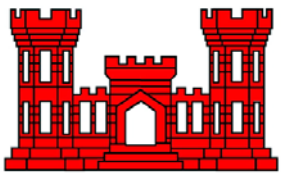
Appendix E
Part 2

Wetland Goods and Services



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Wetland Goods and Services

Ecosystem services, as defined by the Millennium Ecosystem Assessment [Millennium Ecosystem Assessment (MEA), 2005], are the "benefits" people obtain from ecosystems. These include provisioning services such as food and water; regulating services, such as regulation of floods, drought, land degradation, and disease; supporting services, such as soil formation and nutrient cycling; and cultural services, such as recreational, spiritual, religious, and other nonmaterial benefits." Bottomland hardwood forest once covered nearly 25 million acres in the Mississippi Alluvial Valley (MAV). During the 1950's through 1970's, vast quantities of bottomland wetlands and forest were cleared, drained, and filled to aid in agricultural production, and by the 1980's, only 7 million acres remain and much of the remaining habitat is highly fragmented and hydrologically altered. (King et al 2006). The current dominating land use in the MAV, analogous to the project area, is agriculture, dominated by soybeans, corn, cotton and rice. In suitable conditions, converting agricultural fields back to their original composition of hydric vegetation and soil can result in a gain of ecosystem services, which in turn benefits society and the nation (Jenkins 2010).

Most scientists, regulatory agencies, and the general public would tend to agree that wetlands, in their natural state, provide valuable ecological services. Likewise, most scientist, regulatory agencies, and the general public would agree that agriculture provides little to no ecological services/value and in fact likely provides "negative value". For example, wetlands provide a vital ecosystem service of treating and removing a variety of waste products and some wetlands have been reported to reduce concentrations of nitrate by more than 80 percent (MEA), 2005. Excessive nutrient loading is a contributor to the Gulf of Mexico hypoxia problem. Based on SPARROW (Spatially Referenced Regression on Watershed attributes) data, the project area was ranked by Robertson et al (2009), with 95% certainty for Total Nitrogen and 90% certainty for Total Phosphorus, as being a top 15 watershed (out of 847) contributor of nutrients to the Mississippi Alluvial Valley. Thus, the majority of land in the project area results in "anti-wetland" goods and services in regards to nutrients and is seen as a persistent problem.

Zedler (2003) stated the following:

- When large areas of wetlands are drained for agriculture, the ecosystem services these wetlands performed are lost.
- Lost services include flood abatement, improved water quality, and support for biodiversity.

Likewise, Mitsch *et al.* (2001) stated:

> "Because of extensive artificial drainage over the past 200 years, many of the once-ubiquitous freshwater wetlands and riparian zones associated with the streams and rivers of the basin no longer exist. Gone with them is their capacity to mitigate water pollution. In the Mid-Western states, water quality is particularly degraded by nutrients, pesticides, and sediments from farms and urban areas, in these states, 80% of the wetland acreage has been drained. In seven states in the upper Mississippi River Basin (Indiana, Illinois, Iowa, Minnesota, Missouri, Ohio, and Wisconsin), about 18.6 million ha (46 million

acres) of land has been drained (Zucker and Brown 1998), much of which was wetlands at some time. In total, 14.1 million ha (35 million acres) of wetlands were lost in these states between the 1780s and the 1980s (Dahl 1990). Thus, the landscape has lost part of its ability to maintain a biochemical balance, and the stream and rivers are no longer buffered from runoff from upland regions".

Ecosystem services provided by or derived from wetlands (MEA, 2005) consist of the following:

- Provisioning
  - Food
  - Fresh Water
  - Fiber and Fuel
  - Biochemical
  - Genetic Materials
- Regulating
  - Climate Regulation
  - Water Regulation (hydrologic flows)
  - Water Purification and Waste Treatment
  - Erosion Regulation
  - Natural Hazard Regulation
  - Pollination
- Cultural
  - Spiritual and Inspirational
  - Recreational
  - Aesthetic
  - Educational
- Supporting
  - Soil Formation
  - Nutrient Cycling

