3.14 CLIMATE CHANGE

3.14.1 Existing Conditions

Global Climate Change refers to any significant change in the measures of climate lasting for an extended period of time. Climate Change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer. Some gases, such as carbon dioxide and methane, trap heat in the atmosphere and transform the light of the sun into heat, similar to the glass walls of a greenhouse; these are known as greenhouse gases (GHG).

Earth's average temperature is predicted to change from 1.1°C to 6.4°C from the year 1990 to 2100 (IPCC 2007). Human-generated GHG emissions significantly contribute to the changes in the global climate, which have a number of physical and environmental effects. Effects associated with Global Climate Change include sea level rise, flooding, and impacts to ecosystem and biodiversity. Therefore, while impacts may be seen locally, Climate Change has a global study area.

3.14.1.1 Climate Change

Over time, the Earth's climate has undergone periodic ice ages and warming periods, as observed in fossil isotopes, ice core samples, and through other measurement techniques. Recent Climate Change studies use the historical record to predict future climate variations and the level of fluctuation that might be considered statistically normal given historical trends.

Temperature records from the Industrial Age (ranging from the late eighteenth century to the present) deviate from normal predictions in both rate and magnitude. Most modern climatologists predict an unprecedented warming period during the next century and beyond, a trend that is increasingly attributed to human-generated greenhouse gas emissions resulting from the industrial processes, transportation, solid waste generation, and land use patterns of the twentieth and twenty-first centuries. Increased GHG emissions are largely the result of increasing fuel consumption, particularly the incineration of fossil fuels. According to the United Nations Intergovernmental Panel on Climate Change (IPCC), GHG emissions associated with human activities have grown since pre-industrial times, increasing by 70 percent between 1970 and 2004, and further predicts that the range of global mean temperature change from year 1990 to 2100 could be anywhere from 1.1°C to 6.4°C (IPCC 2007).

The GHG emissions from an individual project, even a very large development project, would not individually generate sufficient greenhouse gas emissions to measurably influence Global Climate Change (AEP 2007); however, Climate Change is an irreversible, significant cumulative impact on a global scale. Consideration of a project's impact to Climate Change, therefore, is essentially an analysis of a project's contribution to a cumulatively significant global impact through its emission of GHG.

3.14.1.2 Climatology

See Section 3.13.1.2.

3.14.2 Greenhouse Gases

Gases that trap heat in the atmosphere are called GHG because they transform the light of the sun into heat, similar to the glass walls of a greenhouse. Common GHG included in the analysis are carbon dioxide, methane, and nitrous oxides.

Carbon dioxide (CO_2) is an odorless, colorless gas, which has both natural and anthropogenic sources. Natural sources include decomposition of dead organic matter; respiration of bacteria, plants, animals, and fungus; evaporation from oceans; and volcanic outgassing. Anthropogenic sources of carbon dioxide are from burning coal, oil, natural gas, and wood. CO_2 emissions in South Carolina are mainly associated with fossil fuel combustion in in-state power plants.

Methane (CH_4) is a flammable gas and is the main component of natural gas. A natural source of methane is the anaerobic decay of organic matter. Geological deposits, known as natural gas fields, also contain methane, which is extracted for fuel. Other sources include the exhaust from the combustion of fossil fuels, landfills, fermentation of manure, and cattle.

Nitrous oxide (N_2O), also known as laughing gas, is produced naturally by microbial processes in soil and water. Anthropogenic sources of nitrous oxide include agricultural sources, industrial processing, fossil fuel-fired power plants, and vehicle emissions. N_2O also is used as an aerosol spray propellant and has medical applications (EPA 2015k).

3.14.2.1 Existing levels of GHGs

Global

Worldwide anthropogenic emissions of CO_2, CH_4, and N_2O in 2010 were approximately 45,000 mllion metric tons (MMT) CO_2e (million metric tons of carbon dioxide equivalence), including ongoing emissions from land use and forestry. CO_2 emissions account for about 34,000 MMT CO_2e of the total emissions of 45,000 MMT CO_2e. CH_4 emissions account for about 7,000 MMT CO_2e and N_2O emissions for about 4,000 MMT CO_2e (EPA 2014c).

United States

The EPA publication, *Inventory of U.S. GHG Emissions and Sinks: 1990-2013,* provides a comprehensive emissions inventory of the nation's primary anthropogenic sources and sinks of GHG. Emissions of CO_2, CH_4, and N_2O in 2012 in the United States totaled 6,673 MMT CO_2e. Of the total, CO_2 accounted for 82 percent, CH_4 accounted for 10 percent, and N_2O accounted for 5 percent. Overall, United States emissions increased by 2.0 percent from 2012 to 2013. Recent trends can be attributed to multiple

factors, including increased emissions from electricity generation, an increase in miles traveled by on-road vehicles, an increase in industrial production and emissions in multiple sectors, and year-to-year changes in the prevailing weather. Additionally, GHG emissions in 2013 were 9 percent below 2005 levels (EPA 2015l).

