NED justified. Instead it can be justified by its contribution to restoring the structure or function, or both, of a degraded ecosystem, after considering the cost of the action. Specifically, ecosystem restoration actions can be justified if monetary *and* non-monetary benefits are demonstrated to be greater than costs. (See: http://144.3.144.209/corpusdata/usace/usace-docs/eng-regs/er1165-2-501/entire.pdf). In the end, justification will require a qualitative decision that relies on experience, and professional judgment.

Evidence from this report suggests that the watershed action scenario could be justified under the framework of the Corps ecosystem restoration guidelines. The Corps guidelines were used because they provide a logical and rational approach to blending monetary and non monetary measures into a decision making process. However, because the reforestation will not be paid from the Corps budget particular Corps budget policies were not considered in the application of the approach. The guidelines put at least three burdens on the analysis. First, an ecosystem restoration action should be a cost effective means of addressing the restoration problem or opportunity. This means that the restoration action to restore what the Corps defines as the structure or function of degraded ecosystems cannot be produced more cost effectively by another alternative plan. Second, there must be adequate evidence that the actions make a contribution to addressing significant environmental planning problems and opportunities. Significant environmental problems and opportunities are institutionally, publicly, or technically recognized as important. Finally, the analysis should document that the costs are "reasonable".

Test 1: Cost effectiveness: The Corps includes within its definition of ecosystem structure and function such measures as water quality parameters like dissolved oxygen, suspended sediment and soil organic content. The particular listing is not relevant here; what is relevant is nutrient load reduction, sediment trapping and other water quality improvement indicators as well as carbon sequestration would fit in a list of ecosystem functions and structure In Section 4 we prefer to call these services. In Section 4, arguments for the NED benefit assessment documented that the alternatives to reforestation for nutrients reduction and carbon sequestration were the least cost alternatives. These arguments are also the evidence that reforestation is a cost effective means to enhance water quality by reducing loads to the watershed and for reducing GHG by carbon sequestration. [57]

Test 2: Significance: Instead of valuing the structure and functions in some way the guidelines ask that the analysis document the institutional, public policy, or technical significance of the restoration results. In previous sections of this report there has been extensive documentation of the national policy and institutional significance of the nutrient reduction and carbon sequestration results from reforestation as public policy targets.

In addition there are other significant water quality results that were not considered in the NED based analysis. Sediment reduction and reduction of pesticide runoff are also likely to be substantial (Section 2) with reforestation. These results will accrue in the larger watershed as well as in the Yazoo basin itself. Localized water quality effects were not considered in the NED analysis, but provide added documentation for the significance of the reforestation. Table 6-2 lists the impaired waters and their cause in the lower Yazoo. Given the *national* commitment to improvement and restoration of

[57] Because the reforestation action yielded multiple services, a cost allocation among those services would be required to formally justify the claim that reforestation is a cost effective means of achieving the separate sequestration and nutrient reduction results. Such a cost allocation was not completed, but the results of a cost allocation are suggested by the discussion of test 3 that follows.

waters on each states 303 (d) list (See: http://www.epa.gov/OWOW/tmdl/index.html) the national significance of reforestation actions to improve local water quality can be established.[58]

Table 6-2 Impaired Waters in the Lower Yazoo River

Waterbody	Parameter of Concern
Collings Creek-	pesticides siltation organic enrichment/low DO nutrients
Yazoo River	metals pathogens PH
Yazoo River seg 2	nutrients organic enrichment/low DO
Big Sunflower River diversion channel	pesticides siltation nutrients

Source: http://www.epa.gov/iwi/303d/08030208_303d.html

Test 3: Reasonableness of NED Cost: For applying this test we *removed* the nutrient reduction and carbon sequestration benefits from the NED results reported in Section 4. The NED benefits for timber, private hunting and non-crop agricultural flood damage reduction remain in the calculation. This is a crude cost allocation for attributing the remaining NED cost of reforestation to nutrient reduction and carbon sequestration outcomes. However, it provides a context for asking if the cost to achieve the significant environmental results associated with the reforestation are reasonable.

The result of *removing* nutrient and carbon benefits from the NED analysis reported in Section 4 was to make the NPV of the NED negative $19.5 million and make average annual NED equal a negative $1.33 million. That this NED cost is a reasonable one for the sequestration and nutrient reduction results achieved can be demonstrated with a single argument. Initially ignore completely the local and Gulf of Mexico water quality effects of reforestation. Sequestered carbon is the environmental effect that is left and all costs are allocated to carbon sequestration. The average annual amount of carbon sequestered by the 88,000 acre reforestation is approximately .9MT per acre per year (King, D. M., L. A. Wainger and W. Currie ,1999), or 79.2 MT per year for the whole scenario. The annual NED cost for sequestering this 79,200 MT is $1.33M, or $16.79 per

[58] This argument is one where Corps policy would prohibit the use of its budget for making water quality improvements that are a substitute for the responsibility of other programs and of landowners. While the prohibition may make sense for the Corps (and there is no recommendation in this report that Corps funds be spent on water quality) the national EPA and USDA budgets for securing agricultural pollution load reductions suggest that there is a significant federal interest in securing water quality improvements at the local scale.

ton ($1.33M/79,200 MT). The Council of Economic Advisors simulation finds that $14 per metric ton would be the equilibrium price in a global trading system (CEA,1998). The US Department of Energy has a goal of reducing thorough research the cost of sequestration to $10 per metric ton per year by the year 2015. See: http://fetc-ip.fetc.doe.gov/publications/press/1999/tl_seq99.html (page2). By these standards a cost of $16.79 per metric ton is quite reasonable.

Now recall that the same reforestation also promises nutrient load reduction and improved local water quality parameters. Thus a substantial share of costs could be allocated to water quality outcomes. Under this condition costs that would be allocated to carbon sequestration would fall and the cost per ton would fall. For illustrative purposes allocate 50 % of the $1.33 million annual cost to these water quality effects. This would make the cost per ton of sequestered carbon $8.40 ($665,000/79,200) – below the $10 per ton DOE target for 2015. Then, the $665,000 allocated to nutrient reduction would yield 866,800 pounds of reduction at a reasonable per pound cost of $.77/ pound.

Applying the logic and test of the Corps ecosystem restoration guidelines we conclude that the watershed action scenario can be justified, without the formal use of the NED benefits for carbon sequestration and nutrient reduction. For this reason, and because the technical validity of the NED analysis also can be defended, the watershed action scenario can be justified. With this justification, the nation may choose to develop plans and program to encourage landowner and community adoption of nonstructural actions such as those in the scenario. A implementation approach is discussed later in this section.

6A2. NED Justification for a Pump Should be Reviewed

Section 5 reported on an analysis that raised questions about the preliminary agricultural damage reduction benefits that may be reported for a pump. Analysis of the preliminary documentation of agricultural benefit calculations provided by the Corps suggested that there may be flaws in the agency's agricultural benefit analysis. If the agricultural flood damage reduction benefits prove flawed then the NED justification for a pump will be undermined, because agricultural flood damage reduction is the predominant benefit category for justifying the pump. Table 6-3, which lists and briefly explains the benefit and cost categories and the preliminary benefit estimates from the Corps pumps analysis,[59] provides the basis for the statement that agricultural damages reduced are critical to justification for the pump. [60]

[59] This listing and description is not an endorsement of the technical validity of the calculations. In fact, as we note below, there are significant questions about the validity of the reported benefits of the pump.

[60] For this study we began by reviewing the categories of NED benefits and costs that the Corps ascribes to its pump project (Table 6-3). In this way we would assure that the evaluation of the watershed action scenario was considering the same benefit categories and, by extension, many of the same watershed problems and opportunities. Benefits were not estimated for all these categories in the analysis of the watershed action scenario; nonetheless, the actions in that scenario would address the same problems said to be addressed by a pump. Residential and infrastructure damages would be addressed by relocation and other flood hazard mitigation actions. Similar actions could address damages to catfish farms. The farm

Table 6-3: NED Benefit Categories in Corps Pump Analysis

Benefit	% Total benefits	Description
Agricultural crop damage reduction	69.14%	Increased net returns to agricultural producers from shorter planting delays, less frequent replanting of flood damaged crops and higher yields.
Agricultural / Non crop	13.99%	This benefit category results when flood damages are removed from on-farm items such as equipment, farm buildings, production inputs (seed, fertilizer, chemicals, etc.), grain bins, stored crops, fences, farm roads, drainage systems, trash removal, etc.
Structural Property	9.45%	There are approximately 1,550 structures flooded by the 100-year flood under existing conditions. With the structural alternatives currently being considered, the number of structures flooded by this event would be reduced substantially, but damages would remain.
Roads and Bridge	3.77%	This benefit category represents reduction in flood damages to public roads and bridges, inclusive of county and state maintained roads.
Catfish	2.10%	Damages to commercially grown catfish operations occur when levees are overtopped resulting in catfish production losses and restocking costs.
Agricultural Intensification	1.80%	Benefits result when farmers are able to change cropping patterns from a less profitable crop to a more profitable crop because of the reduced threat of flooding.
Reduced emergency costs	0.68%	Emergency costs include such items as evacuation and reoccupation costs; flood-fighting expenses; cost for emergency shelter and food for evacuees; state and Federal disaster relief; increased expense for normal operations; increased costs of police, fire, and/or military patrol; and losses due to abnormal depreciation of equipment; e.g., fire trucks, patrol cars, bulldozers, etc., resulting from catastrophic flooding.
Streets	0.40%	Avoided street repair costs.
Reduced flood insurance costs	0.14%	Benefits from the reduction in the cost of administering the National Flood Insurance Program deal with probable changes in the aerial extent of the 100-year flood plain for the with- versus the without- project conditions.
Automobiles	0.07%	Avoided flood damages to cars and trucks.
Total	100%	

Source: Adapted from FAX communication, March 25, 1999 from M. Garton to L. Shabman ,VPI Questions and Corps Responses, Yazoo Backwater Reformulation Study, Re: e-mail message to J. Meador and J Derby , March 19, 1999, Question 1a.

6.B. Implications

6B1. The Office of Management and Budget (OMB) Should Review Agricultural Returns Calculations

In the Yazoo study area we found significant differences in net returns results from this study and the preliminary analysis provided to us by the Corps. Because the calculation of economic benefits of continued agricultural production in frequently

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income consequences of the agricultural damages would be addressed by the reforestation payments and the crop insurance program. Non crop damages are a benefit category used in the nonstructural evaluation. The benefit categories of reduced flood insurance costs and reduced emergency costs would be realized by relocation and other nonstructural flood hazard mitigation actions.

flooded areas is critical to the NED analysis of both structural and nonstructural actions, the logic employed to calculate these returns and the data bases used should be a subject for review. These differences could significantly affect the estimates of the NED benefits of agricultural flood damages avoided in the Corps analysis of the pump project. Without the final report on the Corps analysis of the pumps project, it is not possible to fully evaluate the final techniques and data they have used. When the Corps report becomes available, the Office of Management and Budget could review both study approaches for calculating agricultural returns.

A review of project justification by OMB would be routine if the project had not yet been authorized. In fact there are specific requirements and procedures set forth in Executive Order 12322--Water Resources Projects. (See Appendix F). However, the pump project has already been authorized and the restudy report may not be subject to OMB review unless a request is received at OMB after the Corps releases its report on the pump. Therefore the EPA should request a review by the Office of Management and Budget.

