10.0 ADDITIONAL IMPACT ANALYSIS

The additional impacts analysis, required for projects subject to PSD review, evaluates project impacts pertaining to associated growth; soils, vegetation, and wildlife; and visibility impairment. Each of these topics is discussed in the following subsections. Based on a thorough review of emissions expected as a result of this project, it is concluded that GREC will not cause any adverse impacts to the soils, vegetation, or wildlife of relevant Class I and II areas.

10.1 GROWTH IMPACTS ANALYSIS

10.1.1 PROJECT GROWTH IMPACTS

The purpose of the growth impact analysis is to quantify growth resulting from the construction and operation of the proposed project and assess air quality impacts that would result from that growth.

Impacts associated with construction of GREC will be minor. During the approximate 34-month construction period, GREC will employ an average of 168 workers. While not readily quantifiable, the temporary increase in vehicle miles traveled in the area would be insignificant, as would any temporary increase in vehicular emissions.

GREC is being constructed to meet general area electric power demands; therefore, no significant secondary growth effects due to operation of the project are anticipated. When operational, GREC is projected to employ approximately 44 fulltime workers. This number of new personnel will not significantly affect growth in the area. The increase in natural gas and diesel fuel oil demand due to the operation of GREC will have no major impact on local fuel markets. No significant air quality impacts due to associated industrial/commercial growth are expected at this time.

10.1.2 AREA GROWTH SINCE 1977

United States census data shows that the populations of Alachua County and the City of Gainesville have increased by 64 and 51 percent between 1980 and 2007, respectively.

The 2007 estimated populations of Alachua County and Gainesville are 247,561 and 122,671, respectively. Alachua County was the 23rd most populous of the 67 counties in Florida based on the 2007 census data, and it ranked 23rd in density.

Alachua County has also experienced little industrial growth since 1977. The EPA Air-Data Web site shows only three significant (i.e., actual emissions greater than 5 tpy) NO_x and SO_2 emission sources for 2002—the latest year available for facility data. The largest industrial facility, DGS, has been operating in Alachua County for more than 30 years. The latest significant emission source to locate in Alachua County is the Florida Rock Industries cement plant situated in Newberry. This facility was subject to PSD review and therefore uses BACT to minimize emissions.

Based on the current low densities of population and industrial activity, it is concluded that air quality in Alachua County has not deteriorated since 1977. As discussed in Section 8.0, the emissions associated with GREC will result in air quality impacts that are well below the national and Florida AAQS.

10.2 IMPACTS ON SOILS, VEGETATION, AND WILDLIFE

Potential impacts to soils, vegetation, and wildlife resources of the GREC Site and environs resulting from the proposed plant operation include effects of air emissions. Table 10-1 summarizes the modeled emissions concentrations due to the GREC emission sources for all relevant Class I and II areas. As previously discussed, GREC will employ state-of-the-art equipment and emission controls. Maximum air quality impacts in the vicinity of GREC will be well below the applicable AAQS. Given the resulting low emission rates and insignificant potential air quality impacts, potential detrimental effects on soils, vegetation, and wildlife will be insignificant.

A general discussion of air emission impacts on soils, vegetation, and wildlife is provided in the following subsection. Following this general discussion, specific analyses of impacts in the vicinity of GREC as well as the two nearest Class I areas (i.e., the Okefenokee and Chassahowitzka NWAs) are provided.

Table 10-1. GREC Maximum Pollutant Concentration Impacts

Pollutant	Averaging Period	Class I Area Impact ($\mu g/m^3$) Chassahowitzka NWA	Class I Area Impact ($\mu g/m^3$) Okefenokee NWA	Class II Area Impact ($\mu g/m^3$)
NO_x	Annual	0.0015	0.0025	0.4
SO_2	Annual	0.0015	0.0023	0.3
	24-Hour	0.044	0.051	3.3
	3-Hour	0.15	0.23	5.6
PM_{10}	Annual	0.0021	0.0029	5.3
	24-Hour	0.051	0.057	20.4
CO	1-Hour	N/A	N/A	159.9
	8-Hour	N/A	N/A	420.5

Source: ECT, 2009.

10.2.1 GENERAL AIR EMISSIONS IMPACTS ON SOILS

Sulfur and nitrogen can be added to soil as a result of atmospheric deposition. Sulfur and nitrogen deposition in soil can have beneficial effects to vegetation if they are currently lacking these elements. At levels above plant requirements, gaseous emission impacts on soils can cause acidic conditions to develop. Acidic conditions in the soil can cause the leaching of basic cations essential for plant life and in extreme circumstances can transform aluminum to a more soluble form where toxicity can occur (Goldstein *et al.*, 1985).

Nitrogen deficiency is common in nonagricultural areas, and, therefore, much of the atmospherically deposited NO_x is biologically assimilated. There is a limited soil adsorption mechanism for nitrate, so unutilized nitrate will be leached through the soil (Johnson and Reuss, 1984). Both of these factors indicate that nitrate does not play a significant role in soil acidification, and sulfate is more of a concern. Atmospheric deposition of nitrogen can facilitate eutrophication of the soil and vegetative community. Critical loads of nitrogen above which eutrophication caused a change in vegetative species present in calcareous forests was found to be 15 to 20 kilograms per hectare per year (kg/ha/yr) (Thimonier *et al.*, 1994).

Sulfur deposition can facilitate soil acidification. Sulfur exists in the soil predominantly in the form of sulfate. The maintenance of sulfate in soil solution facilitates the loss of cations. Therefore, the more sulfate that is adsorbed to soil particles, the more buffered the soils will be (Johnson and Reuss, 1984). The soil is a much larger sink for sulfate than vegetation (Johnson and Reuss, 1984). Sulfate can be adsorbed on the surface of reactive clays and iron/aluminum oxides within the soil, which often releases hydroxide, further buffering the soil (Johnson and Reuss, 1984). Soils found in Florida and Georgia that have high adsorption rates for sulfates include ultisols and certain suborders of inceptisols and entisols (Psamments) (Johnson and Reuss, 1984). The high iron and aluminum content of the subsurface spodic (B_h) horizon of spodosols likely adsorbs the sulfate anion to a large extent as is shown to occur with the anion of phosphate. The development of acidic conditions in the Southeast are thought to be well buffered by the high amount of sulfate adsorption (USGS, 1999).

Dissolution of sulfate and nitrate can also facilitate the formation of nitric and sulfuric acid in rainwater, which increases acidic hydrogen ion (H^+) composition within the soil. Soils that are well buffered to the addition of acid causing H^+ ions, have a high cation exchange capacity (CEC), often imparted by surface or subsurface clays and a high base saturation. Barton *et al.* (2002) found soils with a base saturation of 12 to 19 percent and reactive clays, to be buffered to acidic inputs, whereas soils with a base saturation of 3 to 7 percent by depth show the effects of soil acidification. In addition, organic horizons of wetland histosols buffer acidic inputs protecting the depletion of cations from the mineral horizons (Koptsik *et al.*, 1998).

