



GLOBAL NAVIGATION SATELLITE SYSTEMS AND THE BAD ELF 2500 UNITS

Tom Biernacki

Division of Environmental Assessment and Restoration
Florida Department of Environmental Protection

Tallahassee, FL | November 5, 2025

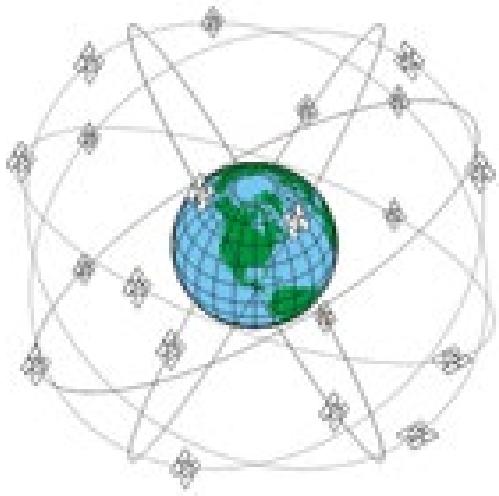


GLOBAL NAVIGATION SATELLITE SYSTEMS

- A Global Navigation Satellite System (GNSS) is a network, or constellation, of satellites that transmit ranging signals that are used for determining position location anywhere on the globe.
- The current global constellations are:
 - The global positioning system (GPS) – United States.
 - The global orbital navigation satellite system (GLONASS) – Russia.
 - The Galileo global navigation satellite system – Europe.
 - The Beidou global navigation satellite system – China.

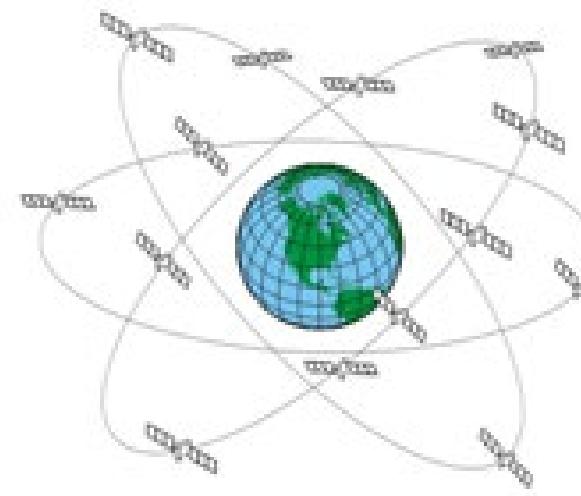


GLOBAL NAVIGATION SATELLITE SYSTEMS



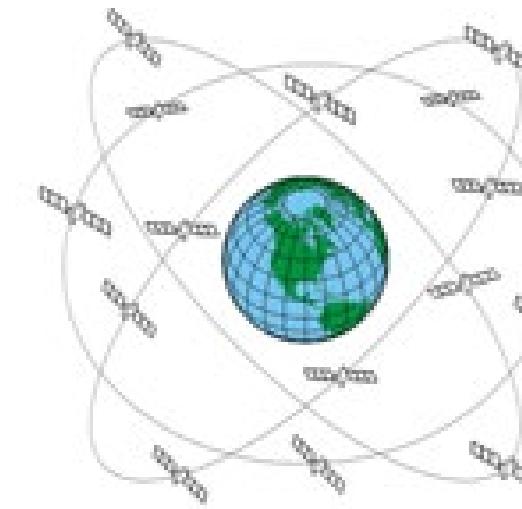
GPS

- Six Orbital planes.
- 24 Satellites.
- 55° Inclination Angle.
- Altitude 22,200 kilometers.



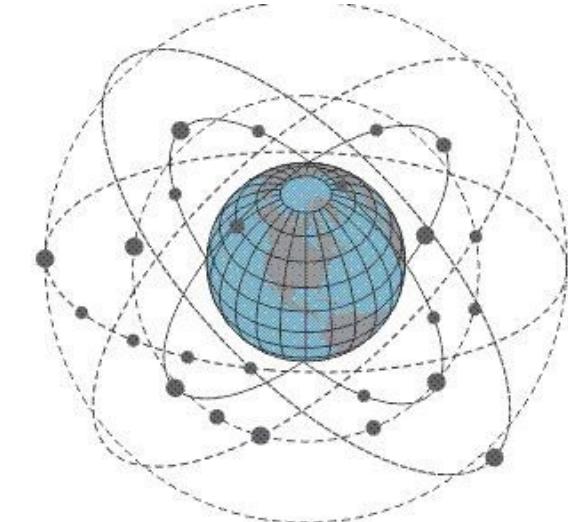
Galileo

- Three Orbital planes.
- 27 Satellites.
- 56° Inclination Angle.
- Altitude 23,616 kilometers.