6B2. The Administration Should Secure Revised Study Authority From the Congress

This analysis concludes that a nonstructural plan should be pursued for the Yazoo study area and that the preliminary agricultural flood reduction benefits for the pump may be flawed. Therefore, the Corps should be asked to lead an interagency effort to develop a nonstructural implementation plan for addressing the problems and opportunities in the Yazoo backwater study area and in the larger watershed. The agency's understanding of the area, the relationship with the local community and its technical expertise suggest that the Corps could exercise leadership responsibility for formulating a watershed restoration program for the region.

The administration could seek authorization in WRDA 2000 for the Corps to chair a federal interagency committee of equal partners (FEMA, USDA, EPA, CEQ, FWS, and OMB). In addition, the Congressional direction for the study could affirm that implementation, as with the pumps, will be a full federal responsibility.

The interagency committee would:

- refine and apply the tools, practices and application of the NED and environmental analysis in order to set a reforestation/restoration target for the area
- prepare an implementation plan for voluntary adoption of reforestation actions for the watershed. The federal agency partnership should develop formal linkages with state, non-governmental organizations (NGOs) and private sector participants for plan implementation.
- develop a coordinated approach toward farm income assurance with the Federal Crop Insurance Corporation and USDA and toward local protection and relocation efforts with the Federal Emergency Management Agency.

Such planning for the Yazoo backwater study area could be extended to the whole watershed and address the continuing controversy over other projects there. Also, the approach could serve as a model for other areas of the Delta and for elsewhere in the nation.[61]

6B3. Income Assurance Options Should be Developed in the New Study

The nonstructural implementation plan developed by the interagency partnership could assure landowners that future income loses associated with flooding will be compensated.[62] The present value of the payout from such a program was estimated using the computer model employed to calculate NED benefits. The present value of the maximum flood damages estimated for the eligible area (the area above the 2-year flood event [63]) are $11.5M, although a somewhat larger amount of damages may be possible.[64] The $11.5 million present value of the payout can be made in two ways. Landowners would be offered a contract that would guarantee payments for flooding losses under certain contract conditions or the program could be attached to the current crop insurance program as a premium subsidy. Given the uncertainties that would be perceived by both the government and landowners, an alternative payment system might be favored. In that system a per-acre one-time payment would be made to landowners who encumber their land so that they and all subsequent owners forgo future claims for disaster aid and for participation in the federal crop insurance program. Setting up this program at full federal cost makes this expenditure a federal government subsidy just like the subsidy implied by the federal government bearing the cost of a pump.

6B4. Programs to Supplement the Wetlands Reserve Program Should Be Developed in the New Study

The Fish and Wildlife Service, in its planning aid report to the Corps, reviewed the recent history of reforestation in the watershed (FWS, 1999). The FWS concluded that 43,432 acres of land will be reforested even without a new initiative to promote reforestation. This existing trend to reforestation will be a response to policies such as the WRP. The results in Section 4 provide a justification for continuing the Wetlands Reserve Program (WRP) in the Yazoo backwater study area. [65]

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[61] This recommendation would initiate a study process analogous to the effort that was undertaken for the Atchafalaya River (M. Reuss, 1998) and more recently for the Florida Everglades.

[62] In one sense the pump is an income assurance action. Income assurance is offered here for its political and not economic justification. Specifically, if landowners feel they have a claim on federal financial support for a pump (Delta Council, undated), then the income assurance program is offered in lieu of a pump.

[63] No land below the 2-year flood event would be eligible for the payments. Instead, income opportunities for lands in the 2 year flood plain would be offered through a reforestation incentive program.

[64] This calculation assumes that an insurance program would have no conditions that would limit payments to landowners (such as deductibles). If the program was tied to the existing crop insurance program then the budget cost would need to be based on the premiums that would be subsidized to obtain coverage.

[65] The WRP is just one of a genre of USDA and other agency programs that provide subsidies for landowners to change land use. The term of art is "green payments". These subsidies are warranted if there are national benefits to (for example) reforestation, but landowners cannot capture a cash payment for these

However, the analysis of the watershed action scenario suggests that more reforestation than would occur under the without action trend can be justified. While all areas should not be reforested, the expansion of landowner incentives encouraging reforestation on lands where soybean production is marginally profitable is sound public policy. [66]

When such incentive payment programs are put in place the landowner can choose to participate or can choose to continue the current land use practices. The design of a program to encourage reforestation requires understanding both the economic and non-economic considerations that factor into a landowner's willingness to reforest. Each landowner's outlook on farming and forestry will differ according to the size of the farming operation, whether the land is farmed by an owner-operator or by a renter, the expectations for future policy and market conditions and willingness to participate in government programs designed to encourage reforestation (Pease, 1998). The next section describes one possible program design.

6B41 Designing the WRP Supplemental Program

Although the case study was for the Yazoo watershed area, the incentive program envisioned could logically apply across the whole watershed and the whole Delta. As the program expands in geographic scope, it is essential that budget limitations be recognized and that there be a logical basis for enrolling land in a reforestation program. The program design should assure that payments from non-governmental sources are maximized *and* that landowner payments do not exceed the compensation required to induce them to reforest. [67]

6B41a Government Easement Payments – A Bid-in System

Government easement payments offer landowners the opportunity to earn an up-front payment or predictable annual payment for switching land use from farming to forest production. The payment might be necessary to compensate the landowner for the increased variability in cash flow from forest product sales relative to annual agricultural sales, to address landowner unease over uncertain future timber yields and prices and/or to bridge any gap between forestry returns and the forgone returns from crop production (Pease, 1997).

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values. The logic is that we are providing a means by which landowners can capture cash payments for the value of the national benefits provided by reforestation (Heimlich, 1999).

[66] Expansion would be by easements offered by willing sellers and would not be fee simple acquisition. There would be no condemnation of land with compensation. Condemnation and even fee simple purchase of large areas of land can initiate political opposition (for a specific example see M. Reuss, 1998). Acceptability of the action is critical to securing its support. The P&G notes that one of the four criteria for formulating a plan is "acceptability". The P&G states (VI.1.6.2(c)(4) "Acceptability is the workability and viability of the alternative plan with respect to acceptance by State and local entities and the public..."

[67] Past studies (Amacher, et. al., 1997) have found that the WRP subsidy in the area was excessive in terms of what might be needed to get landowners to reforest. To avoid such budget inefficiency in the payment program, we recommend a bid-in program in the last section of the report.

Reforestation occurs when cash payments to landowners cover forest establishment costs and provide compensation for forgone farm income from all sources (including prospective future subsides from the crop insurance program that may subsidize the income from farming frequently flooded land). An estimate of the upper bound of the required payments for land and reforestation costs in the study area is $650 per acre. [68]

However, the federal government need not and should not be the only source of funds for easements payments. In fact, the NED benefit categories and the analysis of benefits suggest that there are other revenue sources including hunting lease sales, carbon credit sales and nutrient reduction credit sales that might be used to make easement payments. In addition, it is possible that forest products companies or non-governmental organizations (NGOs) might make payments to landowners who dedicate their lands to saw timber and pulp production in return for the harvest right to the trees.

In general, the program for making government payments must have an annual appropriations cap and landowners must bid for payments from that program, with low bidders who meet reforestation success criteria receiving payment priority. The program design challenge is to keep the landowners and other participants (for example, forest product companies) from shifting costs to the public sector. In principle, the landowner will minimize their bid request to the extent that they can secure income from hunting lease sales and private sector payments to reforest.

This bid-in concept would require some deviation from the rules and procedures in the current WRP program. The WRP is not a bid in program in the sense described here. Landowners offer land and the land is evaluated for its contribution to the environment. Land that is chosen for enrollment in the program is offered a payment based on a county-specific formula that is expected to reflect the opportunity cost of the enrollment the landowners. While the WRP can offer a significant inducement to reforestation, there are unresolved issues related to species that can be planted, harvest rules and tax treatment of program payments that will need to be addressed in the design of a new bid-in program (Poe, 1998).

A bid–in program could be built around two new initiatives: initiative one would implement programs and policies to create new markets for the environmental services of reforested areas.[69] Initiative two would work out contracting systems that would allow landowners to take advantage of the market opportunities.

[68] In fact, much of the land in the watershed action scenario could be acquired in fee simple for around $500 per acre. WRP payments made in Issaquena and Sharkey counties were as low as $200 per acre in 1992 and in 1996 were as high as $455 per acre. These easement costs are consistent with those provided by the Corps and conform with the model calculations of the present value of net returns made for this study.

[69] Market creation possibilities include expanded hunting lease sales, sales of carbon sequestration credits and sales of nutrient reduction credits from reforestation. The development and of carbon and nutrient markets requires public initiative and oversight to 1) define, certify and keep accounts of the credits that will be bought and sold and 2) initiate polices that create the demand for the credits. For example, there needs to be a certification of the amount of credits that accrue from any scale and practice of

6B41b Advance the Hunting Lease Markets

The bottomland hardwood forests of the Yazoo basin provide habitat for a variety of game and waterfowl, including deer, turkey, duck and quail. Recreational hunting opportunities in these forests are marketed in the form of hunting leases. A market for hunting opportunities is well established in the Yazoo basin, both in the form of hunting lease sales and in lieu exchanges.[70] Furthermore, regional trends in participation rates in hunting, fishing and wildlife watching and lease hunting lease sales suggest an expanding market (USFWS, 1997).

The market price of hunting leases is site specific. Bottomland hardwoods, or mixed cottonwood-oak forests, provide the greatest potential for huntable wildlife production. Landowners who are nearer to urban centers have a greater potential for the sale of hunting leases. Also, for the landowner to be successful leasing land, a substantial amount of acres need to be reforested, especially for deer habitat. If neighboring landowners also reforest, then there is increased chance of securing high price for hunting leases. However, if these same landowners also sell hunting leases then the price may be depressed.

Market development in this context may mean three actions. First, technical assistance and financial planning advice may be offered to landowners who are seeking to sell leases. Second, a program to match buyers of leases with sellers, even through an internet site, could be considered. Third, any advertising or other programs to increase demand for leases in the face of increasing supply could help to maintain lease prices over time.

6B41c. Advance Markets for Carbon Sequestration

The initiation of the early reduction credit program for carbon emitters pending in Congress (S. 547 and HR. 2520) or the cap and trade system proposed by HR 2980 would introduce carbon sequestration payments as a source of landowner income. In anticipation of such programs there has been extensive private sector interest in making payments to landowners who reforest for carbon sequestration. A comprehensive and continuously updated source on such programs can be found at the website of the International Emissions Trading Association (http://www.ieta.org/). Actions now underway in a variety of venues should be assessed and adapted by the interagency study team to develop market sales opportunities for sequestered carbon in the Yazoo area and

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reforestation. Such certification offers both buyers and sellers an independent judgment on the credits available to be sold. In this report we do not address these issues. The issues are recognized in policy design. For example see Senate Bill 547 noted in Table 6-1. In addition, the concern over the careful design of such programs has been recognized more widely (see: US general Accounting Office" Experts Observations on Enhancing Compliance With a Climate Change Agreement", GAO/RCED-99-248, August 1999).

[70] We are aware of anecdotes about people buying land for the hunting rights and then enrolling in WRP. These anecdotes suggest that the justification for a bid-in program where people capture the value of the marketable services of reforestation before they enroll in an easement program is valid.

throughout the Delta (Sonneborn, 1999). Certification programs including baseline establishment and monitoring will be especially valuable for promoting the sale of carbon credits from this region.