10.2.2 GENERAL AIR EMISSIONS IMPACTS ON VEGETATION

It is difficult to predict site-specific ecological impacts due to air emissions based on data and conclusions in available literature because of significant variations in experimental designs relating dose, duration, and vegetation species. Minor variations in experimental design and the conditions under which the various vegetation species have been fumigated can result in large differences in the tolerance limits of tested species.

Table 10-2 presents a summary of the thresholds for the most sensitive vegetation and the air-pollution induced effects, for important air pollution constituents. To demonstrate the range of tolerances for relevant vegetation, Table 10-3 lists literature results for injury threshold concentrations and characteristic injury symptoms of plants found in the southeastern United States. The species listed are likely to occur in all or many of the Class I areas addressed herein. As a result, all listed vegetation will be used as bioindicators for impacts to all the Class I and II areas relevant to GREC.

Vegetation damage is described as impacts resulting in foliar damage. Less apparent vegetation injury is described as a reduction in growth and/or productivity without visible damage, as well as changes in secondary metabolites such as tannins and phenolic

Table 10-2. Estimated Maximum Facility Impacts Compared to General Plant Injury Symptoms and Threshold Concentrations for Important Air Pollutants

Pollutant	Symptoms	Injury Threshold $\mu g/m^3$	Injury Threshold Sustainable Exposure	Estimated Maximum Facility Impact ($\mu g/m^3$)
SO_2	Bleached spots, intercostal chlorosis	131*	8 hours	5.6†† (3-hour)
SO_2	Absence of the most sensitive lichen	13-26†	Chronic	
NO_2	Increase in Nitrate Reductase activity in sensitive bryophytes	65‡	24 hours	0.4†† (annual)
Mercury	Chlorosis and abscission; brown spotting; yellowing of veins	0.08**	5 weeks	1.1 E-04††

Note: Conservative (worst-case) impact estimated based on modeling results presented in Section 8.0.

Sources: *Jones *et al.,* 1974.
†Wetmore, 1983.
‡World Health Organization, 2000.
**Hindawi, 1970.
††ECT 2009.

Table 10-3. Air Pollutant Injury Threshold Concentrations for Plants Native to the Southeast

Common Name	Scientific Name	SO_2	NO_x
Red maple	*Acer rubrum*	786[a] (5 hours)	
Maple	*Acer* sp.	524 to 6,550[b] (8 hours)	
Bald Cypress	*Taxodium distichum*	2,620[c] (48 hours)	
Bracken fern	*Pteridium aquilinum*	131 to 1,310[b] (8 hours)	
Blackberry	*Rubus* sp.	131 to 1,310[b] (8 hours)	
Ragweeds	*Ambrosia* sp.	1,310 to 2,620[h] (1 hour) 790 1,570 (3 hours)	
Southern red oak	*Quercus falcata*	1,310 to 2,620[h] (1 hour) 790 to 1,570 (3 hours)	
Black oak	*Quercus velutina*	1,310 to 2,620[h] (1 hour) 790 to 1,570 (3 hours)	
Legumes		1,310 to 2,620[h] (1 hour) 790 to 1,570 (3 hours)	
Locust	*Gleditsia* sp.	2,620 to 5,240[h] (1 hour) 1,570 to 2,100 (3 hours)	
Many crop and garden species		2,620 to 5,240[h] (1 hour) 1,570 to 2,100 (3 hours)	
American elm	*Ulmus americana*	131 to 1,310[b] (8 hours)	
White ash	*Fraxinus americana*	131 to 1,310[b] (8 hours)	
Sumacs	*Rhus* spp.	131 to 1,310[b] (8 hours)	
Tulip poplar	*Liriodendron tulipifera*	524 to 6,550[b] (8 hours)	
Sweetgum	*Liquidambar styraciflua*	524 to 6,550[b] (8 hours)	
Slash pine	*Pinus elliottii*	149[f] (chronic)	
Basswood	*Tilia glabra=T. americana*	524 to 6,550[b] (8 hours)	
Pin oak	*Quercus palustris*	524 to 6,550[b] (8 hours)	
Red cedar	*Juniperus virginiana*	>5,240[b] (8 hours)	
Potato		2,620 to 5,240[h] (1 hour) 1,570 to 2,100 (3 hours)	

Table 10-3. Air Pollutant Injury Threshold Concentrations for Plants Native to the Southeast (Continued, Page 2 of 2)

Common Name	Scientific Name	SO_2	NO_x
Upland cotton	*Gossypium hirsutum*	>5,240[h] (1 hour) >2,100 (3 hours)	
Corn	*Zea mays*	>5,240[h] (1 hour) >2,100 (3 hours)	
Lichen	*Ramalina americana*	13 to 26[d] (chronic)	
Lichens	Sensitive species of *Usnea*, *Lobaria*, *Cladonia*	>30[e] (chronic)	
White oak	*Quercus alba*	>5,240[b] (8 hours)	
Dogwood	*Cornus florida*	>5,240[b] (8 hours)	
Bryophyte	*Several Bryophyte species*		65[g] (24 hours)
Birch	*Betula* sp.		120[g] (chronic)
Common sunflower	*Helianthus annuus*		375[g] (chronic)
Alfalfa	*Medicago sativa*		1,000[g] (5 hours)
Peach	*Prunus persica*		>5,240 (1 hour) >2,100 (3 hours)
Garden pea	*Pisum sativum*		850[g] (7 hours)
Cultivated tobacco	*Nicotiana tabacum*		2,000 to 3,000[g] (3.5 hours)
Perennial ryegrass	*Lolium perenne*		125[g] (chronic)
Southern pine	*Pinus* spp.	1572[b] (3 hours)	

Note: Concentrations in $\mu g/m^3$ (exposure times shown in parentheses).

Sources: [a]Davis and Shelly, 1992.
[b]Jones *et al.*, 1974.
[c]Shanklin and Kozlowski, 1985.
[d]Wetmore, 1983.
[e]Treshow and Anderson, 1989.
[f]Hogsett *et al.,* 1985.
[g]World Health Organization, 2000.
[h]EPA, 1982.

compounds (Fitzgerald *et al.*, 1996). Vegetation damage often results from acute exposure to pollution (i.e., relatively high doses over relatively short time periods). Injury is also associated with prolonged exposures of vegetation to relatively low doses of pollutants (chronic exposure). Acute damages, which have both functional and visible consequences, are usually manifested by internal physical damage to foliar tissues. Chronic injuries are typically more associated with changes in physiological processes. The following discussion summarizes descriptions from the literature of the potential effects upon vegetation associated with the relevant pollutants.

10.2.2.1 Nitrogen Oxides

During combustion, atmospheric nitrogen is oxidized to NO and small amounts of NO_2 (Taylor *et al*., 1975). Impacts to vegetation from NO_2 result from high concentrations occurring during short time periods (Taylor and MacLean, 1970). Acute exposures of this sort will cause necrotic lesions in leaf tissue and excessive defoliation (MacLean *et al*., 1968). Nonvascular bryophytes are very sensitive to NO_x exhibiting reductions in nitrate reductase activity at concentrations of 65 $\mu g/m^3$ with an exposure duration of 24 hours (WHO 2000). Bald cypress (*Taxodium distichum*), a common tree species in wetlands of this geographical area, shows no adverse impacts below 2,620 $\mu g/m^3$ with an exposure time of 48 hours (Shanklin and Kozlowski, 1985).

