

*Appendix G*  
*Additional Impacts Analysis*

## **Spiritwood Station**

### **Appendix G – Additional Impacts Analysis**

In accordance with 40 CFR 52.21(o), Spiritwood Station has assessed whether air emissions from the construction and operation of the Spiritwood Station facility could adversely affect nearby: (1) soils and vegetation, (2) threatened or endangered plant and animal species, and (3) visibility. Spiritwood Station has also assessed whether general commercial, residential, industrial, or other economic growth due to the project may indirectly impact air quality in the area.

#### **Growth Analysis**

This section evaluates the potential for indirect air quality impacts due to economic and employment growth in the project area. The nearest town in proximity to the proposed Spiritwood Station site is Spiritwood, North Dakota, population 103. Employees and temporary construction workers would also be drawn from the nearby city of Jamestown and throughout Stutsman County and surrounding areas. The current population of Stutsman County is 20,835, which is about a 4.9% decrease from 2000 levels. The county population has remained level since 2000. Private non-farm employment in Stutsman County reached about 8,302 according to the 2003 survey, which was a decrease of 12.8% from the 2000 census.<sup>1</sup> Overall, the Jamestown, ND area is seeing a notable economic decline and population decrease.

Spiritwood Station's proposed project is expected to create 40 new fulltime equivalent jobs at the plant by the time that full operations commence in 2009. During construction, which is expected to last approximately two years, the project is expected to employ a peak of about 100 workers, while the long term operations of the facility will require 40 workers. The project will increase the local rate of economic and development growth moderately; however, the comparative increase in local employment and economic activity due to the project is expected to only partially offset the current decline in population.

#### **Construction Impacts**

Under certain meteorological conditions, diesel exhaust and dust from trucks and other vehicles can temporarily affect local air quality during site construction and preparation. However, Stutsman County and the entire state of North Dakota is in attainment or is unclassified for all criteria

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<sup>1</sup> 2000 - 2003 Census Data; downloaded from <http://quickfacts.census.gov/qfd/states/38/38093.html> on October 2, 2006.

pollutants.<sup>2</sup> Temporary air emissions from construction vehicles are not expected to significantly impact ambient air quality, especially given that the site is in a relatively rural area where little traffic currently takes place. However, truck traffic and other construction activity can raise nuisance levels of dust during dry periods. Therefore, fugitive dust will need to be managed as necessary through the application of water to onsite roads used by construction equipment.

### **Soils and Vegetation Analysis**

This section summarizes the potential effects of NO<sub>2</sub>, SO<sub>2</sub>, CO, and PM<sub>10</sub> emissions on vegetation and soils in eastern North Dakota generally and in the area surrounding Spiritwood Station specifically.

#### ***Eastern North Dakota Vegetation***

The project area is in the Northern Glaciated Plains ecoregion of North Dakota. Vegetation in this ecoregion was historically transitional between tallgrass and shortgrass prairie. These grasslands were dominated by big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), Indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*) and western wheatgrass (*Pascopyrum smithii*). As a result of the level topography and productive soils of the region, most of the area has been converted to cropland or pasture. Principal crops include wheat and small grains, sunflowers and alfalfa. There are a number of small temporary and seasonal wetlands scattered across the landscape. Many of these have been tilled or are tilled and planted.

#### ***Project Area Vegetation***

Based on USGS data, land cover in the area within a one mile radius of the facility consists primarily of row crops. Table G-1 details the National Land Cover Data (NLCD) vegetation types within a one mile radius of the facility. Over 59% of the land is in row crops, with an additional 18% in pasture or hay. Wetlands comprise less than 9% of the land cover in the area. Wetlands near the plant are primarily emergent wetlands that are either seasonally or semi-permanently flooded. Figure 1 at the end of this report highlights these land cover details.

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<sup>2</sup> 40 CFR 81.335

**Table G-1. National Land Cover Data Vegetation Types in One Mile Study Area**

Land Cover Type	Acres	% of total
Open Water	131	6.5%
Low Intensity Residential	7	0.3%
High Density Residential	4	0.2%
Commercial/Industrial/ Transportation	48	2.4%
Deciduous Forest	< 1	0.0%
Evergreen Forest	2	0.1%
Grasslands/Herbaceous	70	3.5%
Pasture Hay	359	17.9%
Row Crops	1193	59.3%
Urban/Recreational Grasses	28	1.4%
Emergent Herbaceous Wetlands	169	8.4%

Source data: Landcover, 30m, NLCD, Landsat Thematic Mapper. U.S. Geological Survey EROS Data Center, Sioux Falls, SD.

