GeoPlanner™

GPS Study

Gibson Solar

Prepared on Behalf of
Gibson Solar LLC

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Table of Contents

1. Introduction

This report examines whether or not the proposed Gibson Solar Project would cause signal blockage of GPS antennas which are used as part of a network of continuously operating reference stations (CORS). These stations are registered with the NOAA CORS database and are used to measure GPS carrier phase and code range information to mitigate the effects of the atmosphere, multipath, and timing errors on satellite signals. These measurements are used to generate correction files which are then stored and used to post-process GPS data collected by various users including government, academic and private organizations to improve data accuracy. The correction files are available free of charge and can be found at the following website link: www.ngs.noaa.gov/CORS from a few days to several months after the GPS data was collected.

Likewise, this report examines the impact on the FAA's Wide-Area Augmentation System (WAAS) which was developed primarily to assist aerial navigation but could also be used for agricultural, surveying, recreational and other applications. WAAS antennas are located throughout North America which collect signals from GPS satellites to correct position, velocity, or timing errors and improve data accuracy. Unlike the CORS methodology for correcting GPS data, the WAAS network provides GPS error correction in real time. If real-time correction is not needed, however, CORS offers greater accuracy. Each WAAS station sends data to one of three WAAS Master Stations (WMS) via a terrestrial communications link and transmits messages to one of three WAAS geosynchronous (GEO) satellites using any one of six ground uplink stations (GUS). GPS users could then access the correction data via downlink from one of the GEO satellites.

2. Project Area

The location of the Gibson Solar Project in Gibson County, Indiana is shown in Figure 1. The facility will generate electricity using silicon photovoltaic (PV) modules fixed to single axis solar trackers. It will have an installed capacity of up to 280 MW ac (340 MW dc) and a maximum height of 12 feet.