10.2.2.2 Sulfur Dioxide

Natural (ambient) background concentrations of SO_2 range between 0.28 and 2.8 $\mu g/m^3$ on a mean annual basis (Prinz and Brandt, 1985). The most common source of atmospheric SO_2 is the combustion of fossil fuels (Mudd and Kozlowski, 1975). Gaseous SO_2 primarily affects vegetation by diffusion through the stomata (Varshney and Garg, 1979). Small amounts of SO_2 may also be absorbed through the protective cuticle. At low concentrations SO_2 byproducts are effectively detoxified by the plant and can become a sulfur source to the plant, while elevated concentrations can be toxic (Zeiger, 2002). Adverse effects on plants from SO_2 are primarily due to impacts to photosynthetic processes. SO_2 can react with chlorophyll by bleaching or phaeophytinization. This latter process constitutes a photosynthetic deactivation of the chlorophyll molecule. Acute damage due to SO_2 appears as marginal or intercostal areas of dead tissue that at first cause leaves to appear water-soaked (Barett and Benedict, 1970). Chronic injuries are less apparent; the leaves remain turgid and continue to function at a reduced level. In more severe cases of chronic SO_2 exposure, there is some bleaching of the chlorophyll that appears as a mild chlorosis or yellowing of the leaf and/or a silvering or bronzing of the undersurface. Species that are categorized as sensitive to SO_2 emissions are those which show damage to at least 5 percent of the leaf area upon being exposed to 131 to 1,310 $\mu g/m^3$ SO_2 for a period of 8 hours (Jones *et al*., 1974).

Researchers have conducted numerous studies to determine the effects of SO_2 exposure to a wide variety of selected plant species. A review of the literature demonstrates that the most sensitive vascular plants (e.g., white ash, sumacs, tulip poplar, goldenrods [*Solidago* spp.], legumes, blackberry [*Rubus* spp.], black oak [*Quercus velutina*], and ragweeds [*Ambrosia* spp.]) exhibit visible injury to short-term (3 hours) exposure to SO_2 concentrations ranging from 790 to 1,570 $\mu g/m^3$. Tolerant plants native to the southeast region are dogwood (*Cornus florida*), red cedar (*Juniperus virginiana*), and white oak (*Quercus alba*) with injury thresholds greater than 5,240 $\mu g/m^3$ for a 3-hour exposure period (Jones *et al*., 1974). Plants with intermediate tolerance (131 to 1,310 $\mu g/m^3$ for an 8-hour period) are maples (*Acer* spp.), tulip poplar (*Liriodendron tulipifera*), and sweetgum (*Liquidambar styraciflua*). Vascular plant species found in this region of the southeast, which are sensitive or moderately sensitive to SO_2, include bracken fern (*Pteridium aquilinum*), blackberry, sumacs (*Rhus* spp.), and tulip poplar. Complicating generalizations regarding SO_2 injury is the observation that the genetic variability of native annual plants can result in the selection of SO_2 resistant strains in as little as 25 years (Westman *et al*., 1985).

Due to their rather diminutive and inconspicuous nature, lichens and bryophytes are often not considered as important biological components of the ecosystem. However, these nonvascular plants do play a valid role in the environment by functioning as habitat for invertebrates, containing blue-green bacteria that fix nitrogen, participating in mineral cycling, and providing a food source for various fauna, among others.

Nonvascular plants such as lichens and bryophytes are especially important as bioindicators due to well-documented air pollution sensitivity. Because of relatively low chlorophyll content and the absence of the protective covering of a cuticle (common in the leaves of higher plants), nonvascular plants are more sensitive to SO_2 injury. Hart *et al.* (1988) showed that *Ramalina* sp., a lichen genus, exhibited a reduction of CO_2 uptake and biomass gain at SO_2 exposures of 400 µg/m^3 for 6 weeks. Tolerant lichens can resist SO_2 concentrations in the range of 79 to 157 µg/m^3; higher concentrations are deleterious to most nonvascular flora (LeBlanc and Rao, 1975). A mean annual concentration of 30 µg/m^3 of SO_2 may injure sensitive individuals of some lichen species such as *Usnea*, *Lobaria*, *Ramalina*, and *Cladonia* (Treshow and Anderson, 1989). One lichen species, *Ramalina americana*, is known to be absent where SO_2 concentration mean annual values range from 13 to 26 µg/m^3 (LeBlanc and Rao, 1972; Wetmore, 1983).

10.2.2.3 Particulate Matter

In addition to gaseous emissions, small amounts of PM will be emitted by the proposed Project. Typically, the density of PM limits impacts such that only vegetation in proximity to the source may be affected.

Included among the PM may be low concentrations of metals, to the extent present at low levels in biomass fuels. Mercury may occur as both mercury vapors and particulates. The mechanism of mercury phytotoxicity is currently under investigation. Past investigations indicate that mercury vapors will cause chlorosis, abscission of older leaves, growth reduction, and poor development. Most investigations have been restricted to greenhouse crops where air quality monitoring was not conducted. One investigation indicates that vegetation exposed to 50 µg/m^3 mercury for 7 days experienced leaf abscission (Siegel *et al*., 1984). Plants found in the region showing injury at this concentration and period of exposure to mercury are willow (*Salix* spp.) and red maple (*Acer rubrum*).

The literature regarding effects on vegetation from beryllium, arsenic, and lead is scarce. One investigation indicates that vegetation growth was reduced by beryllium concentrations in excess of 735 µg/m^3 (Gough *et al*., 1979). Arsenic uptake by vegetation to a concentration of 5 micrograms per gram (μg/g) is considered harmful. Lead retards plant growth above a concentration of 30 μg/g in the soil.

10.2.2.4 Carbon Monoxide

CO is not considered harmful to plants and is not known to be effectively taken up by plants (Bennett and Hill, 1975). Microorganisms within the soil appear to be a major sink for CO.

10.2.3 GENERAL AIR EMISSIONS IMPACTS ON WILDLIFE

Impacts to wildlife can occur due to direct uptake of pollutants through ingestion or via the skin and more indirectly as a result of air pollution induced changes to wildlife habitat and food source. Studies have shown direct air pollution induced injury and death in wildlife as a result of fluoride, cadmium, SO_2, particulates, NO_x, arsenic, mercury, and oxidants like ozone (Newman 1980; Newman & Schreiber 1985). These impacts are mostly the result of extreme incidences due to acute toxicity. This acute toxicity occurs most severely in circumstances where air pollutants were likely elevated far above the AAQS, or where significantly elevated concentrations of pollutants occurred on vegetation that was subsequently consumed. The AAQS were previously shown in Section 3.0 on Table 3-1. No observed impacts upon wildlife are expected at concentrations below the values reported in Table 10-4.