### **Potential Air Emission Impacts**

In general, air pollution can damage vegetation in two ways: high-level short-term acute exposure, or prolonged or chronic exposures. Acute exposures usually damage plants through direct physical damage to leaf tissues, while chronic exposure damage is usually due to the inhibition of physiological processes such as photosynthesis, carbon allocation, and stomata functioning. An evaluation of the potential for acute or chronic exposure to each criteria air pollutant is provided below.

#### **Sulfur Dioxide**

Short- and long-term exposure to SO<sub>2</sub> can harm many plant species.<sup>3</sup> Numerous studies have been conducted studying the effects of SO<sub>2</sub> on vegetation including crop plants,<sup>4</sup> trees and shrubs,<sup>5</sup> and herbaceous plants.<sup>6</sup> SO<sub>2</sub> can cause interveinal necrotic blotches in angiosperms and red brown banding in gymnosperms.<sup>7</sup> Plants found to be susceptible to SO<sub>2</sub> injury include red cedar (*Juniperus virginiana*), oaks, sumacs (*Rhus spp.*), ash, raspberries (*Rubus spp.*), American elm (*Ulmus*

<sup>3</sup> Heath 1980; Kozlowski and Constantinidou 1986; Darrall 1989

<sup>4</sup> Guderian and Stratman (1968) in Kozlowski and Constantinidou 1986; Huang et al. 1976; Reinert et al. 1975; Tingey et al. 1971; Darrall 1989

<sup>5</sup> Linzon 1986; Kozlowski and Constantinidou 1986; Darrall 1989

<sup>6</sup> Winner and Mooney 1980; Westman et al. 1985; Darrall 1989

<sup>7</sup> Kozlowski and Constantinidou 1986

*americana*), red maple (*Acer rubrum*), black willow (*Salix nigra*), bracken fern (*Pteridium aquilinum*), soybean (*Glycine max*), and corn (*Zea mays*). Injury threshold concentrations varied by species and dose (131-5,240  $\mu\text{g}/\text{m}^3$  for 8 hours, 393-3,930  $\mu\text{g}/\text{m}^3$  for 2 hours, and 1,310  $\mu\text{g}/\text{m}^3$  for 4 hours). The secondary NAAQS for  $\text{SO}_2$ , which is a level selected to avoid damage to crops and other resources, is 1,300  $\mu\text{g}/\text{m}^3$  (3-hour average). The maximum  $\text{SO}_2$  ambient concentration expected to occur near Spiritwood Station is 101  $\mu\text{g}/\text{m}^3$  (3-hour average), well below the levels of concern.

### *Nitrogen Oxides*

During fuel combustion, atmospheric nitrogen is oxidized to nitrogen oxide (NO) and small amounts of  $\text{NO}_2$ . The NO is photochemically oxidized to  $\text{NO}_2$ . As with  $\text{SO}_2$  emission research,  $\text{NO}_2$  has been shown to deleteriously impact vegetation.<sup>8</sup> Similar to  $\text{SO}_2$ , high  $\text{NO}_2$  levels can cause interveinal necrotic blotches on angiosperms and red-brown distal necrosis in gymnosperms.<sup>9</sup> But injury threshold concentrations are much higher than that of  $\text{SO}_2$ , and vary by species and dose. In general, short-term high concentrations of  $\text{NO}_2$  are required for deleterious impacts on plants.<sup>10</sup> The injury threshold for two crop plants grown in the region – tomato (*Lycopersicon esculentum*) and annual sunflower (*Helianthus annuus*) – is 4 hours at a concentration of 7,380  $\mu\text{g}/\text{m}^3$ . A common, weedy plant found throughout the Prairie Parkland Region, lamb's quarters (*Chenopodium album*), was not injured for two hours at concentrations 1.9  $\mu\text{g}/\text{m}^3$   $\text{NO}_2$ . Furthermore, short-term fumigations of approximately 1 hour, 20 hours, and 48 hours at  $\text{NO}_2$  concentrations of 940 to 38,000  $\mu\text{g}/\text{m}^3$ , 470  $\mu\text{g}/\text{m}^3$ , and 3,000 to 5,000  $\mu\text{g}/\text{m}^3$ , respectively, have been shown to deter photosynthesis in a number of herbaceous (tomato, oats, alfalfa) and woody plants.<sup>11</sup> Moreover, reported long term phytotoxic exposures of  $\text{NO}_2$  ranged from 280 to 560  $\mu\text{g}/\text{m}^3$ .<sup>12</sup> Again, the maximum ambient  $\text{NO}_2$  concentration modeled near the plant (8  $\mu\text{g}/\text{m}^3$  annual average) is significantly less than the  $\text{NO}_2$  injury thresholds to nearby vegetation.