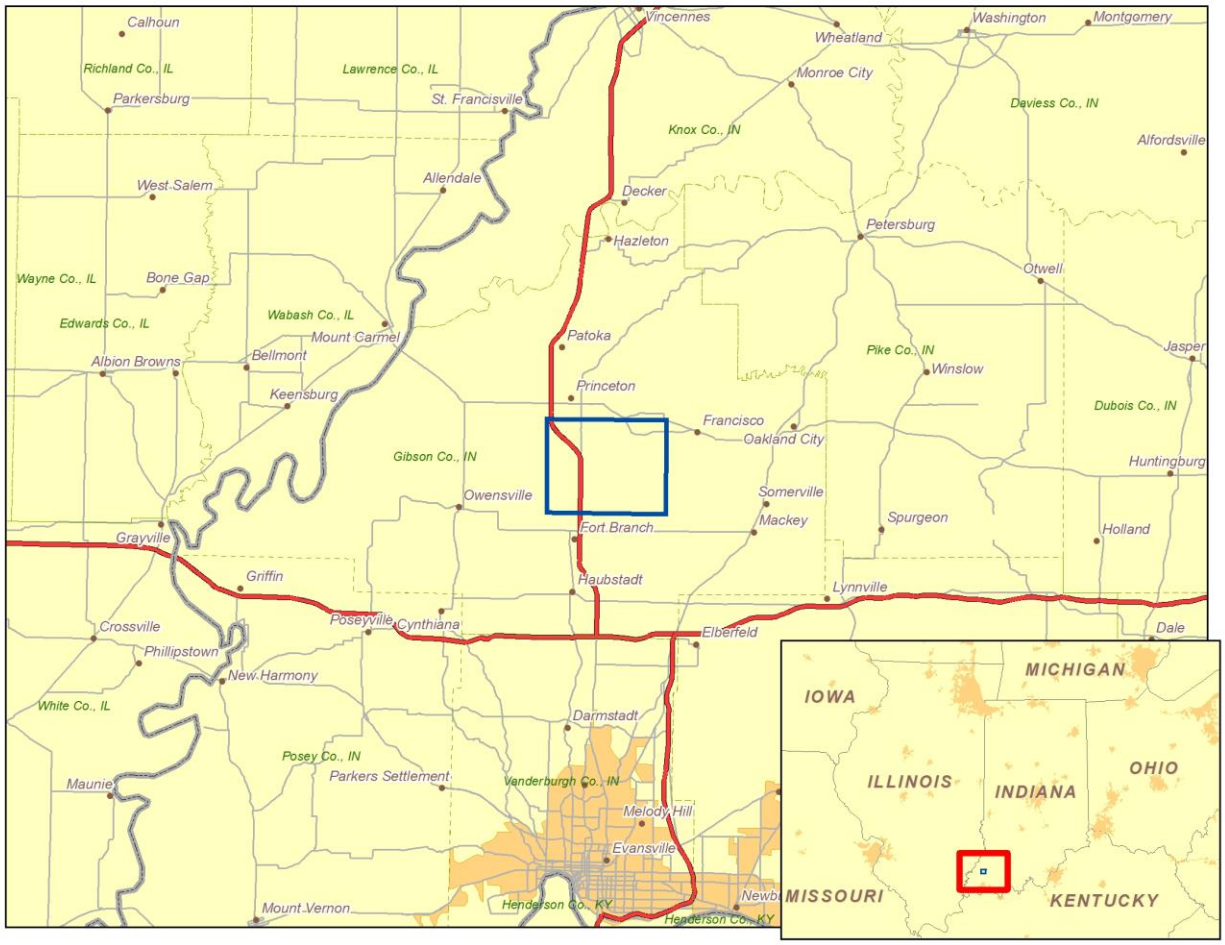

Figure 1: Location of the Gibson Solar Project in Indiana

3. Impact Assessment

The locations of the project area of interest (AOI) with respect to the five nearest CORS antenna locations are shown in Figure 2. The callsigns of the five antennas and corresponding distances from the Area of Interest are listed in table 1.