6B41d. Advance Markets for Nutrient Reduction Credit Sales

Currently proposed EPA regulations support an offset program to meet water quality goals. An offset program would use regulatory direction to define what nutrient (or other pollution) controls are required at regulated point sources. Under proposed rules regulated sources would be required to apply all technically feasible controls and then would be expected to buy non point source reductions (called offsets) if the point source controls do not meet ambient water quality standards. See: http://www.epa.gov/OWOW/tmdl/proprule.html) Such payments might be made if a watershed load cap became binding. If a Mississippi River wide program is put in place an offset payment program might be developed. The possibility of securing offset payments for reforestation actions should be continuously monitored as part of an on-going watershed planning program initiated by the interagency study team.

6B41e. Contracting Systems to Seize Market Opportunities

As markets are established there will be a need to assist landowners in taking advantage of the market opportunities. One possibility is to encourage private forest products firms or non governmental organizations to become the responsible party for the reforestation. If forest products firms or NGOs (hereafter referred to as intermediaries) were involved they would contract with landowners to assume responsibility for timber management on the land and would make payments to landowners for use of land for timber production.[71] The intermediaries would contract with landowners and offer an up-front cash payment that is the expected value of the timber at a future date. The intermediaries get a harvest right that is affirmed by a regulatory rule that defines the permissible harvest approach that can be employed at a future date (clear cut, selective harvest, etc.).

Intermediaries could receive payments from energy companies under a program that provides payments for early net carbon emission reductions (carbon sequestration credits). These same intermediaries could accept the payments for nutrient source reductions attributed to tree planting and receive timber establishment cost share. The intermediaries assume the responsibility for the retention and management of the forest cover and the carbon and nutrient accounts. Some share of the carbon payments might be transferred to the landowner who sells the harvest rights to the intermediary. The division of the income from all sources that results in the amount paid to the landowner would be negotiated as part of the contract between the landowner and the firm or the NGO. Intermediaries are central to the success of this program because they will have

[71] For example, a Nature Conservancy program in the Clinch Valley of Virginia has this exact same relationship with landowners (Nature Conservancy, 1998).

low contracting costs with landowners, energy companies and industrial and other sources of nutrient loads.

6C. Budget Costs

Federal taxpayers are currently responsible for the full financial cost of any pump project. Costs are likely to exceed $150 million for pump construction and there will be added costs for operation, maintenance and mitigation. Pending release of a final report, costs for a plan that includes a pump can not be reported here. The financial responsibility for the nonstructural plan and resulting actions might also be a federal responsibility, however the budget cost will be well below the cost of the pump.[72]

The federal budget costs for easements to increase reforestation actions ***above*** the expected trend under WRP described by the Fish and Wildlife Service will depend on how many acres are reforested, the design of the incentive program and the development of markets for the services of reforestation such as hunting leases and carbon sequestration. First, assume that the full payment for the reforestation would be from the federal government and that the additional number of acres to be reforested is 40,000.[73] If easement payments were a full federal responsibility, the added budget cost for reforestation in the case study area would be $26 million, at $650 per acre. However, to the extent that other sources of payment are secured and that landowners bid in for supplemental payments this upper bound on cost will be reduced, perhaps by a significant amount.

The income assurance program would have a present value cost of $11.5 million. This is the present value of the maximum flood damages estimated for the eligible area (the area above the 2-year flood event), although a somewhat larger amount of damages may be possible. However, because this estimate does not account for the fact that this program replaces payouts from existing disaster aid and crop insurance programs, the net cost to the treasury may be less.

The direct costs to the federal government for the easement payment program plus income assurance programs will be around $37 million, using the estimates made for this study. It is not possible to predict the costs that would be incurred in planning the program and administering the incentives plan. Creating and administering new institutions will not be costless. However, because the $37 million is likely to be a high budget cost estimate for these programs, administrative costs will not be considered further and we assume total costs of $37 million for the two actions.

The remaining cost that has not been reported here is for flood protection for structures, catfish ponds, roads and infrastructure that might be susceptible to flood risk.

[72] We argue in this report that the national economy as measured by NED may be worse off if a pump is built and the economy will be better off if the nonstructural plan is initiated. That NED argument is independent of the budget analysis in this section.

[73] The 40,000 acres is the approximate difference between the FWS projection of the without action (WRP only) reforestation and the 88,000 acres analyzed in the watershed action scenario.

A program modeled after the new Challenge 21 program authorized in WRDA 1999 could be implemented after development by the interagency team. The amount that might be spent on such a program can not be calculated at this time. However, some perspective on the budget exposure can be offered. From one perspective, the average annual value of the expected damages to properties in the watershed (according to Corps estimates reported in Section 3) is $1.2 million. At the discount rate of 6 7/8%, this is a present value cost is about $17 million. If spending on relocation and local protection went forward to the point where total expenditures were equal to the damages now incurred ($17 million) this amount plus the $37 million for the other program in the scenario would be less than ½ of the pump costs. For another perspective on cost, the Corps reports that there are 1544 structures in the 100 year flood plain. The total market value of those structures was less than $40 million. This means that the market value all of the property in the watershed plus the cost of the insurance program and easement programs approximately ¾ the cost of a pump.

6D. Moving Forward

Positive national economic development (NED) benefits are expected from implementation of nonstructural actions in the Yazoo study area. Included in the NED analysis are benefits for carbon sequestration and nutrient load reduction. Without these benefit categories NED is negative. However, nonstructural actions also were justified by documenting that significant environmental results are secured for a modest cost to the nation. While nonstructural actions may be warranted, agricultural flood protection benefits for a pump project appear insufficient to justify costs. Also, if the problems and opportunities of the watershed area are to be addressed with federal funds, nonstructural actions can be implemented for budget cost significantly lower than the cost for a pump.

The report concludes that the calculation of economic returns from continued agricultural production on frequently flooded land is critical to an analysis of both structural and nonstructural actions. Therefore, the logic and databases used to calculate agricultural returns under the new protocol and by the Corps in its pump evaluation should be reviewed by the Office of Management and Budget.

The report also concludes that a federal interagency committee should be chartered to refine the proposed evaluation protocol for NED and environmental analysis and to employ the procedures to establish a reforestation/restoration target for the Yazoo backwater area. As part of its work the interagency committee should design an implementation plan to provide incentives for voluntary adoption of reforestation actions for the watershed, to provide farm income assurance and to secure justified local protection and relocation for properties at risk. The implementation plan would involve linkages with state, non-governmental organizations (NGOs) and private sector participants.

Appendix A: Crop Budgets

Table A-1 Cotton Budget

Table 2.A Estimated costs per acre
Solid cotton, silty clay soil, 8-row equipment
Delta Area, Mississippi, 1998

ITEM	UNIT	PRICE	QUANTITY	AMOUNT	YOUR FARM
		dollars		dollars	
DIRECT EXPENSES					
CUSTOM SPRAY					
App by Air (2 gal)	appl	2.20	7.0000	15.40	
App by Air (5 gal)	appl	3.20	2.0000	6.40	
HARVEST AIDS					
Dropp 50 WP	lb	52.92	0.1260	6.67	
Prep	pt	5.91	1.3300	7.86	
Def 6	pt	5.13	1.3300	6.82	
GIN/DRY					
Gin	lb	0.08	725.0000	58.00	
FERTILIZERS					
Potash (60% K2O)	cwt	7.27	2.0000	14.54	
UAN (32% N)	cwt	6.93	4.7000	32.57	
FUNGICIDES					
Fungicide	lb	2.03	8.0000	16.24	
HERBICIDES					
Treflan EC	pt	3.73	2.0000	7.46	
Cotoran 4L	pt	4.39	1.5000	6.58	
Cotoran + MSMA	pt	3.01	1.6000	4.82	
Fusilade DX	oz	0.90	5.0000	4.50	
Bladex 4L	qt	6.71	0.7500	5.03	
INSECTICIDES					
Temik 15G	lb	3.14	4.0000	12.56	
Bidrin 8E	oz	0.67	16.0000	10.72	
Methyl Parathion 4E	pt	3.42	1.5000	5.13	
Synthetic Pyrethroid	oz	1.84	12.5000	23.00	
Ovicide	oz	0.40	15.0000	6.00	
Curacron 8E	pt	12.31	0.5000	6.16	
Tracer	oz	5.64	9.0000	50.76	
Carbamate	oz	0.40	24.0000	9.60	
SEED/PLANTS					
Cotton Seed	lb	0.92	15.0000	13.80	
GROWTH REGULATORS					
Pix	oz	0.75	8.0000	6.00	
SERVICE FEE					
Insect Scouting	acre	6.00	1.0000	6.00	
ADJUVANTS					
Surfactant	pt	0.86	0.1000	0.09	
CUSTOM HARVEST/HAUL					
Haul Cotton	lb	0.02	725.0000	14.50	
OPERATOR LABOR					
Tractors	hour	7.87	1.5855	12.48	
Self-Propelled Eq.	hour	7.87	0.5022	3.95	
HAND LABOR					
Implements	hour	6.56	0.5988	3.93	
Labor (Weed Control)	hour	6.56	1.0000	6.56	
UNALLOCATED LABOR	hour	7.87	1.6702	13.14	
DIESEL FUEL					
Tractors	gal	0.76	13.4832	10.25	
Self-Propelled Eq.	gal	0.76	2.1374	1.62	
REPAIR & MAINTENANCE					
Implements	acre	8.58	1.0000	8.58	
Tractors	acre	9.00	1.0000	9.00	
Self-Propelled Eq.	acre	17.74	1.0000	17.74	
INTEREST ON OP. CAP.	acre	13.87	1.0000	13.87	
TOTAL DIRECT EXPENSES				458.34	
FIXED EXPENSES					
Implements	acre	20.60	1.0000	20.60	
Tractors	acre	27.50	1.0000	27.50	
Self-Propelled Eq.	acre	34.98	1.0000	34.98	
TOTAL FIXED EXPENSES				83.08	
TOTAL SPECIFIED EXPENSES				541.42	

Note: Cost of production estimates are based on last year's input prices.
Fertilization decisions should be based on soil tests.

(MAFES, 1998)

Table A-2: Soybean Budget

Table 8.A Estimated costs per acre
Soybeans, clay soil, 12-row 20" equipment
Delta Area, Mississippi, 1998

ITEM	UNIT	PRICE	QUANTITY	AMOUNT	YOUR FARM
		dollars		dollars	
DIRECT EXPENSES					
CUSTOM SPRAY					
App by Air (3 gal)	appl	2.60	0.1000	0.26	________
FERTILIZERS					
Phosphorus(46% P2O5)	cwt	11.24	0.6600	7.42	________
Potash (60% K2O)	cwt	7.27	1.0000	7.27	________
FUNGICIDES					
Apron XL	oz	9.02	0.0640	0.58	________
HERBICIDES					
Treflan EC	pt	3.73	2.0000	7.46	________
Scepter 70 DG	oz	6.05	2.8600	17.30	________
Storm	pt	8.46	1.5000	12.69	________
Fusilade DX	oz	0.90	1.2000	1.08	________
INSECTICIDES					
Larvin 3.2	oz	0.40	1.8000	0.72	________
SEED/PLANTS					
Soybean Seed Private	lb	0.32	40.0000	12.80	________
ADJUVANTS					
Surfactant	pt	0.86	0.5000	0.43	________
Crop Oil (Petroleum)	pt	0.73	0.2000	0.15	________
CUSTOM HARVEST/HAUL					
Haul Soybeans	bu	0.16	30.0000	4.80	________
OPERATOR LABOR					
Tractors	hour	7.87	0.5510	4.34	________
Self-Propelled Eq.	hour	7.87	0.1220	0.96	________
HAND LABOR					
Implements	hour	6.56	0.2645	1.74	________
UNALLOCATED LABOR	hour	7.87	0.6057	4.77	________
DIESEL FUEL					
Tractors	gal	0.76	5.1829	3.94	________
Self-Propelled Eq.	gal	0.76	0.6954	0.53	________
REPAIR & MAINTENANCE					
Implements	acre	4.18	1.0000	4.18	________
Tractors	acre	3.37	1.0000	3.37	________
Self-Propelled Eq.	acre	6.16	1.0000	6.16	________
INTEREST ON OP. CAP.	acre	4.30	1.0000	4.30	________
TOTAL DIRECT EXPENSES				107.23	________
FIXED EXPENSES					
Implements	acre	9.03	1.0000	9.03	________
Tractors	acre	10.28	1.0000	10.28	________
Self-Propelled Eq.	acre	12.18	1.0000	12.18	________
TOTAL FIXED EXPENSES				31.49	________
TOTAL SPECIFIED EXPENSES				138.72	________

Note: Cost of production estimates are based on last year's input prices.
Fertilization decisions should be based on soil tests.