South Carolina

In 2005, activities in South Carolina accounted for approximately 93 MMT of CO_2e emissions. South Carolina's gross GHG emissions increased 39 percent from 1990 to 2005, while national emissions rose by 16 percent from 1990 to 2005. Principal sources of South Carolina's GHG emissions are electricity consumption and transportation, accounting for 35 percent and 34 percent of South Carolina's gross GHG emissions in 2005, respectively. The next largest contributor is the residential, commercial, and industrial fuel use sector, accounting for about 19 percent of gross GHG emissions in 2005. The waste management and agriculture sectors each contribute 3 percent and industrial process emissions comprised 4 percent of State GHG emissions in 2005 (CCS 2008).

3.14.3 Predicted Effects of Climate Change

Climate Change could have a number of adverse effects. Although these effects would have global consequences, in most cases they would not disproportionately affect any one site or activity. In other words, many of the effects of Climate Change are not site-specific. Emission of GHG would contribute to the changes in the global climate, which would in turn, have a number of physical and environmental effects. A number of general effects that may occur are discussed below.

Sea Level: Increase in atmospheric temperature in turn increases ocean temperature. The warming of seawater causes it to increase its volume through a process called thermal expansion. Climate Change also causes ice to melt. Thus, sea levels rise due to thermal expansion and the input of more water from snow and ice melt. Sea level rise is classified into two categories: global and relative. Absolute sea level rise is the net increase in sea level averaged over the globe. Relative sea level rise is specific to locations and takes land changes into account, such as the subsidence and rising of land. From 1993 to 2014, absolute sea level rose approximately 0.11 to 0.14 inch per year. From 1960 to 2014, the absolute sea level rose about 4 inches; however, the relative sea level rise along the South Carolina coast rose between 6 and 8 inches from 1960 to 2013 (EPA 2015m). Of South Carolina's 851 miles of coastline, about 327 miles are at moderate vulnerability to further relative sea level rise, nearly 240 miles are highly vulnerable, and over 218 miles are very highly vulnerable (NOAA 2011).

Increased Frequency and Intensity of Storm Events: A predicted result of Climate Change is the increase in storm events and their intensity, causing greater water inputs in shorter periods of time, affecting flood frequency and duration. The Climate Change phenomena of increasing land, surface water, sea surface and atmospheric temperatures in addition to rising sea level have the potential to cause more severe flood events, increased coastal flooding, and increased storm surge flooding

(SCDNR 2013). The City of North Charleston is subject to flooding from Atlantic Ocean hurricanes and other storms. The City has experienced many hurricanes resulting in local property damaged being caused by high winds and flood. The most recent events were Hurricane Hugo in 1989 and Hurricane Floyd in 1999 (City of North Charleston 2016).

Ecosystems and Biodiversity: Climate Change is expected to have effects on diverse types of ecosystems, from alpine to deep sea habitat. As temperatures and precipitation change, seasonal shifts in vegetation will occur; this could affect the distribution of associated flora and fauna species. As the range of species shifts, habitat fragmentation could occur, with acute impacts on the distribution of certain sensitive species. The IPCC states that "20 percent to 30 percent of species assessed may be at risk of extinction from Climate Change impacts within this century if global mean temperatures exceed 2 to 3°C (3.6 to 5.4°F) relative to pre-industrial levels." Shifts in existing biomes could also make ecosystems vulnerable to invasive species encroachment. Wildfires, which are an important control mechanism in many ecosystems, may become more severe and more frequent, making it difficult for native plant species to repeatedly re-germinate. In general terms, Climate Change is expected to put a number of stressors on ecosystems, with potentially catastrophic effects on biodiversity. Warmer air and water temperatures, hurricanes, increased storm surges, and sea level rise are expected to alter the Southeast's local ecosystems and agricultural productivity. Declining freshwater availability, saltwater intrusion, land loss, drought, and increasing temperatures are expected to stress agricultural crops and decrease yields. Some croplands may be lost entirely to inundation this century while production of crops that need chilling periods, such as many fruits, may need to shift northward with warming temperatures. High temperatures also cause heat stress for dairy cows and livestock and reduce production yields, potentially leading to relocation of these industries, or shifts to more heat-tolerant breeds. Sea level rise will increase the salinity of estuaries, coastal wetlands, tidal rivers, and swamps. Rapid sea level rise could also eliminate some barrier islands that currently protect inland habitats, while reduction of wetlands increases the potential for loss of important fishery habitat. Ocean warming could affect seafood harvest in the Southeast by changing the species in the region, altering migration patterns and timing of fish presence, or affecting fish growth rates (EPA 2015n).