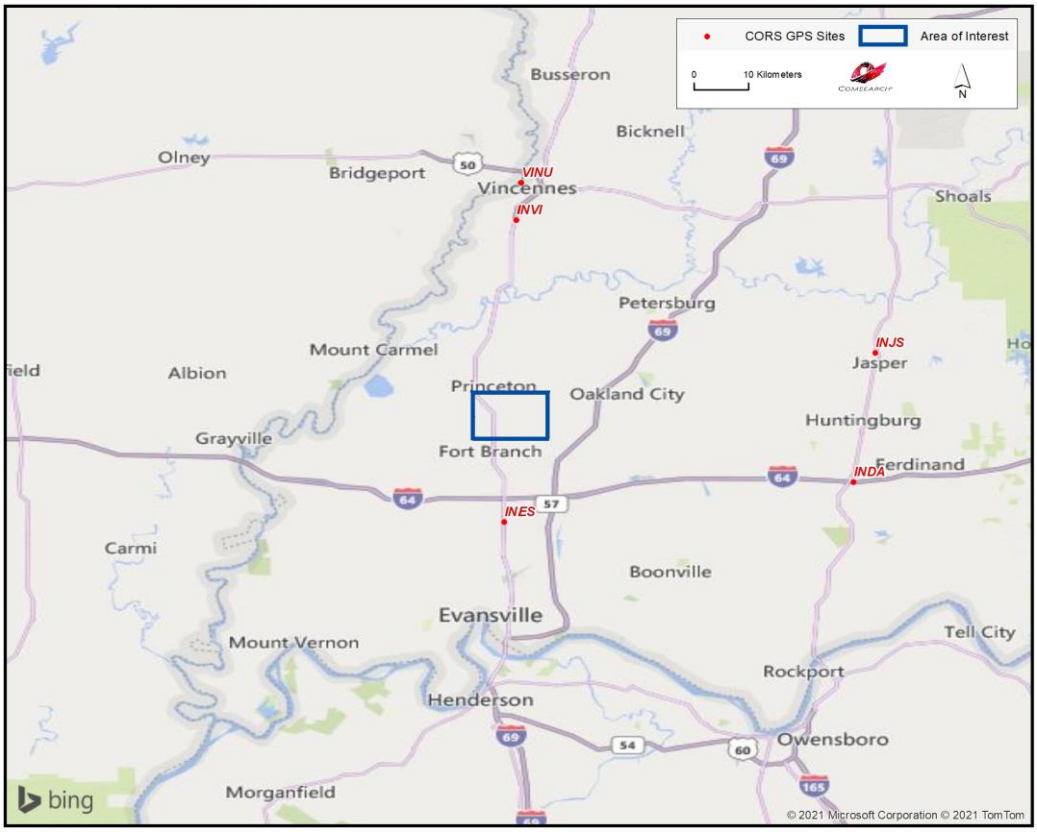

Figure 2: Nearest CORS Antennas and the Gibson Solar Project Area

Name	Latitude (NAD83)	Longitude (NAD83)	Distance to the Area of Interest (km)
INES	38.129167	-87.550278	15.25
INVI	38.627222	-87.530556	31.60
VINU	38.689167	-87.522778	38.47
INDA	38.195000	-86.973889	45.01
INJS	38.408333	-86.938611	47.86

Table 1: Nearest CORS Antennas and Distances from the Area of Interest

The project AOI with respect to the nearest WAAS antenna is shown in Figure 3. The antenna is registered under callsign KZAU and is 386.8 km from the Area of Interest. It consists of three antennas that are roughly 10 meters apart, all of which are on the rooftop of an FAA office building located at 619 W Indian Trail, Aurora, IL 60506. The next closest WAAS site is in Memphis, TN which is 413 km away and therefore is not visible on the map.

The coordinates of the individual WAAS antennas for KZAU are listed in Table 2. There is also a NOAA CORS GPS antenna on the same building under call sign ZAU1.