(MAFES, 1998)

Table A-3: Corn Budget

Table 13.A Estimated costs per acre
Corn, nonirrigated, 8-row 40" eq. 100 bu yield goal
Delta Area, Mississippi, 1998

ITEM	UNIT	PRICE	QUANTITY	AMOUNT	YOUR FARM
		dollars		dollars	
DIRECT EXPENSES					
FERTILIZERS					
Phosphorus(46% P2O5)	cwt	11.24	0.7600	8.54	
Potash (60% K2O)	cwt	7.27	0.5800	4.22	
UAN (32% N)	cwt	6.93	4.6875	32.48	
HERBICIDES					
Atrazine 4L	pt	1.29	4.0000	5.16	
Dual 8E	pt	7.77	2.0000	15.54	
Accent SP	oz	27.17	0.1670	4.54	
INSECTICIDES					
Lorsban 15G	lb	1.78	6.9000	12.28	
SEED/PLANTS					
Corn Seed	thous	0.97	22.0000	21.34	
CUSTOM FERT/LIME					
Lime (Spread)	ton	26.73	0.3750	10.02	
Apply Liquid Fert	acre	2.50	2.0000	5.00	
CUSTOM HARVEST/HAUL					
Haul Corn	bu	0.16	100.0000	16.00	
OPERATOR LABOR					
Tractors	hour	7.87	1.0050	7.91	
Self-Propelled Eq.	hour	7.87	0.2410	1.90	
HAND LABOR					
Implements	hour	6.56	0.1935	1.27	
UNALLOCATED LABOR	hour	7.87	1.1214	8.83	
DIESEL FUEL					
Tractors	gal	0.76	9.3306	7.09	
Self-Propelled Eq.	gal	0.76	1.3737	1.04	
REPAIR & MAINTENANCE					
Implements	acre	5.31	1.0000	5.31	
Tractors	acre	6.08	1.0000	6.08	
Self-Propelled Eq.	acre	12.22	1.0000	12.22	
INTEREST ON OP. CAP.	acre	9.45	1.0000	9.45	
TOTAL DIRECT EXPENSES				196.21	
FIXED EXPENSES					
Implements	acre	11.25	1.0000	11.25	
Tractors	acre	18.57	1.0000	18.57	
Self-Propelled Eq.	acre	24.15	1.0000	24.15	
TOTAL FIXED EXPENSES				53.98	
TOTAL SPECIFIED EXPENSES				250.19	

Note: Cost of production estimates are based on last year's input prices.
Fertilization decisions should be based on soil tests.

(MAFES, 1998)

Table A-4: Wheat Budget

Table 15.A Estimated costs per acre
Wheat followed by soybeans, 50 bu yield goal
Delta Area, Mississippi, 1998

ITEM	UNIT	PRICE	QUANTITY	AMOUNT	YOUR FARM
		dollars		dollars	
DIRECT EXPENSES					
CUSTOM SPRAY					
App by Air (5 gal)	appl	3.20	1.0000	3.20	
FERTILIZERS					
Phosphorus(46% P2O5)	cwt	11.24	0.6600	7.42	
Potash (60% K2O)	cwt	7.27	0.5000	3.64	
Urea, Solid (46% N)	cwt	11.65	2.6000	30.29	
HERBICIDES					
Harmony Extra	oz	12.14	0.6000	7.28	
SEED/PLANTS					
Wheat Seed Private	lb	0.22	90.0000	19.80	
ADJUVANTS					
Surfactant	pt	0.86	0.1000	0.09	
CUSTOM FERT/LIME					
App Fert by Air	cwt	4.10	2.6000	10.66	
CUSTOM HARVEST/HAUL					
Haul Wheat	bu	0.14	50.0000	7.00	
OPERATOR LABOR					
Tractors	hour	7.87	0.2980	2.35	
Self-Propelled Eq.	hour	7.87	0.0980	0.77	
HAND LABOR					
Implements	hour	6.56	0.1940	1.27	
UNALLOCATED LABOR	hour	7.87	0.3168	2.49	
DIESEL FUEL					
Tractors	gal	0.76	2.9144	2.21	
Self-Propelled Eq.	gal	0.76	0.5586	0.42	
REPAIR & MAINTENANCE					
Implements	acre	3.19	1.0000	3.19	
Tractors	acre	1.87	1.0000	1.87	
Self-Propelled Eq.	acre	4.87	1.0000	4.87	
INTEREST ON OP. CAP.	acre	5.16	1.0000	5.16	
TOTAL DIRECT EXPENSES				113.98	
FIXED EXPENSES					
Implements	acre	6.78	1.0000	6.78	
Tractors	acre	5.72	1.0000	5.72	
Self-Propelled Eq.	acre	9.62	1.0000	9.62	
TOTAL FIXED EXPENSES				22.12	
TOTAL SPECIFIED EXPENSES				136.11	

Note: Cost of production estimates are based on last year's input prices.
Fertilization decisions should be based on soil tests.
Apply 30 lbs of nitrogen prior to field cultivation to wheat following any crop except soybeans or fallow.

(MAFES, 1998)

Table A-5: Sorghum Budget

Table 14.A Estimated costs per acre
Grain sorghum, 12-row 20" eq, 70 bu yield goal
All Areas, Mississippi, 1998

ITEM	UNIT	PRICE	QUANTITY	AMOUNT	YOUR FARM
		dollars		dollars	
DIRECT EXPENSES					
FERTILIZERS					
Amm Nitrate (34% N)	cwt	10.07	3.5000	35.25	______
Phosphorus(46% P2O5)	cwt	11.24	0.7600	8.54	______
Potash (60% K2O)	cwt	7.27	0.5800	4.22	______
HERBICIDES					
Bicep	qt	7.89	3.0000	23.67	______
SEED/PLANTS					
Grain Sorghum Seed	lb	0.95	6.0000	5.70	______
CUSTOM FERT/LIME					
Lime (Spread)	ton	26.73	0.2500	6.68	______
CUSTOM HARVEST/HAUL					
Haul Sorghum	bu	0.16	70.0000	11.20	______
OPERATOR LABOR					
Tractors	hour	7.87	0.6000	4.72	______
Self-Propelled Eq.	hour	7.87	0.1410	1.11	______
HAND LABOR					
Implements	hour	6.56	0.1980	1.30	______
UNALLOCATED LABOR	hour	7.87	0.6669	5.25	______
DIESEL FUEL					
Tractors	gal	0.76	5.8680	4.46	______
Self-Propelled Eq.	gal	0.76	0.8037	0.61	______
REPAIR & MAINTENANCE					
Implements	acre	3.71	1.0000	3.71	______
Tractors	acre	3.77	1.0000	3.77	______
Self-Propelled Eq.	acre	6.94	1.0000	6.94	______
INTEREST ON OP. CAP.	acre	4.49	1.0000	4.49	______
TOTAL DIRECT EXPENSES				131.62	______
FIXED EXPENSES					
Implements	acre	8.67	1.0000	8.67	______
Tractors	acre	11.52	1.0000	11.52	______
Self-Propelled Eq.	acre	13.72	1.0000	13.72	______
TOTAL FIXED EXPENSES				33.91	______
TOTAL SPECIFIED EXPENSES				165.53	______

Note: Cost of production estimates are based on last year's input prices.
Fertilization decisions should be based on soil tests.

(MAFES, 1998)

Table A-6: Rice Budget

Table 16.A Estimated costs per acre
Contour Levee Rice
Delta Area, Mississippi, Mississippi, 1998

ITEM	UNIT	PRICE	QUANTITY	AMOUNT	YOUR FARM
		dollars		dollars	
DIRECT EXPENSES					
CUSTOM SPRAY					
App by Air (10 gal)	appl	5.10	2.0000	10.20	________
App Ordram by Air	appl	4.00	0.5000	2.00	________
App by Air (3 gal)	appl	2.40	1.0000	2.40	________
GIN/DRY					
Dry Rice	bu	0.40	125.0000	50.00	________
FERTILIZERS					
Urea, Solid (46% N)	cwt	11.65	4.0000	46.60	________
HERBICIDES					
Propanil 4E	qt	4.20	8.0000	33.60	________
Ordram 15-G	lb	1.07	13.5000	14.45	________
Grandstand	qt	19.36	0.5000	9.68	________
IRRIGATION SUPPLIES					
Rice Gates	each	2.50	0.3000	0.75	________
SEED/PLANTS					
Rice Seed	lb	0.20	105.0000	21.00	________
CUSTOM FERT/LIME					
App Fert by Air	cwt	4.10	4.0000	16.40	________
CUSTOM HARVEST/HAUL					
Haul Rice	bu	0.10	125.0000	12.50	________
OPERATOR LABOR					
Tractors	hour	7.87	1.2562	9.89	________
Self-Propelled Eq.	hour	7.87	0.2410	1.90	________
Labor (Rice Mgt.)	hour	7.87	1.5000	11.81	________
HAND LABOR					
Implements	hour	6.56	0.1140	0.75	________
Labor (Hnd. & Stor.)	hour	6.56	0.2500	1.64	________
IRRIGATION LABOR					
Irrigate (Rice)	hour	6.56	0.1868	1.23	________
Labor (Drain)	hour	6.56	0.1000	0.66	________
Labor (Flood)	hour	6.56	0.1500	0.98	________
Labor (Inst. Gates)	hour	6.56	0.1000	0.66	________
UNALLOCATED LABOR	hour	7.87	2.6975	21.23	________
DIESEL FUEL					
Tractors	gal	0.76	11.7837	8.96	________
Self-Propelled Eq.	gal	0.76	1.4039	1.07	________
Irrigate (Rice)	gal	0.76	24.1230	18.33	________
REPAIR & MAINTENANCE					
Implements	acre	6.20	1.0000	6.20	________
Tractors	acre	7.60	1.0000	7.60	________
Self-Propelled Eq.	acre	12.59	1.0000	12.59	________
Irrigate (Rice)	acre	9.57	1.0000	9.57	________
INTEREST ON OP. CAP.	acre	10.49	1.0000	10.49	________

TOTAL DIRECT EXPENSES				345.30	________
FIXED EXPENSES					
Implements	acre	16.71	1.0000	16.71	________
Tractors	acre	23.08	1.0000	23.08	________
Self-Propelled Eq.	acre	25.00	1.0000	25.00	________
Irrigate (Rice)	acre	21.78	1.0000	21.78	________

TOTAL FIXED EXPENSES				86.57	________

TOTAL SPECIFIED EXPENSES				431.87	________

Note: Cost of production estimates are based on last year's input prices.
Fertilization decisions should be based on soil tests.