### *Synergistic Effects of $\text{NO}_2$ and $\text{SO}_2$*

Air pollutants are known to act in concert to cause injury to or decrease the functioning of plants.<sup>13</sup> The inhibitory combined effects of  $\text{SO}_2$  and  $\text{NO}_2$ ,<sup>14</sup>  $\text{NO}_2$  and NO,<sup>15</sup>  $\text{NO}_2$  and  $\text{O}_3$ ,<sup>16</sup> and  $\text{O}_3$  and  $\text{SO}_2$ <sup>17</sup> have been reported in various short-term studies for crop plants (e.g., soybean, broad bean, annual

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<sup>8</sup> Taylor et al. 1975; Heath 1980; Kozlowski and Constantinidou 1986; and Darrall 1989

<sup>9</sup> Kozlowski and Constantinidou 1986

<sup>10</sup> Prinz and Brandt 1985

<sup>11</sup> Hill and Bennett 1970; Capron and Mansfield 1976; and Smith 1981

<sup>12</sup> Taylor and McLean (1970)

sunflower, and tomato) and various trees that are occasionally present within the Northern Glaciated Plains (e.g., eastern cottonwood, sugar maple, ash, and oak). In this case, even considering potential synergistic effects, the long-term concentrations of any of the pollutants causing damage in these studies (80 to 981  $\mu\text{g}/\text{m}^3$ ) are substantially higher than concentrations predicted to occur near Spiritwood Station.

### *Particulate Matter*

Particulates may contain trace elements and heavy metals such as arsenic, boron, beryllium, copper, fluoride, nickel, lead, mercury, manganese, and cobalt. These compounds have been shown to be detrimental to vegetation typically within the immediate vicinity of the source.<sup>18</sup> The most obvious effect of particle deposition on vegetation is a physical smothering of the leaf surface. This will reduce light transmission to the plant, in turn causing a decrease in photosynthesis.<sup>19</sup> However, the fugitive and stack emissions of particulates expected from the new Spiritwood Station and Spirit Ethanol facilities along with the existing Cargill Malt plant are expected to be far below the levels required to damage vegetation. Concentrations of  $\text{PM}_{10}$  due to the ultimate planned operation of these three facilities in the Spiritwood Industrial Park are expected to result in maximum  $\text{PM}_{10}$  concentrations of 72  $\mu\text{g}/\text{m}^3$  (24-hour average) and 26  $\mu\text{g}/\text{m}^3$  (annual average). These levels remain well below the  $\text{PM}_{10}$  NAAQS (150  $\mu\text{g}/\text{m}^3$  24-hour, 50  $\mu\text{g}/\text{m}^3$  annual), and therefore have a negligible impact on surrounding vegetation.

### *Carbon Monoxide*

Carbon monoxide is not known to injure plants nor be taken up by plants. Consequently, no adverse impacts to vegetation at or near Spiritwood Station are expected from CO stack emissions.

### *Soil Impacts*

Seven soil types are present in the one mile radius study area around Spiritwood Station including both Stutsman and Barnes Counties. The soil types present and their total acreage are provided in

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<sup>13</sup> See reviews of Reinert et al. 1975; Omrod 1982

<sup>14</sup> White et al. 1974; Wright et al. 1986

<sup>15</sup> Capron and Mansfield 1976

<sup>16</sup> Furakawa et al. 1984; Okana et al. 1985

<sup>17</sup> Costonis 1970, Carlson 1979; Jensen 1981; Omrod et al. 1981

<sup>18</sup> Woolhouse 1990

<sup>19</sup> Meteorological Service of Canada 2002

Table G-2 and represented in Figure G-2 at the end of this appendix. Both Table G-2 and Figure G-2 show the majority of the soil within a one mile of the facility is loam.