Studies have shown damage to the tracheal epithelium of bird species at extreme concentrations of NO_x and SO_2 of 2,500 $\mu g/m^3$ and 1,221 $\mu g/m^3$, respectively (Llacuna *et al.*, 1993). These values are far elevated above concentrations that are expected.

Ambient air quality concentrations as a result of GREC will not exceed the NAAQS or values listed in Table 10-4. Pollutant deposition on vegetation at levels harmful to wildlife will likely be lower than plant injury thresholds (Table 10-2 and 10-3). Absent any site-specific studies on baseline levels of pollutants, it is assumed that wildlife impacts will be insignificant if pollutant effects on vegetation are also expected to be insignificant.

Table 10-4. Examples of Reported Stresses to Animals at Various Air Pollutant Concentrations

Pollutant	Reported Effect	Concentration ($\mu g/m^3$)	Animal Exposure
SO_2*	Respiratory stress in guinea pigs	427 to 854	1 hour
	Respiratory stress in rats	267	7 hours/day; 5 days/week for 10 weeks continually for 5 months
	Decreased abundance in deer mice	13 to 157	
NO_x†‡	Respiratory stress in mice	1,917	3 hours
	Respiratory stress in guinea pigs	96 to 958	8 hours/day for 122 days continually for 2 months
Particulates*	Respiratory stress, reduced respiratory disease defenses	120 PbO_3	2 hours
	Decreased respiratory disease defenses in rats, same with hamsters	100 $NiCl_2$	

Sources: *Newman and Schreiber, 1988.
†Gardner and Graham, 1976.
‡Trzeciak *et al.*, 1977.

Persistent pollutants such as mercury have the potential to collect in the environment and bioaccumulate to elevated concentrations in upper-trophic level wildlife. Mercury is a persistent pollutant that accumulates in the sediments. Mercury methylation, whereby inorganic forms of mercury are biologically converted to a bioavailable organic form, occurs most predominantly in the anaerobic conditions found in ponds, lakes, and wetlands (St. Louis *et al.*, 1994; Krabbenhoft *et al.*, 1995; Driscoll *et al.*, 1998). As a result, species living and feeding within these aquatic systems are the most sensitive to mercury bioaccumulation.

Most impacts to wildlife due to emissions from power plants are indirect, predominantly as a result of effects on habitat quality. One such indirect effect is increased acidification. Amphibians are particularly sensitive to increased acidification in vernal pools and ponds as a result of the permeability of their skin. The highest potential for acidification to impact amphibian egg-laying habitat occurs in snow-melt water pools, which do not occur in the project area (Schreiber and Newman, 1988). Loss of fish, amphibians, algae, invertebrates, and vegetative habitat as a result of acidification can impact species further up the food chain such as fish-eating feral mink (Bevanger and Albu, 1986) and wetland waterfowl (Rattner *et al.*, 1987). These studies indicate that the greatest possible impact to wildlife as a whole is degradation of the composition, structure, and habitat value due to increased acidification of the soils and aquatic systems caused by elevated SO_x and NO_x. As discussed in subsequent sections, the atmospheric concentrations of SO_x and NO_x and deposition of sulfur and nitrogenous compounds as a result of the GREC Project are unlikely to cause soil and water acidification.

10.2.4 SPECIFIC AIR EMISSIONS IMPACTS IN THE VICINITY OF GREC

10.2.4.1 Vegetation Impact Evaluation

A description of the vegetative community in the vicinity of GREC is provided Section 3.3.5 of the SCA.

Nitrogen Oxides

Vegetation most sensitive to nitrogen oxides are bryophytes, which have NO_2 tolerances of 65 μg/m^3 for 24 hour exposure (Table 9-3). The maximum annual average NO_2 air quality impact projected for GREC of 0.4 μg/m^3 (Table 10-1) is well below the NAAQS of 100 μg/m^3 (0.0523 ppm) (Table 3-1), and lower than the thresholds of sensitive bryophytes (Table 10-2). As such, no significant vegetative impacts are likely to occur as a result of NO_x emissions from GREC.

Sulfur Dioxide

Sensitive vegetative species show damage to at least 5 percent of their leaf area upon exposures of 131 to 1,310 μg/m^3 SO_2 for a period of 8 hours (Table 10-3). One species of lichen (*Ramalina Americana)* has been shown to be absent at concentrations from 13 to 26 μg/m^3 with chronic, long-term exposures (Table 10-3). The maximum GREC air quality impacts for averaging times of 3 hours, 24 hours, and annual durations of 5.6, 3.3, and 0.3 μg/m^3 (Table 10-1), respectively, result in impacts that are well below the 24-hour and annual AAQS of 0.10 ppm (260 μg/m^3) and 0.02 ppm (60 μg/m^3), respectively (Table 3-1). The most sensitive vascular plants will not exhibit injury symptoms until concentrations increase to values of at least 131 μg/m^3 for 8 hours (Table 10-2) much more than the modeled values of 5.6 μg/m^3 for 3 hours (Table 10-1). Vascular plants are not expected to be affected by emissions from GREC.

PM_{10}

PM_{10} concentrations are projected to increase in the vicinity of GREC by 5.3 and 20.4 μg/m^3, for annual and 24-hour durations, respectively (Table 10-1). NAAQS standards for PM_{10} are 150 μg/m^3 for a 24-hour duration (Table 3-1). Florida's PM_{10} AAQS standards are 150 and 50 μg/m^3 for 24-hour and annual averaging periods, respectively. GREC emissions are well below these AAQS standards. Therefore, no adverse impacts to vegetation are expected in the project vicinity as a result of particulate matter emissions.

CO

CO is not considered harmful to plants and is not known to be effectively taken up by plants (Bennett and Hill, 1975). In addition, the GREC CO air quality impacts of 0.42 milligram per cubic meter (mg/m^3) (420.5 $\mu g/m^3$) and 0.16 mg/m^3 (159.9 $\mu g/m^3$) for durations of 1 hour and 8 hours (Table 10-1), respectively, are orders of magnitude smaller than the 1-hour and 8-hour primary NAAQS of 40 and 10 mg/m^3, respectively (Table 3-1). Therefore, no adverse impacts to vegetation are expected as a result of CO emitted by GREC.

10.2.4.2 Wildlife Impact Evaluation

A description of wildlife in the vicinity of GREC is discussed in Subsection 3.3.6 of the SCA.

Air pollutant concentrations in the project vicinity are projected to be significantly lower than NAAQS standards and minimum threshold concentrations (Table 10-4), below which no wildlife acute toxicity is expected to occur. Most effects on wildlife are indirect, predominantly as a result of decreased habitat quality. As discussed in Section 10.2.4.1, minimal impacts to vegetation are expected to occur as a result of GREC. Therefore, no adverse impacts to wildlife are expected.

Mercury deposition in the area surrounding GREC is projected to be 0.0102 microgram per square meter per year ($\mu g/m^2/yr$). This value is two orders of magnitude smaller than average conservative estimates for background deposition rates of 0.5 to 1 $\mu g/m^2/yr$ as reported in the literature (Bindler, 2003). Therefore, direct impacts to wildlife should be less than normal background deposition.