(MAFES, 1998)

Table A-7: Pasture Budget

Budgets were not available for pasture; therefore, production practices and costs for the maintenance of pastureland were taken from “Table 2. Estimated Cost and Net returns per acre Common Bermuda pasture maintenance, typical management practices” included in the Data Supplement to Crop Budgets and Flood Damage Loss Component Documentation prepared for the Vicksburg Corps of Engineers District, February, 1979. Revenues and production costs included in the pasture budget were adjusted to 1997 dollars using the average annual indexes of prices paid and prices received by producers of feed grains and hay provided by the National Agricultural Statistical Service, USDA.

Appendix B: Flooding parameter for Forestry and Agricultural Modules[74]

Table B-1 Julian Dates of Earliest, Latest and Most Frequent Final Planting Date for Spring Crops and Winter Wheat: Elevation Ranges One-Four

	Elevation Range One		Elevation Range Two		Elevation Range Three		Elevation Range Four	
	Spring Crops*	Wheat	Spring Crops*	Wheat	Spring Crops*	Wheat	Spring Crops*	Wheat
Dayslate parameter : Julian date of earliest possible "final planting"	69	11	69	11	69	11	69	11
Dayslate parameter: Julian date of latest possible "final planting"	205	312	193	312	184	312	177	299
Dayslate parameter: Julian date of most frequent "final planting"	70	12	70	12	70	12	70	12
Reach 2 - Dayslate parameter : Julian date of earliest possible "final planting"	69	11	69	11	69	11	69	11
Reach 2 -Dayslate parameter: Julian date of latest possible "final planting"	204	312	191	312	183	304	175	298
Reach 2 -Dayslate parameter: Julian date of most frequent "final planting"	70	12	70	12	70	12	70	12

*Spring crops include soybeans, cotton, corn, rice and sorghum

[74] Note: In the per acre analysis, net returns were calculated for lands between the 2-year and 3-year event. The flooding parameters for this range are reported in the column labeled elevation range three. In the final analysis, however, all land between the 2- year and 5-year event was consolidated into a single elevation range. This new, larger elevation range is the elevation range three that is referred to in the text of the document. By consolidating elevation range three, the column of per acre returns reported for elevation range three in the tables below became unnecessary and was not used in the final analysis. Instead, the per acre returns reported in the table below for elevation range four, were in fact applied to land in the new, consolidated elevation range three. This means that the labeling of the columns of per acre returns reported below indicate an elevation range that is one higher than the actual elevation range that the per acre returns are applied to. The per acre net returns reported in the column labeled elevation range eight, apply to both the actual elevation range seven and the actual elevation range eight.

Table B-2 Julian Dates of Earliest, Latest and Most Frequent Final Planting Date for Spring Crops and Winter Wheat: Elevation Ranges Five-Eight

	Elevation Range Five		Elevation Range Six		Elevation Range Seven		Elevation Range Eight	
	Spring Crops*	Wheat	Spring Crops*	Wheat	Spring Crops*	Wheat	Spring Crops*	Wheat
Dayslate parameter : Julian date of earliest possible "final planting"	69	11	69	11	69	11	69	11
Dayslate parameter: Julian date of latest possible "final planting"	172	294	163	285	71	13	71	13
Dayslate parameter: Julian date of most frequent "final planting"	70	12	70	12	70	12	70	12
Reach 2 - Dayslate parameter : Julian date of earliest possible "final planting"	69	11	69	11	69	11	69	11
Reach 2 -Dayslate parameter: Julian date of latest possible "final planting"	170	292	160	284	71	13	71	13
Reach 2 -Dayslate parameter: Julian date of most frequent "final planting"	70	12	70	12	70	12	70	12

*Spring crops include soybeans, cotton, corn, rice and sorghum

Table B-3 Annual Probabilities of Replanting by Crop Type

	Soybeans	Cotton	Rice	Sorg	Wheat	Corn
Elevation Range One						
ProbReplant parameter: Annual probability of a replant Reach 1	10%	18%	22%	8%	0%	48%
ProbReplant parameter: Annual probability of a replant Reaches 2-4	12%	18%	26%	10%	0%	48%
Elevation Range Two						
ProbReplant parameter: Annual probability of a replant	6%	6%	10%	6%	0%	24%
ProbReplant parameter: Annual probability of a replant Reaches 2-4	6%	8%	14%	6%	0%	22%
Elevation Range Three						
ProbReplant parameter: Annual probability of a replant Reach 1	2%	6%	6%	2%	0%	14%
ProbReplant parameter: Annual probability of a replant Reaches 2-4	6%	8%	8%	0%	0%	14%
Elevation Range Four						
ProbReplant parameter: Annual probability of a replant Reach 1	4%	6%	6%	2%	0%	12%
ProbReplant parameter: Annual probability of a replant Reaches 2-4	6%	8%	10%	4%	0%	14%
Elevation Range Five						
ProbReplant parameter: Annual probability of a replant Reach 1	2%	8%	8%	2%	0%	6%
ProbReplant parameter: Annual probability of a replant Reaches 2-4	2%	8%	8%	2%	0%	6%
Elevation Range Six						
ProbReplant parameter: Annual probability of a replant Reach 1	0%	2%	2%	0%	0%	2%
ProbReplant parameter: Annual probability of a replant Reaches 2-4	0%	2%	2%	0%	0%	2%
Elevation Range Seven						
ProbReplant parameter: Annual probability of a replant Reach 1	2%	2%	2%	0%	0%	2%
ProbReplant parameter: Annual probability of a replant Reaches 2-4	2%	2%	2%	0%	0%	2%
Elevation Range Eight						
ProbReplant parameter: Annual probability of a replant Reach 1	0%	0%	0%	0%	0%	0%
ProbReplant parameter: Annual probability of a replant Reaches 2-4	0%	0%	0%	0%	0%	0%

Table B-4 Annual Probabilities that Depth will be Exceeded for Critical Duration

Elevation Range One	*2ft*	*3ft*	*4ft*	*5ft*	*6ft*	*7ft*	*8ft*	*9ft*	*10ft*	*11ft*	*12ft*
DEPTH-DURATION parameter: Reach 1	52.00%	42.00%	34.00%	26.00%	22.00%	16.00%	16.00%	10.00%	2.00%	2.00%	2.00%
DEPTH-DURATION parameter: Reaches 2-4	42.00%	38.00%	32.00%	22.00%	18.00%	16.00%	10.00%	6.00%	2.00%	2.00%	0.00%
Elevation Range Two	*2ft*	*3ft*	*4ft*	*5ft*	*6ft*	*7ft*	*8ft*	*9ft*	*10ft*	*11ft*	*12ft*
DEPTH-DURATION parameter: Reach 1	22.00%	16.00%	16.00%	10.00%	2.00%	2.00%	2.00%	0.00%	0.00%	0.00%	0.00%
DEPTH-DURATION parameter: Reaches 2-4	18.00%	15.70%	10.00%	6.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Elevation Range Three	*2ft*	*3ft*	*4ft*	*5ft*	*6ft*	*7ft*	*8ft*	*9ft*	*10ft*	*11ft*	*12ft*
DEPTH-DURATION parameter: Reach 1	6.00%	2.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
DEPTH-DURATION parameter: Reaches 2-4	2.00%	2.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Elevation Range Four	*2ft*	*3ft*	*4ft*	*5ft*	*6ft*	*7ft*	*8ft*	*9ft*	*10ft*	*11ft*	*12ft*
DEPTH-DURATION parameter: Reach 1	2.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
DEPTH-DURATION parameter: Reaches 2-4	2.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Elevation Range Five	*2ft*	*3ft*	*4ft*	*5ft*	*6ft*	*7ft*	*8ft*	*9ft*	*10ft*	*11ft*	*12ft*
DEPTH-DURATION parameter: Reach 1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
DEPTH-DURATION parameter: Reaches 2-4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Elevation Range Six	*2ft*	*3ft*	*4ft*	*5ft*	*6ft*	*7ft*	*8ft*	*9ft*	*10ft*	*11ft*	*12ft*
DEPTH-DURATION parameter: Reach 1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
DEPTH-DURATION parameter: Reaches 2-4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Elevation Range Seven	*2ft*	*3ft*	*4ft*	*5ft*	*6ft*	*7ft*	*8ft*	*9ft*	*10ft*	*11ft*	*12ft*
DEPTH-DURATION parameter: Reach 1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
DEPTH-DURATION parameter: Reaches 2-4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Elevation Range Eight	*2ft*	*3ft*	*4ft*	*5ft*	*6ft*	*7ft*	*8ft*	*9ft*	*10ft*	*11ft*	*12ft*
DEPTH-DURATION parameter: Reach 1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
DEPTH-DURATION parameter: Reaches 2-4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Appendix C: Forestry Regimes and Production Costs

Table C-1: Sycamore and Sweetgum Production Costs (in 1997 dollars)

Year	*Activity*	*Cost Per Activity*	*Total Cost per Acre*
Zero	Light Site Prep		$10.16
	Subsoiler - one pass		
	Fuel @ $0.84/ac.	$0.84	
	Repair and Maintenance @ $1.13/ac.	$1.13	
	Labor @ $1.69/ac.	$1.69	
	Interest on Operating Capital @ $0.34/ac.	$0.34	
	Disk Harrow - two passes		
	Fuel @ $1.16/ac.	$1.16	
	Repair and Maintenance @ $2.14/ac.	$2.14	
	Labor @ $2.34/ac.	$2.34	
	Interest on Operating Capital @ $0.52/ac.	$0.52	
One	Disk Harrow - two passes		$121.06
	Fuel @ $1.16/ac.	$1.16	
	Repair and Maintenance @ $2.14/ac.	$2.14	
	Labor @ $2.34/ac.	$2.34	
	Interest on Operating Capital @ $0.52/ac.	$0.52	
	Planting		
	Hand Planting Seedlings (12’x12’ stocking)		
	Labor @ $50/ac.	$50.00	
	Equipment @ $1.81/ac.	$1.81	
	Supervision @ $2.29/ac.	$2.29	
	Seedlings @ $60.80/ac. ($0.20/seedling)	$60.80	
Two	Cultivation		$2.32
	Fuel @ $0.45	$0.45	
	Repair and Maintenance @ $0.87	$0.87	
	Labor @ $0.90	$0.90	
	Interest on Operating Capital @$0.10	$0.10	
Rotation Age	Harvest		$0.00
	Stand is harvested. Stumpage prices account for harvest costs.	$0.00	

Table C-2: Green Ash Production Costs (in 1997 dollars)

Year	*Activity*	*Cost Per Activity*	*Total Cost per Acre*
Zero	Light Site Prep		$10.16
	Subsoiler - one pass		
	Fuel @ $0.84/ac.	$0.84	
	Repair and Maintenance @ $1.13/ac.	$1.13	
	Labor @ $1.69/ac.	$1.69	
	Interest on Operating Capital @ $0.34/ac.	$0.34	
	Disk Harrow - two passes		
	Fuel @ $1.16/ac.	$1.16	
	Repair and Maintenance @ $2.14/ac.	$2.14	
	Labor @ $2.34/ac.	$2.34	
	Interest on Operating Capital @ $0.52/ac.	$0.52	
One	Disk Harrow - two passes		$121.06
	Fuel @ $1.16/ac.	$1.16	
	Repair and Maintenance @ $2.14/ac.	$2.14	
	Labor @ $2.34/ac.	$2.34	
	Interest on Operating Capital @ $0.52/ac.	$0.52	
	Planting		
	Hand Planting Seedlings (12'x12' stocking)		
	Labor @ $50/ac.	$50.00	
	Equipment @ $1.81/ac.	$1.81	
	Supervision @ $2.29/ac.	$2.29	
	Seedlings @ $60.80/ac. ($0.20/seedling)	$60.80	
Two	Cultivation		$2.32
	Fuel @ $0.45	$0.45	
	Repair and Maintenance @ $0.87	$0.87	
	Labor @ $0.90	$0.90	
	Interest on Operating Capital @$0.10	$0.10	
Rotation Age	Harvest		$0.00
	Stand is harvested. Stumpage prices account for harvest costs.	$0.00	