Of the soil types listed in Table G-2, the most prevalent in the one mile study area are Svea loam and Barnes loam. Nitrate and sulfate deposition onto soil due to NO<sub>x</sub> and SO<sub>2</sub> emissions, respectively, can exceed the uptake capacity or the acid buffering capacity of soils, leading to cation leaching, nutrient runoff, or soil acidification depending on deposition rates and soil composition. However, given the low modeled emission impacts due to the project, Spiritwood Station will not significantly affect the soils in the region or in the immediate vicinity of the plant.

### **Threatened and Endangered Species**

The U.S. Fish and Wildlife Service (USFWS) and the North Dakota Department of Agriculture Endangered Species Protection Program identify three federally listed species that may occur in the Stutsman County.<sup>20</sup> They are the bald eagle (*Haliaeetus leucocephalus*), the whooping crane (*Grus americana*) and the piping plover (*Charadrius melodus*).

### **Potential Impact**

The bald eagle, a federally threatened species, is known to appear in Stutsman County and throughout North Dakota. The USFWS restricts construction within one quarter (0.25) mile of an active bald eagle nest. Field surveys conducted in June 2006 found no eagle nests known within the 0.25-mile USFWS restriction zone around Spiritwood Station.

The whooping crane prefers shallow wetlands dominated by cattails and sedges. There are a number of these wetlands in Stutsman County and near the project area. No whooping cranes have been recorded near the Spiritwood Station site; however, suitable habitat is present.

The piping plover has been recorded in Stutsman County; however, this species prefers alkaline, salt-encrusted sandy or gravelly beaches of lakes. This habitat type is not found near the project area.

### **Class II Area Visibility Impact Analysis**

A Class I visibility analysis is not required for the Spiritwood project because there are no Class I areas within 250 kilometers of the plant.<sup>21</sup> However, in this section, we assess whether the exhaust

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<sup>20</sup> USFWS Endangered Species Protection Program Database

<sup>21</sup> O'Clair, T.L.; North Dakota Department of Health; "Intradepartmental Memorandum: Criteria Pollutant Modeling Requirements for a Permit to Construct"; September 12, 2006

plumes from the Spiritwood Station emission sources will be visible from the following nearby recreation areas:

- Arrowwood National Wildlife Refuge, located approximately 80 kilometers northwest of the Spiritwood Station site, and
- Little Yellowstone Park, the closest state park, located approximately 50 kilometers southeast of the plant site.

The visibility analysis was performed in accordance with the guidelines set forth in EPA-454/R-92-023, Workbook for Plume Visual Impact Screening and Analysis (Revised). As recommended, the first level VISCREEN analysis uses worst-case meteorological conditions (F-class stability, 1 m/s wind speed). This level of screening results in the most conservative (worst-case) visibility results. If the plume visibility against the sky and terrain is below a level perceivable to the human eye, the visibility modeling is complete. If not, a second level VISCREEN analysis that uses actual meteorological data and refined particle characteristics can be used. The second level model will result in a more realistic visibility analysis. If this plume visibility still does not meet sky and terrain contrast levels, a third level model may be required that adds more statistical analysis.

### ***VISCREEN Input Assumptions***

The inputs to the first level VISCREEN model include particulate matter, NO<sub>x</sub>, primary NO<sub>2</sub>, soot, and primary SO<sub>4</sub>. Total controlled maximum annual particulate emissions from the Spiritwood Station project are 306.1 tons/yr. The corresponding controlled NO<sub>x</sub> emission rate is 978.2 tons/yr. According to the workbook, primary NO<sub>2</sub>, soot, and primary SO<sub>4</sub> can be assumed to be zero except for those sources that directly emit these pollutants. Since the Spiritwood Station plant does not directly emit significant amounts of primary NO<sub>2</sub>, soot, or primary SO<sub>4</sub>, the emissions for these last three species are assumed to be zero. The next set of inputs into the Level 1 VISCREEN model considers the distance between the source, observer and area, and the background visual range. Background visibility was determined from the VISCREEN manual to be 60 kilometers. The last inputs into the model are particle sizes, background ozone, plume-source-observer angle, stability, and wind speed. All of these inputs are automatically set if the default option is chosen. For the Level 1 analysis, the workbook specifies the default option, which sets the following particle sizes:

- Background fine = 0.3 μm diameter, 1.5 g/cm<sup>3</sup> density
- Background course = 6 μm diameter, 2.5 g/cm<sup>3</sup> density
- Plume particulate = 2 μm diameter, 2.5 g/cm<sup>3</sup> density

- Plume soot = 0.1  $\mu\text{m}$  diameter, 2  $\text{g}/\text{cm}^3$  density
- Plume primary sulfate = 0.5  $\mu\text{m}$  diameter, 1.5  $\text{g}/\text{cm}^3$

The background ozone is 0.04 parts per million (ppm), the plume-source-observer angle is 11.25 degrees, the worst case atmospheric stability is an F stability class, and the worst case wind speed is 1 m/s.

### ***VISCREEN Results***

The VISCREEN model output compares the calculated Delta E and contrast from the plume to present default comparison values. Delta E is the color difference parameter used to characterize the perceptibility of the plume on a color difference between the plume and a viewing background such as the sky, a cloud, or a terrain feature. Color differences are due to differences in three dimensions: brightness ( $L^*$ ), color hue ( $a^*$ ), and saturation ( $b^*$ ). Delta E is calculated for several lines of sight. A green contrast analysis is also performed for various lines of sight using a green wavelength and contrasting the plume with the terrain and sky backgrounds. The critical E value is 2.0 and the green contrast value is 0.05.

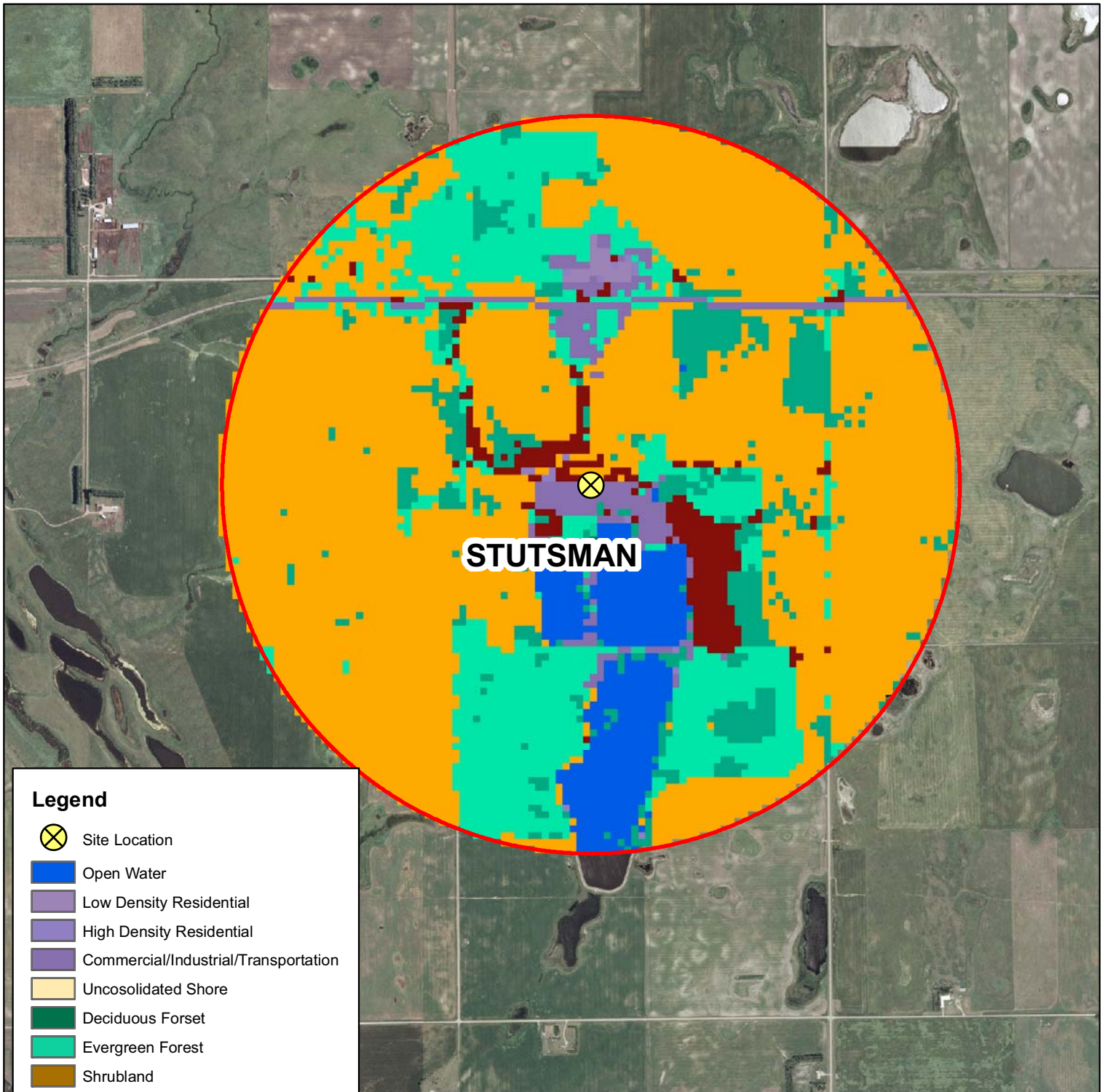
The results of the Level 1 analysis pass the Class I screening criteria at the Arrowwood National Wildlife Refuge, located approximately 80 kilometers northwest of the project site, but not at Little Yellowstone Park, located approximately 50 kilometers southeast of the plant site. Subsequently, the VISCREEN analysis for Little Yellowstone Park must be refined using a Level 2 analysis.