10.2.4.3 Soil Characteristics

A description of wildlife in the vicinity of GREC is discussed in Subsection 3.3.1 of the SCA.

10.2.4.4 Soils Impact Evaluation

Dominant soil in the vicinity of GREC has a moderately high cation exchange capacity in the surface horizon as well as the subsurface organometallic spodic horizon. In addition, the surface horizon of the dominant soil has a cation exchange capacity in the range where sensitivity to changes in pH have been shown to be reduced (Barton *et al.*, 2002). As a result of these chemical properties, it is likely that the dominant soil will not be adversely impacted by GREC. It is also concluded that the hydric/wetland soils in the vicinity will not be adversely affected by GREC.

10.2.5 SPECIFIC AIR EMISSIONS IMPACTS—CLASS I AREAS

The following subsections describe environmental features and provide a discussion of potential impacts to vegetation, wildlife, and soils at the Okefenokee and Chassahowitzka NWA Class I areas.

10.2.5.1 Okefenokee NWA

Vegetation Types

The Okefenokee NWA consists predominantly of a large swamp with a diversity of wetland communities, intermixed with vegetated islands and a few uplands. The vegetative communities as listed in the Okefenokee NWA Comprehensive Conservation Plan are described in the following paragraphs (U.S. Fish and Wildlife Service [USFWS], 2006).

Broadleaved Hardwoods

This vegetative community covers a large portion of the northwest side of the swamp. The canopy of evergreen, deciduous, and broadleaved trees limits understory vegetation. The canopy consists predominantly of blackgum *(Nyssa sylvatica)* and cypress (*Taxodium* spp.*)*. In addition the vegetation consists of loblolly bay (*Gordonia lasianthus*), red bay (*Persea borbonia*), sweet bay (*Magnolia virginiana*), largeleaf gallberry (*Ilex coriacea*), and dahoon holly (*Ilex cassine*) with a sphagnum moss groundcover.

Cypress/Hardwoods

This community consists of unlogged virgin pond cypress (*Taxodium ascendens*) wetlands and logged areas where cypress recruitment is high enough to be separated from broadleaved hardwoods. The understory vegetation is similar to broadleaved hardwoods.

Mixed Wetland Pine

The mixed wetland pine community is defined by a presence of at least 30-percent slash pine (*Pinus elliottii*) in the canopy mixed with other vegetation types. Associated vegetation includes blackgum, loblolly bay, sweet bay, and a variety of ferns.

Scrub/Shrub

The scrub/shrub ecosystem consists of many species of evergreen and deciduous shrubs intermixed with even-aged stands of young, small trees. Evergreen and deciduous shrubs found in this vegetation type include hurrah bush (*Lyonia leucothoe*), dahoon holly, largeleaf gallberry, gallberry (*Ilex glabra*), titi (*Cyrilla racemiflora*), buttonbush (*Cephalanthus occidentalis*), poor man's soap (*Clethra alnifolia*), Virginia sweetspire (*Itea virginica*), fetterbush (*Leucothoe racemosa*), and highbush blueberry (*Vaccinium fuscatum*). Scrub trees include cypress, blackgum, and bay.

Prairie

Prairies are consistent with communities that are usually described as freshwater marsh. There are two types of prairie communities: aquatic macrophyte prairie and herbaceous prairie. The aquatic macrophyte prairie contains water lily (*Nymphaea odorata),* spatterdock (*Nuphar lutea*), floating heart (*Nymphoides aquatica*), pickerel weed (*Pontederia cordata*), golden club (*Orontium aquaticum*), wampee (*Peltandra virginica*), pipewort (*Eriocaulon compressum*), yellow-eyed grass (*Xyris smalliana*), sphagnum moss species (*Ultricularia* spp.), as well as algae.

The herbaceous prairie is dominated by sedges. In addition chain fern (*Woodwardia virginica*), pitcher plants (*Saracenia* spp.), swamp loosestrife (*Decodon verticillatus*), paint root (*Lachnanthes tinctoria*), wampee, golden club, water lily, pipewort, and yellow-eyed grasses.

Upland Hardwoods

Upland hardwoods contain a variety of scrub oaks that are found in sandhills and sandy ridges.

Longleaf Pine

Longleaf pine comprises 70 percent of the basal area of this forest type. The vegetative composition of this community is predominantly defined by the recurrence of fire. Longleaf pine (*Pinus palustris*) and wiregrass (*Aristida stricta*) occur where fire is frequent. In regions surrounding ponds and wetlands where fire is less common, slash pine, loblolly pine, and pond pine (*Pinus serotina*) occur. In addition, several other hardwoods can be found in this community including several scrub oaks species, black gum, persimmon (*Diospyros virginiana*), and sweetgum (*Liquidambar styraciflua*).

Longleaf/Mixed Pine

A total of 35 to 70 percent of the basal area consists of pine trees in longleaf/mixed pine forests. This is a transitional forest where slash, loblolly, and pond pines intermix with longleaf pines.

Mixed Pine/Longleaf Pine

This vegetation type occurs primarily where longleaf pine was logged and/or where fire was suppressed to allow invasion by slash, loblolly, or pond pines from wetter regions. As a result longleaf pine makes up less than 35 percent of the basal area.

Mixed Pine

The longleaf pine component has been replaced by slash, loblolly, and pond pine in mixed pine forests. Other associated species includes sweetbay, swamp tupelo (*Nyssa sylvatica*), pond cypress, pond pine, loblolly bay, live oak (*Quercus virginiana*), red maple (*Acer rubrum*), water oak (*Quercus nigra*), and laurel oak (*Quercus hemisphaerica*).

The hairy rattleweed (*Baptisia arachnifera*) is the only endangered plant species within Okefenokee NWA, and the parrot pitcher plant (*Sarracenia psittacina*), a threatened species, is found there. There are four Georgia species of special concern found within Okefenokee NWA including silver buckthorn (*Sideroxylon alachuense*), greenfly orchid (*Epidendrum conopseum*), fly catcher/golden trumpet (*Sarracenia flava*), and the hooded pitcher plant (*Sarracenia minor*).

Vegetation Impact Evaluation

EPA monitors NO_2, PM_{10} and SO_2 at monitoring stations across the nation. These data are publicly available at the EPA Web site (http://www.epa.gov/air/oaqps/montring.html #attainment). These data will be referred to throughout this discussion to determine baseline concentrations. These stations are monitored for a determination of nonattainment areas based on the NAAQS (Table 3-1). Monitoring stations are spread throughout the region, which makes it difficult to determine the relevance of monitored concentrations to impacts at the Okefenokee NWA. Nevertheless, monitoring stations in the closest proximity will be used to place emissions values in perspective. NO_2 concentrations in Jacksonville, Florida, remain approximately one-fifth of the national standard of 0.053 ppm (100 $\mu g/m^3$) (Table 3-1) and below the vegetative injury threshold of 65 $\mu g/m^3$ with a 24-hour duration (Table 10-2). GREC is projected to have a maximal annual increase in atmospheric NO_2 concentration within the Okefenokee NWA of 0.0025 $\mu g/m^3$ (Table 10-1). This is well below concentrations where any potential vegetative impact to the refuge is likely to occur (Table 10-2). SO_2 monitored at the aforementioned sites consistently remains well below the national standard of 0.03 ppm (80 $\mu g/m^3$) (Table 3-1). GREC is modeled to increase the maximum 3-hour, 24-hour, and annual atmospheric SO_2 concentrations by 0.23, 0.051, and 0.0023 $\mu g/m^3$, respectively (Table 10-1). As shown in Table 10-3, the species most sensitive to SO_2 within an 8-hour duration are American elm and white ash, although injury does not occur until concentrations exceed 131 $\mu g/m^3$ (Table 10-3*)*, which is well above the projected 3-hour average increase

(0.23 μg/m^3) as a result of GREC. Lichens, which are more sensitive to chronic exposure, do not exhibit injury symptoms until concentrations exceed 13 μg/m^3 (Table 10-3). Therefore, it is unlikely that vegetation in Okefenokee NWA will be adversely impacted by GREC SO_2 impacts.