It is generally accepted that wetlands provide favorable goods and services. Although agriculture can contribute some ecosystem services, they also are a source of disservices, particularly to loss of biodiversity, agrochemical contamination and sedimentation of waterways, pesticide poisoning of non-target organisms, and emissions of greenhouse gases and pollutants (Power, 2010, Dale and Polasky, 2007; Zhang *et al.*, 2007). It is generally accepted that agriculture, including wetlands in agricultural areas, impacts aquatic ecosystems (Blann *et al.*, 2009). Table 1 provides a comparison of goods and services provided by wetlands and disservices provided by "wetlands in agricultural areas." Locations with some wetland characteristics, but not subject to regulation under the Clean Water Act or the Food Security Act, and identified here as "wetlands in agricultural areas" result in greater net disservices than services.

Table 1. Ecosystem services and disservices provided by wetlands and "wetlands in agriculture."

	wetland[1]		"wetland in agriculture"	
Service/Disservice	Relative Magnitude	Comment/Example	Relative Magnitude	Comment/Example
Food	+++	Production of fish, wild game, fruits, grains, and so on	+++	"Agriculturists are the de facto managers of the most productive lands on Earth" (Tilman *et al.*,2002)
Freshwater	+	Storage and retention of water; provision of water for irrigation and for drinking	--	Croplands in intensively managed agricultural landscapes typically store less water, and runoff is higher and more flashy (Blann *et al.*, 2009) Agriculture depletes freshwater supplies (Kenny *et al.*, 2009).
Fiber and Fuel	+++	Production of timber, fuel wood, peat, fodder, aggregates	+++	Bio-fuels, alternative sources of energy, etc.
Biochemical Products	?	Extraction of material from biota	-	Agrochemical contamination (Power, 2010)
Genetic Materials	+	Medicine, genes for resistance to plant pathogens, ornamental species, and so on	+/-	Agriculture is used to promote beneficial plants necessary for medicine, ornamental species, and so on. However, agriculture destroys native vegetation that *could* provide new technologies.
Climate Regulation	+++	Regulation of greenhouse gases, temperature, precipitation, and other climatic processes; chemical composition of the atmosphere	---	The global increase in crop production may account for declines in air quality regulation and climate regulation (MEA, 2005, Dale and Polasky, 2007). Agricultural practices affect net greenhouse gas emissions through burning of fossil fuels and through the release of greenhouse gases in plant material (Dale and Polasky, 2007). Agricultural activities are estimated to be responsible for 12-14% of global anthropogenic emissions of greenhouse gases, not including emissions that arise from land clearing (Power, 2010, EPA, 2006).
Hydrologic Regimes	++	Groundwater recharge and discharge, storage of water for agriculture and industry	---	Depletion of groundwater aquifers necessary for irrigation (Kenny *et al.*, 2009).
Pollution Control and Detoxification	++	Retention, recovery, and removal of excess nutrients and pollutants	---	Agriculture and nitrogen fertilizer is a leading contributor to Gulf of Mexico hypoxia (Mitsch *et al.*, 2001 and numerous other citations). Agrochemical contamination (Power, 2010)
Erosion Protection	++	Retention of soils and prevention of structural change	--	Although farming practices have improved drastically, it has long been established that conversion of lands from native vegetation to