The primary difference between the Level 1 and Level 2 VISCREEN analysis is that the Level 2 analysis accounts for a typical wind speed based on the frequency distribution of wind speed and wind direction. For this analysis, the Level 2 wind speed was 3 m/s with a 'D' stability. The Level 2 analysis indicates that the plume from the plant will not be visible from the park. The VISCREEN files are included on a CD included with this permit application.

















**Table G-2. Soil Survey Geographic (SSURGO) database for Barnes County and Stutsman County, North Dakota within one mile of the Spiritwood CHP Site.**

Soil Series	Surface Soil Texture	Taxonomic Class	Acres
Barnes	loam	Fine-loamy, mixed, superactive, frigid Calcic Hapludolls	491
Colvin	silty clay loam	Fine-silty, mixed, superactive, frigid Typic Calciaquolls	5
Fordville	loam	Fine-loamy over sandy or sandy-skeletal, mixed, superactive, frigid Pachic Hapludolls	1
Hamerly	loam	Fine-loamy, mixed, superactive, frigid Aeric Calciaquolls	603
Parnell	silty clay loam	Fine, smectitic, frigid Vertic Argiaquolls	71
Southam	silty clay loam	Fine, smectitic, calcareous, frigid Cumulic Vertic Endoaquolls	108
Svea	loam	Fine-loamy, mixed, superactive, frigid Pachic Hapludolls	648
Water			83

Source data: Soil Survey Geographic (SSURGO) database for Barnes County and Stutsman County, North Dakota. May 23, 2006. U.S. Department of Agriculture, Natural Resources Conservation Service. Fort Worth, Texas. Online\_Linkage: URL:<http://SoilDataMart.nrcs.usda.gov/>



**Legend**

-  Site Location
-  Open Water
-  Low Density Residential
-  High Density Residential
-  Commercial/Industrial/Transportation
-  Unconsolidated Shore
-  Deciduous Forest
-  Evergreen Forest
-  Shrubland
-  Grasslands/Herbaceous
-  Pasture/Hay
-  Row Crops
-  Small Grains
-  Urban/Recreational Grass
-  Woody Wetlands
-  Emergent Herbaceous Wetlands