Average annual PM_{10} concentrations at Jacksonville have never exceeded the Florida/Georgia annual AAQS standard of 50 μg/m^3 (Table 3-1). Maximum PM_{10} emissions as a result of GREC (Table 10-1) are several orders of magnitude lower than national standards (Table 3-1).

Typical Wildlife

The Okefenokee NWA is home to 48 species of mammals, 200 species of birds, 33 species of fish, 101 species of reptiles and amphibians, and many species of invertebrates. The refuge was originally established for the conservation of birds, and there are a variety of migratory and resident birds. Birds found within the refuge include wood ducks, osprey, swallow-tailed kites, as well as a variety of wading birds including great egrets, great blue herons, white ibis, and little blue herons. The refuge is a temporary stopping point for many migrating waterfowl, although populations are not as great as other coastal wetlands within the east coast. Species of waterfowl found in the refuge include ring-necked ducks, mallards, blue-winged, and green-winged teal and wood ducks. Listed bird species known to occur in the Okefenokee NWA include the red-cockaded woodpecker, and one swallow-tailed kite nest was also found. In addition, the swamp has both resident and migratory sandhill cranes.

There are some notable large mammals present in the Okefenokee NWA. Florida black bear, white-tailed deer, the round-tailed muskrat, and the Rafinesque's big-eared bat have been observed on the property. The dominant fish species present on the property include the bowfin and the flier comprising 88 percent of the catch. Overall, 36 species of fish have been identified. The wetlands of the Okefenokee NWA facilitate a diverse amount of herptofauna and reptiles including the American alligator and many species of frogs and turtles. Ephemeral ponds support the flatwoods salamander, the striped newt, the gopher frog, and other species. Federally listed species include indigo snakes along with the American alligator. Other rare or sensitive species that can be found include the gopher tortoise, pine snake, eastern hognose, diamondback rattlesnake, and eastern glass lizard.

Wildlife Impact Evaluation

Air pollutant concentrations in the project vicinity are projected to be well below NAAQS and minimum threshold concentrations (Table 10-4), below which no wildlife acute toxicity is expected to occur. Most air pollution effects on wildlife are indirect, predominantly as a result of decreased habitat quality. As discussed previously, minimal impacts to vegetation are expected to occur as a result of the low emissions increases in the Okefenokee NWA. Therefore, no adverse impacts to wildlife are expected.

Natural conservative background mercury deposition levels determined from accumulated peat are 0.5 and 1 $\mu g/m^2/yr$ (Bindler, 2003). Mercury methylation, whereby mercury is transformed into an organic toxic form, is accelerated in wetlands like Okefenokee (St. Louis *et al.*, 1994; Krabbenhoft *et al.*, 1995; Driscoll *et al.*, 1998). Studies in the Okefenokee Swamp have found mean mercury concentration in fish tissues of 0.359 $\pm$0.21 mg/L weight) (Mason and Bowers, 1995). The presence of mercury in the Okefenokee NWA is thought to occur as a result of wet and dry atmospheric deposition.

As discussed previously, the mercury deposition rate as a result of GREC (0.0102 $\mu g/m^2/yr$) in the vicinity is an order of magnitude lower than natural background deposition (0.5 to 1 $\mu g/m^2/yr$) (Bindler 2003). It is safe to assume that mercury deposition at the distant Okefenokee NWA will be much lower than the small amount emitted in the vicinity of GREC, where it was deemed that no wildlife impacts are projected to occur. Therefore, it is concluded that there will be no adverse impacts to wildlife from mercury within the Okefenokee NWA as a result of GREC.

Soil Characteristics

Soil types within the Okefenokee NWA change with their elevation along a gradient from wetlands to uplands, with corresponding changes in vegetation. Soil series present in the

Okefenokee NWA are Dasher, Pamlico, Croatan, Allanton, Lynn Haven, Surrency, Plummer, Pelham, Sapelo, Leon, Mascotte, Olustee, Mandarin, and Ridgeland (USFWS, 2006). National Resources Conservation Service (NRCS)/U.S. Department of Agriculture (USDA) soil surveys were used where available to compile a table of soil pHs (Table 10-7) and relevant soil chemical properties such as CEC and base saturation (Table 10-8). None of the counties in Georgia where the Okefenokee NWA is present have published soil surveys. As a result, all data was taken from Baker County, Florida. The soils listed are histosols in the permanently inundated areas with ultisols in the intermediate elevations and spodosols in the highest elevations.

Soils Impact Evaluation

Dominant soil types (Histosols, Ultisols, and Spodosols) have a high degree of sulfate adsorption capability, increasing their buffering capacity to changes in pH (Johnson and Reuss, 1984). The soils by their very nature have a low pH, base saturation, and CEC, and it is likely that the vegetation is adapted to these low pH, low fertility conditions.

As discussed previously, soils are impacted by air pollution predominantly as a result of wet and dry atmospheric deposition of sulfur and nitrogen containing compounds and other trace elements such as mercury. This can contribute to acidification, eutrophication, and other effects.

Due to the relatively low GREC NO_x and SO_2 emissions, sulfur and nitrogen atmospheric wet and dry deposition within the Okefenokee NWA will be insignificant and will not cause any measurable impact on soils or ecosystem health.

10.2.5.2 Chassahowitzka NWA

Vegetation Types

The predominant vegetative communities that are represented in the Chassahowitzka NWA include hardwood swamps, cypress ponds, flatwoods, saltmarsh, sandhill, scrub, and wet prairies (USFWC, 2001).

Table 10-7. Soil pHs for the Soils Found on Okefenokee NWA

Soil	Depth (inches)	Soil Reaction
Dasher	0 to 80	3.6 to 4.4
Allanton	0 to 80	3.6 to 5.5
Leon	0 to 80	3.6 to 6.5
Mandarin	0 to 80	3.6 to 6.0
Mascotte	0 to 80	3.6 to 5.5
Olustee	0 to 80	3.6 to 5.5
Pamlico	0 to 18	3.6 to 4.4
	18 to 80	3.6 to 5.5
Pelham	0 to 80	3.6 to 5.5
Plummer	0 to 80	3.6 to 5.5
Sapelo	0 to 80	3.6 to 5.5
Surrency	0 to 28	3.6 to 5
	28 to 80	3.6 to 5.5

Source: USDA, NRCS soil surveys of Baker County, Florida 1996.