Table C-3: Nuttall Oak, Cherrybark Oak and Bald Cypress Production

Costs (in 1997 dollars)

Year	*Activity*	*Cost Per Activity*	*Total Cost per Acre*
Zero	<u>Light Site Prep</u>		$10.16
	Subsoiler - one pass		
	Fuel @ $0.84/ac.	$0.84	
	Repair and Maintenance @ $1.13/ac.	$1.13	
	Labor @ $1.69/ac.	$1.69	
	Interest on Operating Capital @ $0.34/ac.	$0.34	
	Disk Harrow - two passes		
	Fuel @ $1.16/ac.	$1.16	
	Repair and Maintenance @ $2.14/ac.	$2.14	
	Labor @ $2.34/ac.	$2.34	
	Interest on Operating Capital @ $0.52/ac.	$0.52	
One	Disk Harrow - two passes		$121.06
	Fuel @ $1.16/ac.	$1.16	
	Repair and Maintenance @ $2.14/ac.	$2.14	
	Labor @ $2.34/ac.	$2.34	
	Interest on Operating Capital @ $0.52/ac.	$0.52	
	<u>Planting</u>		
	Hand Planting Seedlings (12'x12' stocking)		
	Labor @ $50/ac.	$50.00	
	Equipment @ $1.81/ac.	$1.81	
	Supervision @ $2.29/ac.	$2.29	
	Seedlings @ $60.80/ac. ($0.20/seedling)	$60.80	
Two	Disk Harrow - two passes		$6.16
	Fuel @ $1.16/ac.	$1.16	
	Repair and Maintenance @ $2.14/ac.	$2.14	
	Labor @ $2.34/ac.	$2.34	
	Interest on Operating Capital @ $0.52/ac.	$0.52	
Thirty	<u>Thinning</u> 20% of total volume at year 30 is harvested and sold at pulpwood stumpage prices. Costs of thinning accounted for in stumpage price.	$0.00	$0.00
Rotation Age	Stand is harvested. Stumpage prices account for harvest costs.	$0.00	$0.00

Table C-4: Cottonwood Production Costs (in 1997 dollars)

Year	*Activity*	*Cost Per Activity*	*Total Cost per Acre*
Zero	Light Site Prep		$10.16
	Subsoiler - one pass		
	Fuel @ $0.84/ac.	$0.84	
	Repair and Maintenance @ $1.13/ac.	$1.13	
	Labor @ $1.69/ac.	$1.69	
	Interest on Operating Capital @ $0.34/ac.	$0.34	
	Disk Harrow - two passes		
	Fuel @ $1.16/ac.	$1.16	
	Repair and Maintenance @ $2.14/ac.	$2.14	
	Labor @ $2.34/ac.	$2.34	
	Interest on Operating Capital @ $0.52/ac.	$0.52	
One	Cultivation		$80.07
	Fuel @ $0.45	$0.45	
	Repair and Maintenance @ $0.87	$0.87	
	Labor @ $0.90	$0.90	
	Interest on Operating Capital @$0.10	$0.10	
	Planting		
	Hand Planting Seedlings (12'x12' stocking)		
	Labor @ $16.95/ac.	$16.95	
	Seedlings @ $60.80/ac. ($0.20/seedling)	$60.80	
Two	Cultivation		$8.48
	Fuel @ $0.45	$0.45	
	Repair and Maintenance @ $0.87	$0.87	
	Labor @ $0.90	$0.90	
	Interest on Operating Capital @$0.10	$0.10	
	Disk Harrow - two passes		
	Fuel @ $1.16/ac.	$1.16	
	Repair and Maintenance @ $2.14/ac.	$2.14	
	Labor @ $2.34/ac.	$2.34	
	Interest on Operating Capital @ $0.52/ac.	$0.52	
Ten			$0.00
	Stand is harvested. Stumpage prices account for harvest costs.	$0.00	
Twelve	Disking		$6.16
	Disk Harrow - two passes		
	Fuel @ $1.16/ac.	$1.16	
	Repair and Maintenance @ $2.14/ac.	$2.14	
	Labor @ $2.34/ac.	$2.34	
	Interest on Operating Capital @ $0.52/ac.	$0.52	

Table C-4: Cottonwood Production Costs (in 1997 dollars) (CONTINUED)

Twenty	Harvest - Stand is harvested. Stumpage prices account for harvest costs.	$0.00	$0.00

Table C-5: Cottonwood – Oak Production Costs (in 1997 dollars)

Year	*Activity*	*Cost Per Activity*	*Total Cost per Acre*
Zero	Light Site Prep		$10.16
	Subsoiler - one pass		
	Fuel @ $0.84/ac.	$0.84	
	Repair and Maintenance @ $1.13/ac.	$1.13	
	Labor @ $1.69/ac.	$1.69	
	Interest on Operating Capital @ $0.34/ac.	$0.34	
	Disk Harrow - two passes		
	Fuel @ $1.16/ac.	$1.16	
	Repair and Maintenance @ $2.14/ac.	$2.14	
	Labor @ $2.34/ac.	$2.34	
	Interest on Operating Capital @ $0.52/ac.	$0.52	
One	Cultivation		$80.07
	Fuel @ $0.45	$0.45	
	Repair and Maintenance @ $0.87	$0.87	
	Labor @ $0.90	$0.90	
	Interest on Operating Capital @$0.10	$0.10	
	Planting		
	Hand Planting Seedlings (12'x12' stocking)		
	Labor @ $16.95/ac.	$16.95	
	Seedlings @ $60.80/ac. ($0.20/seedling)	$60.80	
Two	Cultivation		$8.48
	Fuel @ $0.45	$0.45	
	Repair and Maintenance @ $0.87	$0.87	
	Labor @ $0.90	$0.90	
	Interest on Operating Capital @$0.10	$0.10	
	Disk Harrow - two passes		
	Fuel @ $1.16/ac.	$1.16	
	Repair and Maintenance @ $2.14/ac.	$2.14	
	Labor @ $2.34/ac.	$2.34	
	Interest on Operating Capital @ $0.52/ac.	$0.52	

Table C-5: Cottonwood – Oak Production Costs (in 1997 dollars) (CONTINUED)

Three	<u>Planting</u>		$59.50
	Hand Planting Oak Seedlings		
	(12’x24’ stocking)		
	Labor @ $25/ac	$25.00	
	Equipment	$1.81	
	Supervision	$2.29	
	Seedlings @ $30.40/ac ($0.20/seedling)	$30.40	
Ten	Stand is harvested. Stumpage prices account for harvest costs.	$0.00	$0.00
Twelve	<u>Disking</u>		$6.16
	Disk Harrow - two passes		
	Fuel @ $1.16/ac.	$1.16	
	Repair and Maintenance @ $2.14/ac.	$2.14	
	Labor @ $2.34/ac.	$2.34	
	Interest on Operating Capital @ $0.52/ac.	$0.52	
Twenty	Harvest - Stand is harvested. Stumpage prices account for harvest costs.	$0.00	$0.00
Rotation Age	Stand is harvested. Stumpage prices account for harvest costs.	$0.00	$0.00

Appendix D: Agricultural and Forestry Net Returns[75]

Table D-1:NPV of Agricultural Returns per acre by Crop Type and Elevation Range – Reach One[76]

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
soy	$327.12	$365.86	$392.83	$387.10	$397.75	$404.60	$398.25	$404.60
cott	$43.15	$313.72	$328.15	$348.07	$316.08	$404.53	$404.33	$424.58
ric	$708.48	$928.20	$1,025.33	$1,020.06	$1,040.87	$1,106.84	$1,120.60	$1,130.70
sorg	-$242.15	-$216.44	-$185.38	-$186.42	-$183.73	-$174.76	-$174.76	-$174.76
wht	$77.94	$60.23	$71.63	$77.10	$73.42	$91.59	$690.61	$690.61
corn	-$599.87	-$233.71	-$92.48	-$56.86	-$3.26	$33.15	-$87.73	-$65.67

Table D-2 Annual Equivalent Value of Agricultural Returns per acre by Crop Type and Elevation Range – Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
soy	$22.91	$25.62	$27.51	$27.11	$27.85	$28.33	$27.89	$28.33
cott	$3.02	$21.97	$22.98	$24.37	$22.13	$28.33	$28.31	$29.73
ric	$49.61	$64.99	$71.79	$71.43	$72.88	$77.50	$78.47	$79.17
sorg	-$16.96	-$15.16	-$12.98	-$13.05	-$12.86	-$12.24	-$12.24	-$12.24
wht	$5.46	$4.22	$5.02	$5.40	$5.14	$6.41	$48.36	$48.36
corn	-$42.00	-$16.36	-$6.48	-$3.98	-$0.23	$2.32	-$6.14	-$4.60

[75] Note: In the per acre analysis, net returns were calculated for lands between the 2-year and 3-year event. These results are reported in the column labeled elevation range three. In the final analysis, however, all land between the 2- year and 5-year event was consolidated into a single elevation range. This new, larger elevation range is the elevation range three that is referred to in the text of the document. By consolidating elevation range three, the column of per acre returns reported for elevation range three in the tables below became unnecessary and was not used in the final analysis. Instead, the per acre returns reported in the table below for elevation range four, were in fact applied to land in the new, consolidated elevation range three. This means that the labeling of the columns of per acre returns reported below indicate an elevation range that is one higher than the actual elevation range that the per acre returns are applied to. The per acre net returns reported in the column labeled elevation range eight, apply to both the actual elevation range seven and the actual elevation range eight.

[76] At first glance, the net returns to corn may seem illogical because, in some cases, net returns are better at lower elevation ranges than they are at higher elevation ranges. This result occurs because, at lower elevation ranges, in most years, flooding prevents corn from being planted altogether and soybeans are planted as a substitute crop on corn land. Soybeans yield higher net returns per acre, therefore, the lower elevation ranges that, in many years are planted to soybeans instead of corn tend to realize higher NPV returns.