**Stutsman2003.sid**

**RGB**

-  Red: Band\_1
-  Green: Band\_2
-  Blue: Band\_3



Figure G-1

**LANDCOVER - ONE MILE RADIUS OF SITE**

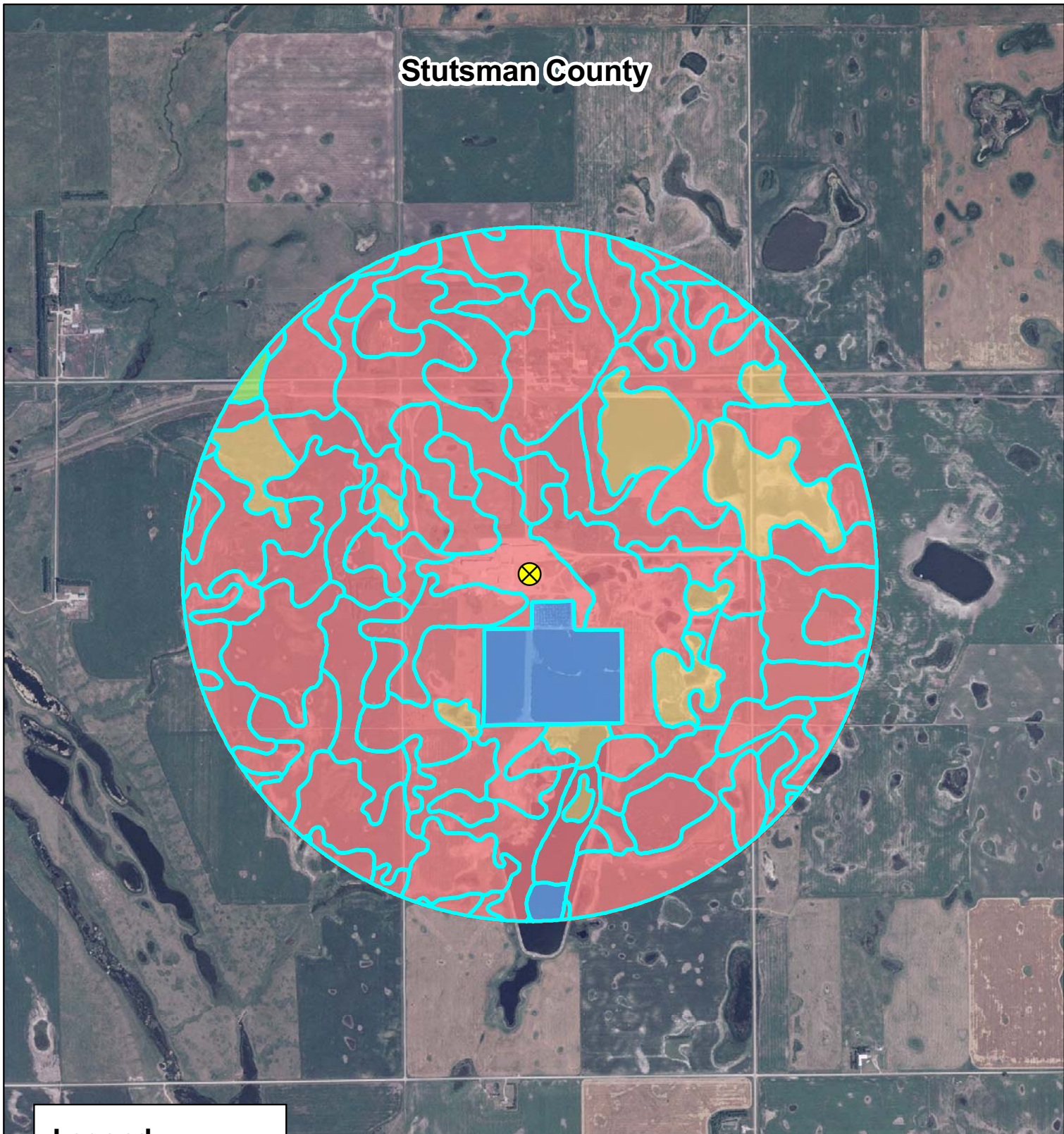
Spiritwood Station  
Spiritwood, North Dakota



Meters



# Stutsman County



Barr Footer: Date: 1/27/2007 12:48:16 PM File: I:\Projects\34\47\003\Maps\2007\Figure G-2 Soils.mxd User: jjm

## Legend

 Site Location

### Surface Texture

-  loam
-  sandy clay loam
-  silty clay loam
-  water

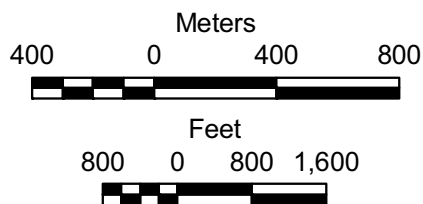


Figure G-2

SOILS - ONE MILE RADIUS OF SITE

Spiritwood Station  
Spiritwood, North Dakota