Table 10-8. Chemical Properties of the Soils Within the Okefenokee NWA

Soil	Depth (cm)	Horizon	Ca	Mg	Na	K	CEC	Base Saturation
Leon	0 to 7	A1	0.25	0.11	0.02	0.01	4.83	8
	7 to 21	A2	0.04	0.01	0.01	0	1.05	6
	21 to 24	Bh1	0.04	0.01	0	0	23.83	—
	24 to 26	Bh2	0.03	0.01	0.01	0	12.35	—
	26 to 38	BC	0.02	0.01	0	0	2.96	1
	38 to 47	E	0.02	0.01	0	0	3.52	1
	47 to 55	B'h1	0.01	0.01	0	0	2.78	1
	55 to 80	B'h2	0.03	0.01	0	0	5.83	1
Mascotte	0 to 6	A	0.7	0.22	0.04	0.06	10.65	10
	6 to 18	E	0.06	0.02	0	0	1.24	6
	18 to 20	Bh1	0.12	0.04	0.02	0.02	13.61	1
	20 to 24	Bh2	0.06	0.02	0	0	24.24	0
	24 to 29	BE	0.03	0.02	0	0	3.86	1
	29 to 38	E'	0.03	0.03	0	0	0.35	17
	38 to 52	Btg1	0.09	0.14	0	0.02	6.42	4
	52 to 56	Btg2	0.03	0.04	0	0.01	15.83	1
	56 to 80	C	0.02	0.01	0	0.01	17.84	0
Olustee	0 to 8	Ap	0.19	0.08	0.03	0.04	5.76	6
	8 to 14	Bh	0.04	0.02	0.03	0.01	4.42	3
	14 to 27	E1	0.02	0.02	0.03	0	1.67	4
	27 to 37	E2	0.02	0.02	0.03	0	2.55	3
	37 to 57	Btg1	0.15	0.29	0.05	0.02	5.32	10
	57 to 80	Btg2	0.18	1.07	0.09	0.01	6.3	21
Sapelo	0 to 6	A	0.12	0.1	0	0.02	3.8	6
	6 to 18	E	0.05	0.03	0	0.01	1.39	6
	18 to 22	Bh1	0.08	0.06	0.02	0.02	3.49	5
	22 to 26	Bh2	0.07	0.02	0	0.01	20.27	0
	26 to 31	BE	0.03	0.01	0	0	5.24	1
	31 to 48	E'	0.04	0.01	0	0.01	0.6	10
	48 to 55	Btg1	0.04	0.02	0	0.01	3.89	2
	55 to 70	Btg2	0.09	0.09	0	0.02	5.95	3
	70 to 80	C	0.08	0.11	0	0.01	4.2	5

Source: USDA, NRCS soil surveys of Baker County, Florida 1996.

Hardwood Swamp

The hardwood swamp is the most prevalent vegetative community in the Chassahowitzka NWA. This community is a palustrine wetland community characterized by the diverse mixture of trees, shrubs, and vines that vary with the differences in elevation. Dominant tree species include bald cypress (*Taxodium distichum*), red maple (*Acer rubrum),* sweet gum (*Liquidambar styraciflua*), winged elm (*Ulmus alata*), southern magnolia (*Magnolia grandiflora*), ashes (*Fraxinus* spp.), and southern red cedar (*Juniperus silicicola*). The subcanopy includes redbud (*Cercis canadensis*) and basswood (*Tilia* spp.*)* in higher elevation sites and red bay (*Persea borbonia*), swamp dogwood (*Cornus foemina*), and dahoon holly (*Ilex cassine*) in lower elevations. The understory vegetation consists of dwarf palmetto (*Sabal minor*), American beautyberry (*Callicarpa americana*), and grape vines (*Vitis* spp.) in higher elevations, while wax myrtle (*Myrica cerifera*), dewberry (*Rubus* spp.), and various ferns are found in lower elevations. The vegetative community provides a good source of mast for numerous wildlife species and plentiful habitat.

Cypress Pond

Cypress ponds are found in depressions throughout the uplands. The vegetative community consists of pond cypress (*Taxodium ascendens*), bald cypress, red maple, sweet gum, Virginia willow (*Itea virginica*), and buttonbush (*Cephalanthus occidentalis).*

Flatwoods

Flatwoods are often located in regions with unproductive soils with low water available to the vegetation. The plant community consists largely of longleaf pine (*Pinus palustris*) or slash pine (*P. elliottii*) with an understory consisting of saw palmetto (*Serenoa repens*) wax myrtle, and gallberry (*Ilex glabra*). The quality of this community for wildlife utilization appears to be poor as a result of historic fire suppression.

Sandhills

Xeric conditions brought on by sandy soils define the sparse vegetative community of the sandhills. The tree canopy consists of longleaf pine, sand pine (*Pinus clausa*), blackjack oak (*Q. incana*), and turkey oak (*Quercus laevis*) with wiregrass (*Aristida stricta*), palmettos, and various herbs in the understory.

Saltmarsh

The saltmarsh community occurs from the Gulf of Mexico in to the tidal creeks with the vegetative community transitioning from black needle rush (*Juncus roemerianus*) and smooth cordgrass (*Spartina alterniflora*) in the high salinity portions to sawgrass (C*ladium jamaicense*) in the fresher portions. Upland islands consist of red cedar, cabbage palm, and live oaks.

Scrub

The scrub community occurs on north-south strands occurring along prehistoric dunes. Scrub communities consist of sand pine, myrtle oak (*Q. myrtifolia*), and scrub live oak (*Q. geminata*).

Wet Prairie

Wet prairies occur scattered throughout the sandhills. They are dominated by marsh species including white-tops (*Dichromena colorata*), spikerushes (*Eleocharis* spp.), bog buttons (*Lachnocaulon anceps*), dahoon holly, American lotus (*Nelumbo lutea*), and spatterdock (*Nuphar lutea*).

Vegetation Impact Analysis

Monitoring stations are spread throughout the region at different distances from the Chassahowitzka NWA. Nonetheless, these measurements can be illustrative of baseline conditions at the Chassahowitzka NWA. The NO_2 concentration at St. Petersburg remains stable at approximately one-fifth of the national annual standard of 0.053 ppm (100 $\mu g/m^3$). As a result of GREC, maximum NO_2 concentrations are projected to have a maximum annual increase of only 0.0015 $\mu g/m^3$ (Table 10-1), a small fraction of levels known to cause harm to the most sensitive vegetation (65 $\mu g/m^3$ for 24 hours) as shown in Table 10-2. Currently, SO_2 at the Tampa-St. Petersburg-Clearwater sites are well below the annual national standard 0.03 ppm (80 $\mu g/m^3$) (Table 3-1). A maximum SO_2 increase in

3-hour, 24-hour, and annual concentrations of 0.15, 0.044, and 0.0015 μg/m^3, respectively (Table 10-1), as a result of GREC will not impact the most sensitive vegetation with tolerances of 131 μg/m^3 for 8 hours and 13 μg/m^3 for chronic exposures (Table 10-3). The SO_2 concentration increase as a result of GREC will produce a negligible increase in concentrations with respect to vegetative impacts.