		(such as coastal erosion, bank slumping, and so on)		croplands generally results in elevated sediment loss (Blann *et al.*, 2009). Morphological changes resulting from drainage networks that alter discharge result in stream incision, bank erosion, and channel widening (Blann *et al.*, 2009).
Natural Hazards	++	Flood control, storm protection	--	Croplands in intensively managed agricultural landscapes typically store less water, and runoff is higher and more flashy (Blann *et al.*, 2009). Agriculture, especially soybeans, in the Mississippi River increases base flow and stream flow (Zhang and Schilling, 2005). In intensively drained landscapes, such as the agricultural Midwest of the United States, the connection of isolated basins has inflated total surface water discharge and increased the density of linear drainage networks (Blann *et al.* 2009).
Spiritual and Inspirational	++	Personal feelings and well-being; religious significance	+/-	Depending on one's culture, agriculture can also be considered a positive for personal feelings and well-being, as well as religious significance. However, a large segment of society is of the opinion that cleared agricultural lands do not prove spiritual and inspirational value.
Recreational	+	Opportunities for tourism and recreational activities	--	Agricultural is responsible for impacting recreational opportunities and remaining activities are limited.
Aesthetic	++	Appreciation of natural features	+/-	Depending on one's personal feelings, agriculture can also be considered aesthetically pleasing. However, a large segment of society is of the feeling that clearing, ditching, and leveling of the vegetated floodplain for agricultural purposes is an aesthetic impact.
Educational	++	Opportunities for formal and informal education and training	+/-	With the exception of agriculturally based education, conversion to agriculture has impacted educational opportunities.
Biodiversity	++	Habitats for resident and transient species	---	Since agricultural practices can harm biodiversity pathways, agriculture is often considered anathema to conservation (Power, 2010)
Soil Formation	++	Sediment retention and accumulation of organic matter	--	Although farming practices have improved drastically, it has long been established that conversion of lands from native vegetation to croplands generally results in elevated sediment loss (Blann *et al.*, 2009). Morphological changes resulting from drainage networks that alter discharge result in stream incision, bank erosion, and channel widening (Blann *et al.*, 2009).

Nutrient Cycling	+++	Storage, recycling, processing, and acquisition of nutrients	---	Agriculture and nitrogen fertilizer is a leading contributor to Gulf of Mexico hypoxia (Mitsch *et al.*, 2001 and numerous other citations).
Pollination	+	Support for pollinators	--	Pesticide poisoning of non-target organisms (Power 2010; Dale and Polasky, 2007)

[1]Seasonal Lakes, Marshes, and Swamps, including Floodplains (MEA, 2009)

Goods and services conclusions for project alternatives are listed below.

Alternative 1

The project area would maintain the same ecological services from vegetated wetlands as well as still experience the impacts attributed to ecological disservices from "wetlands in agricultural" areas. However, disservices attributed to "wetlands in agriculture" would be reduced when lands are converted to WRP which would result in a greater ecological service. Any measure that would take land out of production and reforest it would reduce ecological disservices attributed from the "wetlands in agriculture."

Alternatives 2 – 4

Goods and services would benefit as a result of the project. This is solely due to the fact that the vast majority of the project area is made up of agricultural land. Although these areas have been classified as "wetlands in agriculture" by the EPA, farmland mostly contributes negative ecological functions (*i.e.,* ecological disservices). Goods would benefit from the reduction in flood frequency.

Food – Vegetated wetlands provide fish, wild game, fruits, grains and so on. The project would negatively impact this service (MEA, 2005). Impacts to this ecological service are quantified by the utilization of a variety of fish and wildlife ecologic models. "wetlands in agricultural" areas are the de facto managers of the most productive lands on Earth (Tilman *et al.,* 2002). The project would benefit this ecological good by optimizing agricultural production on farmland by managing flood risks.

Freshwater – Vegetated wetlands store and retain water for irrigation and drinking. However, the majority of the project area water and irrigation supply is extracted from groundwater sources. Therefore, the project would not impact fresh-surface water supplies. Contrary to vegetated wetlands, "wetlands in agricultural" lands are a disservice to freshwater supplies. The vast majority of the project area would still be irrigated regardless of the project. Therefore, disservices far outweigh any ecological services provided. No additional impact to freshwater services is anticipated as a result of the project.

Fiber and Fuel – With the exception of direct impacts, project alternatives are not expected to impact fiber and fuel ecological services of vegetated wetlands. These areas would still be able to perform this service. Project alternatives would benefit the ecological goods provided by "wetlands in agriculture." Managing flood risks in the project area would benefit agricultural

management which in turn would optimize the production of bio-fuels, alternative energy sources, etc.

Biochemical Products- The ecological service provided from freshwater vegetated wetlands is currently not assessed (MEA, 2005). However, any biochemical products produced in agricultural areas would be benefited from the project.

Genetic Materials – There are no *known* significant sources of medicine, genes for resistance, ornamental species, and so on that exist in vegetated wetlands within the project area. Therefore, no significant impact is anticipated. Agriculture is used to produce pharmaceutical compounds. It is likely that this would be further expanded with research and technology. Therefore, since the project would benefit agricultural areas, this ecological good would also benefit. "wetlands in agricultural" areas is considered an ecological disservice because it destroys native plants. However, with the exception of direct impacts, project alternatives are not expected to result in any vegetation conversions. Therefore, no additional disservices are anticipated.