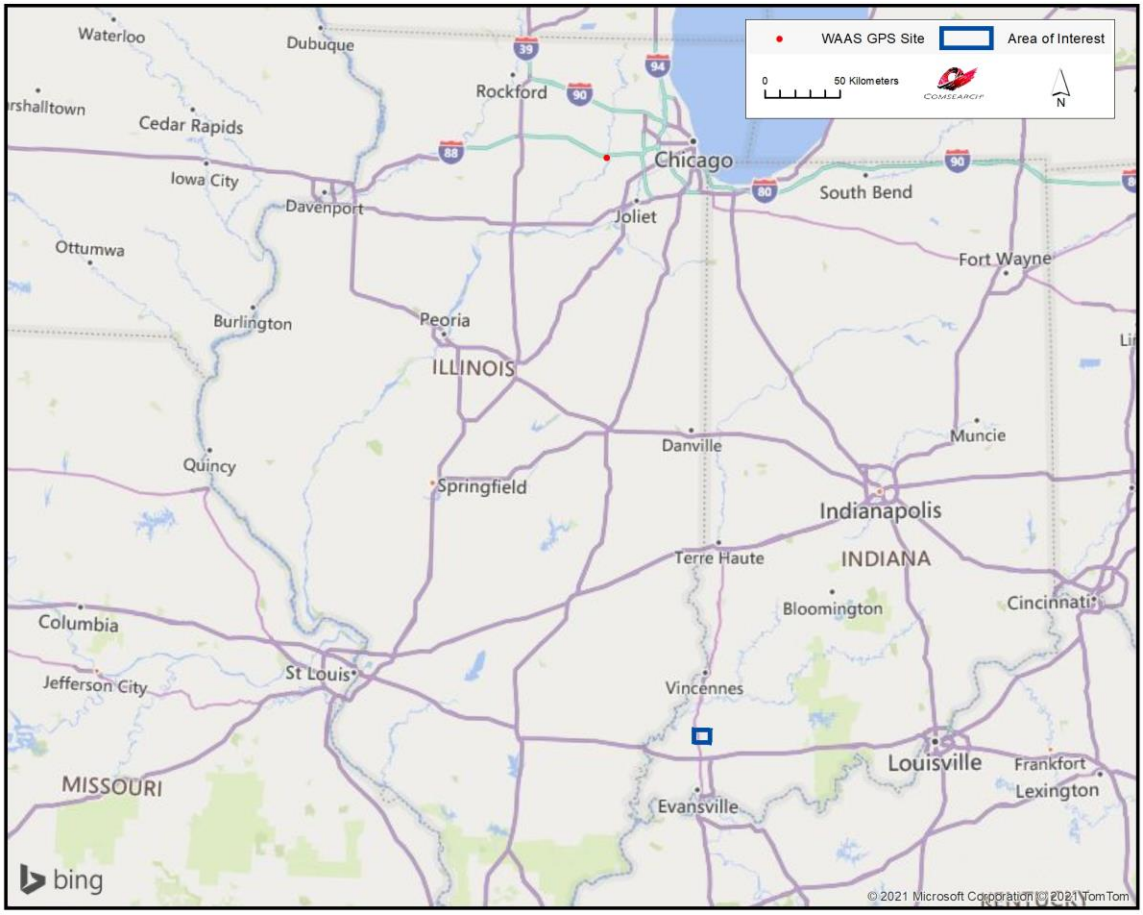

Figure 3: Nearest WAAS Antenna and the Gibson Solar Project Area

Name	Latitude (NAD83)	Longitude (NAD83)	Distance to the Area of Interest (km)
KZAU	41.782596	-88.331334	386.8

Table 2: Nearest WAAS Antenna and Distances from Project Area

To determine the potential impact of the proposed solar farm on the CORS or WAAS GPS antennas, the horizon distance of the nearest GPS antenna to the project area is calculated. If this distance is greater than its separation distance from the solar panels, then line-of-sight (LOS) to certain satellites could be obstructed from the GPS antenna, assuming relatively flat terrain with no nearby trees or buildings looking towards the AOI from the GPS antenna.

The distance to the horizon for a given GPS antenna is a function of its height and is given by:

$$D = (2*H_G)^{½} \qquad \text{(Equation 1)}$$

Where:

- D = Distance to horizon from GPS antenna in miles
- H_G = Height of GPS antenna in feet

Using an estimated antenna height of 15 ft AGL, the horizon distance from the nearest CORS station is determined. From Equation 1, this gives a horizon distance of roughly 5 miles or 7.9 km. Since INES is the nearest station to the project area which is located 15.25 km away, no harmful impact to the GPS station antennas in Tables 1 and 2 is anticipated.

4. Conclusion and Recommendations

Based on the calculated separation distances discussed in Section 3, no harmful impacts to antenna line-of-sight are anticipated to the closest CORS or WAAS GPS antennas.

Furthermore, GPS antennas receive signals from an ample number of medium earth orbit (MEO) satellites that encircle the globe. While the number of GPS satellites varies depending on their life cycle and how many spares are in orbit, there are currently 32 MEO satellites orbiting the Earth along six different orbital planes, each of which are inclined 55 degrees from the equator. Therefore, MEOs form a constellation so that a minimum of four satellites are at least 15 degrees above the horizon at any given time across the globe. And since MEO satellites are in constant motion relative to the Earth, if one becomes obstructed by objects such as trees, grain bins, towers, hills, wind turbines, etc, then other satellites in orbit from the constellation reappear in another part of the sky with a stronger signal.

Therefore, while GPS antennas are capable of detecting signals even from satellites very low on the horizon, it is constantly monitoring and utilizing stronger signals from multiple satellites as they move in different directions across the sky. As a result, Comsearch does not anticipate any harmful impact on the CORS or WAAS system.

5. Contact

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