PM_{10} concentrations in the St. Petersburg-Tampa-Clearwater area remain well below the annual average Florida AAQS standard of 50 μg/m^3. The impact from the small maximum annual and 24-hour PM_{10} increases of 0.0029 and 0.057 μg/m^3, respectively (Table 10-1), as a result of GREC, are negligible with regard to ecosystem impacts within the Chassahowitzka NWA.

Typical Wildlife

The diverse array of communities and the close association between wetlands and uplands allows for a wide array of wildlife species. Many species of wildlife that are endangered, threatened, or species of special concern are present in the Chassahowitzka NWA including the Florida black bear, Florida mouse, gopher tortoise, Eastern indigo snake, Florida gopher frog, American alligator, Florida pine snake, and potentially bald eagles. The heterogeneous composition of the aquatic communities and range of salinities allows for a large diversity of fish species typical of this region of Florida.

Whooping crane populations have recently been established to winter in the Chassahowitzka NWA. In addition, along their migratory pathway, they have been known to occur near the GREC Site. This is a sensitive species brought back from the brink of extinction. On their wintering grounds, the whooping crane prefers a habitat within estuarine marshes, shallow bays, and salt tidal flats and can be found within freshwater wetlands along their migration path. They prefer to feed on crabs, shrimps, clams, snails, frogs, snakes, grasshoppers, larval and nymph forms of flies, beetles, water bugs, birds, and small mammals. In addition, they have been known to eat more than 58 species of fish.

Wildlife Impact Evaluation

Air pollutant concentrations in the project vicinity are projected to be well below NAAQS (Table 3-1) and minimum threshold concentrations (Table 10-4), below which no wildlife acute toxicity is expected to occur. Most air pollution effects on wildlife are indirect, predominantly as a result of decreased habitat quality. As discussed previously, minimal impacts to vegetation are expected to occur as a result of the low emissions increases in the Chassahowitzka NWR. Therefore, no adverse impacts to wildlife are expected due to GREC.

Due to the fact that the cranes are a carnivorous species, predominantly feeding in wetlands, (where mercury methylation is accelerated) there is a potential for biomagnification of mercury. Mercury deposition is monitored at the Chassahowitzka NWR as part of the Mercury Deposition Program. Annual average wet deposition values of mercury at the monitoring station range from 0.3 to 0.5 kg/ha/yr. These values are within the lower end of the range of reported background mercury deposition rates of 0.5 to 1 $\mu g/m^2/yr$ (Bindler, 2003). No studies have been found that determine the impact of mercury deposition on the Chassahowitzka NWA ecosystem, but these deposition levels are roughly equivalent to deposition occurring in Okefenokee NWA.

The mercury deposition rate as a result of GREC (0.0102 $\mu g/m^2/yr$) in the vicinity of GREC is an order of magnitude lower than conservative natural background deposition estimates (0.5 to 1 $\mu g/m^2/yr$) (Bindler 2003). It is safe to assume that mercury deposition at the distant Chassahowitzka NWR will be much lower than the small amount emitted in the vicinity of GREC, where it was deemed that no wildlife impacts are projected to occur. Therefore, it is unlikely that whooping cranes will be significantly affected by mercury along their migratory pathway or in their wintering grounds in the Chassahowitzka NWA as a result of GREC.

Migratory birds spending time in freshwater wetlands can be affected by acidification (Longcore, Ross, and Fischer, 1987). Reproductive success of birds with a variety of feeding habits has declined as a result of acidification-induced reductions in food abundance (Blancher and McAuley, 1987). Due to the low emissions discussed throughout these sections, which have been shown to be below levels causing significant acidity, it is unlikely that the whooping crane will be affected.

<u>Soil Characteristics</u>

Soil types within the Chassahowitzka NWA are listed in the conceptual management plan (USFWS, 2001). NRCS/USDA soil surveys were used to compile a table of soil pH (Table 10-9). Soils found in the Chassahowitzka NWA range from very poorly drained organic soils (Aripeka-Okeelanta-Lauderhill and Okeelanta-Terra Ceia) in the freshwater wetlands and saltwater marshes to excessively drained sandy soils in the sandhills (Candler fine sand). The dominant soils are histosols and the psamment subgroup of the series entisols.

<u>Soils Impacts Evaluation</u>

Dominant soil types (histosols, psamment entisols) have a high sulfate adsorption capacity, increasing buffering to changes in pH (Johnson and Reuss, 1984). Base saturation of the soils of the Chassahowitzka NWA tends to be high, even in surface horizons, further indicating a strong buffering capacity. The Astatula soil has a low base saturation, but it comprises only 0.15 percent of the refuge.

Due to the relatively low GREC NO_x and SO_2 emissions, sulfur and nitrogen atmospheric wet and dry deposition within the Chassahowitzka NWA will be insignificant and will not cause any measurable impact on soils or ecosystem health.

Table 10-9. Soil pHs for the Soils Found in the Chassahowitzka NWA

Soil	Depth (inches)	Soil Reaction (pH)
Adamsville-fine sand	0 to 80	4.5 to 7.8
Anclote fine sand	0 to 80	5.1 to 8.4
Aripeka fine sand	0 to 13	5.6 to 7.8
	13 to 21	6.6 to 8.4
Aripeka - Okeelanta - Lauderhill		
Okeelanta	0 to 27	5.1 to 6.5
	27 to 60	5.1 to 7.3
Lauderhill	0 to 80	6.1 to 8.4
Astatula fine sand	0 to 80	4.5 to 6.5
Basinger fine sand	0 to 8	3.6 to 8.4
	8 to 60	3.6 to 7.3
Basinger fine sand, depressional	0 to 80	3.6 to 7.3
Candler fine sand	0 to 80	4.5 to 6.0
EauGallie fine sand	0 to 25	4.5 to 6.0
	25 to 33	4.5 to 6.5
	33 to 57	5.1 to 7.8
	57 to 63	5.1 to 7.8
Homosassa mucky fine sandy loam	0 to 80	6.1 to 7.8
Lacoochee fine sandy loam	0 to 8	7.9 to 8.4
	8 to 13	6.6 to 8.4
Myakka fine sand	0 to 80	3.6 to 6.5
Okeelanta - Terra Ceia		
Okeelanta	0 to 27	4.5 to 7.8
	27 to 60	5.1 to 7.8
Terra Ceia	0 to 80	5.6 to 8.4
Paola fine sand	0 to 80	3.6 to 7.3
Pomello fine sand	0 to 80	4.5 to 6.0
Tavares fine sand	0 to 80	4.5 to 6.0
Weekiwachee muck	0 to 80	6.1 to 7.8
Weekiwachee - Homosassa	0 to 80	6.1 to 7.8

Source: USDA, NRCS soil surveys of Citrus County, 1988 and Hernando County, 1977.