Table D-3:NPV of Agricultural Returns per acre by Crop Type and Elevation Range – Reaches Two-Four

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
soy	$318.89	$369.00	$379.77	$382.02	$396.62	$404.60	$398.01	$404.60
cott	$59.34	$283.31	$301.20	$331.39	$331.91	$405.10	$408.32	$424.58
ric	$694.67	$890.42	$997.96	$1,021.52	$1,058.61	$1,112.93	$1,118.98	$1,130.70
sorg	-$250.51	-$211.94	-$175.86	-$200.11	-$184.91	-$174.76	-$174.76	-$174.76
wht	$74.73	$77.81	$72.16	$93.05	$95.73	$94.16	$690.61	$690.61
corn	-$584.08	-$198.87	-$96.64	-$87.72	-$16.09	$27.81	-$86.29	-$65.67

Table D-4 Annual Equivalent Value of Agricultural Returns per acre by Crop Type and Elevation Range- Reaches Two-Four

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
soy	$22.33	$25.84	$26.59	$26.75	$27.77	$28.33	$27.87	$28.33
cott	$4.16	$19.84	$21.09	$23.20	$23.24	$28.37	$28.59	$29.73
ric	$48.64	$62.35	$69.88	$71.53	$74.12	$77.93	$78.35	$79.17
sorg	-$17.54	-$14.84	-$12.31	-$14.01	-$12.95	-$12.24	-$12.24	-$12.24
wht	$5.23	$5.45	$5.05	$6.52	$6.70	$6.59	$48.36	$48.36
corn	-$40.90	-$13.93	-$6.77	-$6.14	-$1.13	$1.95	-$6.04	-$4.60

Table D-5 NPV of per acre Forestry Returns on Alligator (hydric) Soils - Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	-$225.83	-$122.75	-$92.19	-$87.81	-$86.35	-$86.35	-$86.35	-$86.35
green ash	-$202.38	-$148.67	-$128.24	-$124.97	-$123.88	-$123.88	-$123.88	-$123.88
sweet gum	-$220.45	-$113.44	-$82.33	-$77.92	-$76.45	-$76.45	-$76.45	-$76.45
nuttal oak	-$207.50	-$155.43	-$122.40	-$113.62	-$112.52	-$112.52	-$112.52	-$112.52
seeded nuttal oak	-$35.81	-$21.48	-$15.50	-$15.24	-$15.21	-$15.21	-$15.21	-$15.21
cottonwood	-$100.61	-$91.75	-$89.86	-$89.86	-$89.86	-$89.86	-$89.86	-$89.86
cottonwood-nuttall oak interplanted	-$148.10	-$113.52	-$98.11	-$93.62	-$93.62	-$93.62	-$93.62	-$93.62
cherrybark oak	-	-	-	-	-	-	-	-
bald cypress	-$194.28	-$162.14	-$136.82	-$128.28	-$127.19	-$127.19	-$127.19	-$127.19

Table D-6 Annual Equivalent Value of per acre Forestry Returns on Alligator (hydric) Soils- Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	-$15.54	-$8.45	-$6.34	-$6.04	-$5.94	-$5.94	-$5.94	-$5.94
green ash	-$13.93	-$10.23	-$8.83	-$8.60	-$8.53	-$8.53	-$8.53	-$8.53
sweet gum	-$15.17	-$7.81	-$5.67	-$5.36	-$5.26	-$5.26	-$5.26	-$5.26
nuttal oak	-$14.28	-$10.70	-$8.42	-$7.82	-$7.74	-$7.74	-$7.74	-$7.74
seeded nuttal oak	-$2.46	-$1.48	-$1.07	-$1.05	-$1.05	-$1.05	-$1.05	-$1.05
cottonwood	-$6.92	-$6.31	-$6.18	-$6.18	-$6.18	-$6.18	-$6.18	-$6.18
cottonwood-nuttall oak interplanted	-$10.19	-$7.81	-$6.75	-$6.44	-$6.44	-$6.44	-$6.44	-$6.44
cherrybark oak	-	-	-	-	-	-	-	-
bald cypress	-$13.37	-$11.16	-$9.42	-$8.83	-$8.75	-$8.75	-$8.75	-$8.75

Table D-7 NPV of per acre Forestry Returns on Dundee (non-hydric) Soils - Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	-$200.22	-$78.49	-$45.30	-$40.80	-$39.30	-$39.30	-$39.30	-$39.30
green ash	-$202.38	-$148.67	-$128.24	-$124.97	-$123.88	-$123.88	-$123.88	-$123.88
sweet gum	-$190.29	-$61.33	-$27.13	-$22.58	-$21.06	-$21.06	-$21.06	-$21.06
nuttal oak	-$205.78	-$152.26	-$118.63	-$109.82	-$108.72	-$108.72	-$108.72	-$108.72
seeded nuttal oak	-$34.35	-$18.79	-$12.29	-$12.01	-$11.98	-$11.98	-$11.98	-$11.98
cottonwood	$176.21	$199.58	$202.10	$202.10	$202.10	$202.10	$202.10	$202.10
cottonwood-nuttall oak interplanted	$61.54	$107.70	$124.24	$129.03	$129.03	$129.03	$129.03	$129.03
cherrybark oak	-$206.80	-$140.20	-$89.32	-$80.24	-$79.11	-$79.11	-$79.11	-$79.11
bald cypress	-	-	-	-	-	-	-	-

Table D-8 Annual Equivalent Value of per acre Forestry Returns on Dundee (non-hydric) Soils- Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	-$13.78	-$5.40	-$3.12	-$2.81	-$2.71	-$2.71	-$2.71	-$2.71
green ash	-$13.93	-$10.23	-$8.83	-$8.60	-$8.53	-$8.53	-$8.53	-$8.53
sweet gum	-$13.10	-$4.22	-$1.87	-$1.55	-$1.45	-$1.45	-$1.45	-$1.45
nuttal oak	-$14.16	-$10.48	-$8.16	-$7.56	-$7.48	-$7.48	-$7.48	-$7.48
seeded nuttal oak	-$2.36	-$1.29	-$0.85	-$0.83	-$0.82	-$0.82	-$0.82	-$0.82
cottonwood	$12.13	$13.74	$13.91	$13.91	$13.91	$13.91	$13.91	$13.91
cottonwood-nuttall oak interplanted	$4.24	$7.41	$8.55	$8.88	$8.88	$8.88	$8.88	$8.88
cherrybark oak	-$14.23	-$9.65	-$6.15	-$5.52	-$5.44	-$5.44	-$5.44	-$5.44
bald cypress	-	-	-	-	-	-	-	-

Appendix E: Net Returns to Carbon, Nutrients and Hunting Leases[77]

Table E-1 NPV of per acre Carbon Returns on Alligator (hydric) Soils - Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	$89.73	$139.83	$145.09	$145.11	$145.12	$145.12	$145.12	$145.12
green ash	$94.97	$151.76	$157.82	$157.86	$157.87	$157.87	$157.87	$157.87
sweet gum	$89.73	$139.83	$145.09	$145.11	$145.12	$145.12	$145.12	$145.12
nuttal oak	$80.46	$135.79	$157.59	$157.74	$157.75	$157.75	$157.75	$157.75
seeded nuttal oak	$68.39	$115.42	$133.95	$134.08	$134.09	$134.09	$134.09	$134.09
cottonwood	$132.08	$135.52	$135.52	$135.52	$135.52	$135.52	$135.52	$135.52
cottonwood-nuttall oak interplanted	$125.42	$160.56	$173.47	$177.07	$177.07	$177.07	$177.07	$177.07
cherrybark oak	-	-	-	-	-	-	-	-
bald cypress	$96.95	$155.01	$161.21	$161.25	$161.27	$161.27	$161.27	$161.27

Table E-2 Annual Equivalent Value of per acre Carbon Returns on Alligator (hydric) Soils - Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	$6.18	$9.62	$9.99	$9.99	$9.99	$9.99	$9.99	$9.99
green ash	$6.54	$10.44	$10.86	$10.86	$10.87	$10.87	$10.87	$10.87
sweet gum	$6.18	$9.62	$9.99	$9.99	$9.99	$9.99	$9.99	$9.99
nuttal oak	$5.54	$9.35	$10.85	$10.86	$10.86	$10.86	$10.86	$10.86
seeded nuttal oak	$4.71	$7.94	$9.22	$9.23	$9.23	$9.23	$9.23	$9.23
cottonwood	$9.09	$9.33	$9.33	$9.33	$9.33	$9.33	$9.33	$9.33
cottonwood-nuttall oak interplanted	$8.63	$11.05	$11.94	$12.19	$12.19	$12.19	$12.19	$12.19
cherrybark oak	-	-	-	-	-	-	-	-
bald cypress	$6.67	$10.67	$11.10	$11.10	$11.10	$11.10	$11.10	$11.10

77 Note: In the per acre analysis, net returns were calculated for lands between the 2-year and 3-year event. These results are reported in the column labeled elevation range three. In the final analysis, however, all land between the 2-year and 5-year event was consolidated into a single elevation range. This new, larger elevation range is the elevation range three that is referred to in the text of the document. By consolidating elevation range three, the column of per acre returns reported for elevation range three in the tables below became unnecessary and was not used in the final analysis. Instead, the per acre returns reported in the table below for elevation range four, were in fact applied to land in the new, consolidated elevation range three. This means that the labeling of the columns of per acre returns reported below indicate an elevation range that is one higher than the actual elevation range that the per acre returns are applied to. The per acre net returns reported in the column labeled elevation range eight, apply to both the actual elevation range seven and the actual elevation range eight.

Table E-3 NPV of per acre Carbon Returns on Dundee (non-hydric) Soils - Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	$89.73	$139.83	$145.09	$145.11	$145.12	$145.12	$145.12	$145.12
green ash	$94.97	$151.76	$157.82	$157.86	$157.87	$157.87	$157.87	$157.87
sweet gum	$89.73	$139.83	$145.09	$145.11	$145.12	$145.12	$145.12	$145.12
nuttal oak	$80.46	$135.79	$157.59	$157.74	$157.75	$157.75	$157.75	$157.75
seeded nuttal oak	$68.39	$115.42	$133.95	$134.08	$134.09	$134.09	$134.09	$134.09
cottonwood	$132.08	$135.52	$135.52	$135.52	$135.52	$135.52	$135.52	$135.52
cottonwood-nuttall oak interplanted	$125.42	$160.56	$173.47	$177.07	$177.07	$177.07	$177.07	$177.07
cherrybark oak	$73.55	$127.46	$158.12	$158.27	$158.29	$158.29	$158.29	$158.29
bald cypress	-	-	-	-	-	-	-	-

Table E-4 Annual Equivalent Value of per acre Carbon Returns on Dundee (non-hydric) Soils- Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	$6.18	$9.62	$9.99	$9.99	$9.99	$9.99	$9.99	$9.99
green ash	$6.54	$10.44	$10.86	$10.86	$10.87	$10.87	$10.87	$10.87
sweet gum	$6.18	$9.62	$9.99	$9.99	$9.99	$9.99	$9.99	$9.99
nuttal oak	$5.54	$9.35	$10.85	$10.86	$10.86	$10.86	$10.86	$10.86
seeded nuttal oak	$4.71	$7.94	$9.22	$9.23	$9.23	$9.23	$9.23	$9.23
cottonwood	$9.09	$9.33	$9.33	$9.33	$9.33	$9.33	$9.33	$9.33
cottonwood-nuttall oak interplanted	$8.63	$11.05	$11.94	$12.19	$12.19	$12.19	$12.19	$12.19
cherrybark oak	$5.06	$8.77	$10.88	$10.89	$10.89	$10.89	$10.89	$10.89
bald cypress	-	-	-	-	-	-	-	-

Table E-5 NPV of per acre Hunting Lease Returns on Alligator (hydric) Soils - Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	$15.47	$26.74	$28.32	$28.39	$28.42	$28.42	$28.42	$28.42
green ash	$25.34	$43.55	$45.95	$46.04	$46.07	$46.07	$46.07	$46.07
sweet gum	$15.47	$26.74	$28.32	$28.39	$28.42	$28.42	$28.42	$28.42
nuttal oak	$20.86	$38.54	$45.92	$46.24	$46.27	$46.27	$46.27	$46.27
seeded nuttal oak	$17.73	$32.76	$39.03	$39.30	$39.33	$39.33	$39.33	$39.33
cottonwood	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
cottonwood-nuttall oak interplanted	$11.46	$35.32	$45.19	$45.19	$45.19	$45.19	$45.19	$45.19
cherrybark oak	-	-	-	-	-	-	-	-
bald cypress	$25.45	$43.74	$46.15	$46.24	$46.27	$46.27	$46.27	$46.27