Climate Regulation – Although vegetated wetlands provide a service to climate regulation, "wetlands in agricultural" provide a disservice. The carbon footprint of the project was quantified and a discussion is found in Section 4.12.

Hydrologic Regimes – Vegetated wetlands perform a service by recharging groundwater supplies that can be used for municipal, industrial, or agricultural purposes. Project alternatives could partially impact this service. For example, this service would still be provided from project area vegetated wetlands that perform this service due to precipitation. However, any groundwater recharge due to impounded interior runoff or backwater flooding could be slightly impacted. Detention of precipitation and floodwaters was quantified with the HGM model. Contrary to vegetated wetlands, "wetlands in agricultural" areas provide a disservice to hydrologic regimes. Agriculture is a leading cause of groundwater depletion (Kenny *et al.,* 1999) and the network of drainage ditches in the project area result in relatively little storage/detention (*i.e.*, the project area has been engineered and the hydrologic regime manipulated to quickly drain water not retain it). Disservices far outweigh any services provided.

Pollution Control and Detoxification – It is well established that wetlands provide a service by removing excess nutrients and pollutants (MEA, 2005). It is also well established that "wetlands in agriculture" perform a disservice by being a leading contributor to Gulf of Mexico hypoxia (Mitsch *et al.,* 2001, numerous others). Water quality is assessed in Section 4.10.

Erosion Protection – Although vegetated wetlands perform a service by retaining soils and preventing them from entering waterways (MEA, 2005), "wetlands in agriculture" perform a disservice (Blann *et al.,* 2009). The disservices generated by the project area, which is over 80 percent agricultural, far outweigh any services provided. No significant impacts are anticipated as a result of project alternatives.

Natural Hazards – Vegetated wetlands perform a service by detaining flood waters and precipitation. However, "wetlands in agriculture" are a leading contributor to increasing discharge (Blann *et al.,* 2009; Zhang and Schilling, 2005). For example, all of the drainage

ditches, storm water improvements to East Prairie funded by the EPA, leveled cleared agricultural lands, and any other hydrologic modification all cumulatively result in a flood problem in the St. Johns Bayou Basin. Likewise, any hydrologic improvements upstream in the Mississippi River watershed all contribute to the flood problem in the New Madrid Floodway. The purpose of the project is to reduce natural hazards by managing flood risk. Therefore, project alternatives would alleviate the natural hazard in the project area. This can be considered a service to the population.

Although constructing flood risk management features would be a service to the project area, an argument can be made that it would be a disservice for downstream communities. The ecological services provided by detain floodwater/precipitation functions were quantified in the HGM model. The potential impact to downstream areas was assessed in Section 4.19. In summary, the project area would still perform a valuable service, any loss of services generated from project alternatives are either mitigated (see HGM model) or no significant impact is anticipated.

Spiritual and Inspirational – Depending on one's culture project alternatives could either be a service or disservice. No significant impacts are anticipated.

Recreational – "wetlands in agricultural" is one of the primary reasons that recreation is limited in the project area. Recreation is limited in vegetated wetlands as a result of flooding. For example, flood waters isolate public lands which prevent the public from being able to access them. Therefore, one can consider project alternatives a benefit to this good.

Aesthetic – Depending on one's culture "wetlands in agriculture" can be considered aesthetically pleasing or displeasing. The tentatively recommended plan would not impact underlying land use. Therefore, no significant impact is anticipated.

Educational – No significant impacts or benefits are anticipated to educational services or disservices are anticipated.

Biodiversity – Significant fish and wildlife resources were assessed with a variety of ecological models (*i.e.*, HGM, shorebirds, waterfowl, and fish).

Soil Formation – No significant impact or benefit to soil retention services from vegetated wetlands or disservices attributed to erosion from "wetlands in agriculture" is anticipated.

Nutrient Cycling – Nutrient cycling is assessed in Section 4.12.

Pollination – No significant impact or benefits are anticipated to ecological services provided by vegetated wetlands or disservices provided by "wetlands in agricultural" areas.