Table E-6 Annual Equivalent Value of per acre Hunting Lease Returns on Alligator (hydric) Soils - Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	$1.06	$1.84	$1.95	$1.95	$1.96	$1.96	$1.96	$1.96
green ash	$1.74	$3.00	$3.16	$3.17	$3.17	$3.17	$3.17	$3.17
sweet gum	$1.06	$1.84	$1.95	$1.95	$1.96	$1.96	$1.96	$1.96
nuttal oak	$1.44	$2.65	$3.16	$3.18	$3.18	$3.18	$3.18	$3.18
seeded nuttal oak	$1.22	$2.25	$2.69	$2.71	$2.71	$2.71	$2.71	$2.71
cottonwood	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
cottonwood-nuttall oak interplanted	$0.79	$2.43	$3.11	$3.11	$3.11	$3.11	$3.11	$3.11
cherrybark oak	-	-	-	-	-	-	-	-
bald cypress	$1.75	$3.01	$3.18	$3.18	$3.18	$3.18	$3.18	$3.18

Table E-7 NPV of per acre Hunting Lease Returns on Dundee (non-hydric) Soils - Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	$15.47	$26.74	$28.32	$28.39	$28.42	$28.42	$28.42	$28.42
green ash	$25.34	$43.55	$45.95	$46.04	$46.07	$46.07	$46.07	$46.07
sweet gum	$15.47	$26.74	$28.32	$28.39	$28.42	$28.42	$28.42	$28.42
nuttal oak	$20.86	$38.54	$45.92	$46.24	$46.27	$46.27	$46.27	$46.27
seeded nuttal oak	$17.73	$32.76	$39.03	$39.30	$39.33	$39.33	$39.33	$39.33
cottonwood	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
cottonwood-nuttall oak interplanted	$11.46	$35.32	$45.19	$45.19	$45.19	$45.19	$45.19	$45.19
cherrybark oak	$17.57	$34.75	$45.03	$45.35	$45.38	$45.38	$45.38	$45.38
bald cypress	-	-	-	-	-	-	-	-

Table E-8 Annual Equivalent Value of per acre Hunting Lease Returns on Dundee (non-hydric) Soils- Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	$1.06	$1.84	$1.95	$1.95	$1.96	$1.96	$1.96	$1.96
green ash	$1.74	$3.00	$3.16	$3.17	$3.17	$3.17	$3.17	$3.17
sweet gum	$1.06	$1.84	$1.95	$1.95	$1.96	$1.96	$1.96	$1.96
nuttal oak	$1.44	$2.65	$3.16	$3.18	$3.18	$3.18	$3.18	$3.18
seeded nuttal oak	$1.22	$2.25	$2.69	$2.71	$2.71	$2.71	$2.71	$2.71
cottonwood	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
cottonwood-nuttall oak interplanted	$0.79	$2.43	$3.11	$3.11	$3.11	$3.11	$3.11	$3.11
cherrybark oak	$1.21	$2.39	$3.10	$3.12	$3.12	$3.12	$3.12	$3.12
bald cypress	-	-	-	-	-	-	-	-

Table E-9 NPV of per acre High-Value Hunting Lease Returns on Alligator (hydric) Soils - Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	$57.28	$97.14	$101.66	$101.73	$101.75	$101.75	$101.75	$101.75
green ash	$67.45	$114.47	$119.82	$119.91	$119.94	$119.94	$119.94	$119.94
sweet gum	$57.28	$97.14	$101.66	$101.73	$101.75	$101.75	$101.75	$101.75
nuttal oak	$55.59	$101.34	$119.80	$120.13	$120.16	$120.16	$120.16	$120.16
seeded nuttal oak	$47.25	$86.14	$101.83	$102.11	$102.13	$102.13	$102.13	$102.13
cottonwood	$69.67	$73.34	$73.34	$73.34	$73.34	$73.34	$73.34	$73.34
cottonwood-nuttall oak interplanted	$30.67	$93.65	$44.10	$119.02	$119.02	$119.02	$119.02	$119.02
cherrybark oak	-	-	-	-	-	-	-	-
bald cypress	$67.57	$114.67	$120.04	$120.13	$120.16	$120.16	$120.16	$120.16

Table E-10 Annual Equivalent Value of per acre High-Value Hunting Lease Returns on Alligator (hydric) Soils - Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	$3.94	$6.69	$7.00	$7.00	$7.00	$7.00	$7.00	$7.00
green ash	$4.64	$7.88	$8.25	$8.25	$8.25	$8.25	$8.25	$8.25
sweet gum	$3.94	$6.69	$7.00	$7.00	$7.00	$7.00	$7.00	$7.00
nuttal oak	$3.83	$6.97	$8.25	$8.27	$8.27	$8.27	$8.27	$8.27
seeded nuttal oak	$3.25	$5.93	$7.01	$7.03	$7.03	$7.03	$7.03	$7.03
cottonwood	$4.80	$5.05	$5.05	$5.05	$5.05	$5.05	$5.05	$5.05
cottonwood-nuttall oak interplanted	$2.11	$6.45	$3.04	$8.19	$8.19	$8.19	$8.19	$8.19
cherrybark oak	-	-	-	-	-	-	-	-
bald cypress	$4.65	$7.89	$8.26	$8.27	$8.27	$8.27	$8.27	$8.27

Table E-11 NPV of per acre High-Value Hunting Lease Returns on Dundee (non hydric) Soils - Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	$57.28	$97.14	$101.66	$101.73	$101.75	$101.75	$101.75	$101.75
green ash	$67.45	$114.47	$119.82	$119.91	$119.94	$119.94	$119.94	$119.94
sweet gum	$57.28	$97.14	$101.66	$101.73	$101.75	$101.75	$101.75	$101.75
nuttal oak	$55.59	$101.34	$119.80	$120.13	$120.16	$120.16	$120.16	$120.16
seeded nuttal oak	$47.25	$86.14	$101.83	$102.11	$102.13	$102.13	$102.13	$102.13
cottonwood	$69.67	$73.34	$73.34	$73.34	$73.34	$73.34	$73.34	$73.34
cottonwood-nuttall oak interplanted	$30.67	$93.65	$44.10	$119.02	$119.02	$119.02	$119.02	$119.02
cherrybark oak	$47.85	$93.09	$118.88	$119.20	$119.23	$119.23	$119.23	$119.23
bald cypress	-	-	-	-	-	-	-	-

Table E-12 Annual Equivalent Value of per acre High-Value Hunting Lease Returns on Dundee (non-hydric) Soils- Reach One

	Elevation Ranges							
	One	Two	Three	Four	Five	Six	Seven	Eight
sycamore	$3.94	$6.69	$7.00	$7.00	$7.00	$7.00	$7.00	$7.00
green ash	$4.64	$7.88	$8.25	$8.25	$8.25	$8.25	$8.25	$8.25
sweet gum	$3.94	$6.69	$7.00	$7.00	$7.00	$7.00	$7.00	$7.00
nuttal oak	$3.83	$6.97	$8.25	$8.27	$8.27	$8.27	$8.27	$8.27
seeded nuttal oak	$3.25	$5.93	$7.01	$7.03	$7.03	$7.03	$7.03	$7.03
cottonwood	$4.80	$5.05	$5.05	$5.05	$5.05	$5.05	$5.05	$5.05
cottonwood-nuttall oak interplanted	$2.11	$6.45	$3.04	$8.19	$8.19	$8.19	$8.19	$8.19
cherrybark oak	$3.29	$6.41	$8.18	$8.20	$8.21	$8.21	$8.21	$8.21
bald cypress	-	-	-	-	-	-	-	-

Appendix F: Executive Order 12322 – Water Resources Projects

Source: The provisions of Executive Order 12322 of Sept. 17, 1981, appear at 46 FR 46561, 3 CFR, 1981 Comp., p. 178, unless otherwise noted.

By the authority vested in me as President by the Constitution and laws of the United States of America, and in order to ensure efficient and coordinated planning and review of water resources programs and projects, it is hereby ordered as follows:

Section 1. Before any agency or officer thereof submits to the Congress, or to any committee or member thereof, for approval, appropriations, or legislative action any report, proposal, or plan relating to a Federal or Federally assisted water and related land resources project or program, such report, proposal, or plan shall be submitted to the Director of the Office of Management and Budget.

Sec. 2. The Director of the Office of Management and Budget shall examine each report, proposal, or plan for consistency with, and shall advise the agency of the relationship of the project to, the following:

(a) the policy and programs of the President;
(b) the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies or other such planning guidelines for water and related land resources planning, as shall hereafter be issued; and
(c) other applicable laws, regulations, and requirements relevant to the planning process.

[Sec. 2 amended by Executive Order 12608 of Sept. 9, 1987, 52 FR 34617, 3 CFR, 1987 Comp., p. 245]

Sec. 3. When such report, proposal, or plan is thereafter submitted to the Congress, or to any committee or member thereof, it shall include a statement of the advice received from the Office of Management and Budget.

Sec. 4. Executive Order No. 12113, as amended, is revoked.

Appendix G: Memorandum on Use of Model Results

June 22, 1999

MEMORANDUM

To: Users of the results of the wholly nonstructural analysis

From: Leonard Shabman

Subject: Interpretation and Use of Empirical Estimates

1. The approaches used for evaluation of wholly nonstructural plans are innovative, when compared with conventional analysis of benefits and costs for federal watershed projects and programs. Nonetheless, the conceptual logic and the computational procedures for the measurement of the benefits and the costs of a wholly non structural plan are well grounded in economic logic, conform with National Economic Development (NED) federal evaluation procedures derived from the Principles and Guidelines, advance major environmental quality (EQ) goals of the administration and the Congress, and are consistent with Corps of Engineers budget priorities and policy.

2. The particular application to the Yazoo backwater study area incorporates the best available data in the development of credible and defensible benefit and cost analysis for the evaluation of "wholly non structural" alternatives for the watershed. A wholly nonstructural alternative for this watershed is motivated by the opportunity to advance the highest priority environmental goals of the nation while being fiscally responsible and contributing to the nation's economic well being. A wholly non structural alternative is characterized by three elements: 1) no change in the current hydrology in order to retain exiting wetlands and related environments; 2) reforestation of some lands; 3) reduced economic loss from flood hazard on productive agricultural lands and for some residential and commercial areas. Preliminary results suggest that wholly non structural alternatives can justified on national economic development and environmental criteria.

3. There have been suggestions to combine reforestation of selected lands in the Yazoo watershed study area with a pump to reduce flood damage on land that is not reforested. The assertion is that combining a pump with reforestation would advance both desired NED and environmental outcomes. The validity of this assertion would require more analysis than simply transferring of the results of this nonstructural evaluation (related to reforestation) to a "combination" alternative. Specifically,

Any alternative that results in a change in hydrology can alter the level and extent of the services derived and the benefits realized from reforestation.

Any alternative that results in a change in hydrology could result in environmental consequences that will need to be mitigated. Conversely, if the assertion is that hydrologic changes would enhance or be compatible with environmental goals, then the plan formulation process would need to consider non-pump alternatives to achieve the changes in hydrology. There should be no implicit assertion that a pump is the best feature for a combined alternative.

Reforestation and a pump would be fully separable elements in any plan and so each component (reforestation and a pump) must be incrementally justified on NED and EQ grounds independent of the other. While we believe that a wholly non structural plan can be NED and EQ justified for the watershed, there is no documentation to demonstrate that a pump can be either NED or EQ justified, with or without a reforestation element in the plan.

For these reasons, any simple transfer of the particular benefit and cost results from analyses of wholly nonstructural alternatives to an alternative that includes a change in the watershed hydrology is a misuse and misapplication of the reported results.

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