GLONASS

- Three Orbital planes.
- 21 Satellites.
- 64.8° Inclination Angle.
- Altitude 19,100 kilometers.



Beidou

- Six Orbital planes.
- 35 Satellites.
- 55° Inclination Angle.
- Altitude 38,500 and 21,500 kilometers.



SATELLITE-BASED AUGMENTATION SYSTEMS

Satellite-Based Augmentation Systems (SBAS).

Help resolve positioning errors caused by delays and distortions of GNSS satellite signs as they pass through the atmosphere's ionosphere.

- The Wide Area Augmentation System (WAAS) transmits correction data for GPS GNSS satellite signals.
- The European Geostationary Navigation Overlay System (EGNOS) transmits correction data for Galileo GNSS satellite signals.
- SBAS signals typically correct data to less than two-meter accuracy where autonomous (non-corrected) has an accuracy around five meters.



GLOBAL NAVIGATION SATELLITE SYSTEMS AND THE BAD ELF 2500

- The Bad Elf 2500 uses all four satellite constellations, GPS, GLONASS, Galileo and Beidou.
- The Bad Elf uses SBAS signals from both WAAS and EGNOS.



NON-GNSS LOCATION DATA

- Locations from a cell phone or tablet internal location provider use a combination of signals from satellites and cellular towers, and do not provide GNSS based location data.
- These non-GNSS location data do not meet data quality requirements for Status and Trend Networks projects.



USING THE BAD ELF 2500 UNITS

Global Navigation Satellite Systems
and the Bad Elf 2500 Units



SYSTEM REQUIREMENTS

System requirements.

- iOS version 11 or newer/Android version 4.1x or newer.
- Bluetooth connection enabled.

Software applications.

- Installed on phone or tablet for Status and Trend monitoring projects.
- Required:
 - Bad Elf Flex application.
 - ArcGIS Field Maps.
 - ArcGIS Survey123.
- Recommended:
 - Google Maps or Apple Maps.
 - Organic Maps: Offline Maps.



BAD ELF DO'S AND DON'TS

General.

- Do read the GNSS basics manual. Detailed instructions for setup, navigation and data collection are included.
- Don't attempt to use the Bad Elf indoors.
- Do keep the antenna oriented towards the sky.
- Don't collect location data with the Bad Elf on a lanyard or in your pocket.
- Do use flexible tripods or other accessories to help with positioning the unit, especially during travel in vehicle/boat.
- Don't submerge in water for extended periods of time. Units have IP67 rating and can withstand rain and accidental submersion for brief time periods.
- Do charge the units after each day's use. Note that the on-screen battery status indicator is often not accurate.



BAD ELF DO'S AND DON'TS

Navigation and Data Collection.

- Do ensure that Bad Elf is set as the location provider – this requires adjusting settings in multiple applications:
 - Bluetooth pairing.
 - Bad Elf Flex.
 - ArcGIS Field Maps.
 - ArcGIS Survey123.
- Do keep the Bad Elf Flex application open in the background when attempting to use the Bad Elf with other applications.
- Do prepare for offline navigation (no cellular data signal).
 - Download offline areas in field maps.
 - Download map areas in organic maps and save KML (Keyhole Markup Language) files with site information on tablet or phone.



BAD ELF DO'S AND DON'TS

Navigation and Data Collection.

- Don't leave the Bad Elf in the vehicle when walking or boating to the site. The location displayed is the location of the Bad Elf, not of the tablet.
- Do follow on-screen warnings when collecting data in Survey123.
 - Always use Bad Elf external receiver.
 - Wait for SBAS GNSS fix.
 - Use position averaging mode and collect at least 30 positions.



TROUBLESHOOTING SBAS FIX

Loss of SBAS signal is the most common encountered warning in Survey123.

- Turn on Bad Elf outdoors several minutes before it is needed.
- Ensure antenna is oriented correctly and has clear sky view (as clear as possible given site conditions).
- Wait at least five minutes at the site to attempt to get SBAS fix.
- If unable to get an SBAS fix, proceed with data collection and add a comment in Survey123. Data will be marked as autonomous collection method, but position averaging and number of satellites used will help to increase accuracy.



CLOSING THOUGHTS

Do Read the GNSS Basics Manual.

- You will find the answers to most of your questions in the manual.
- For manual see: <https://floridadep.gov/dear/watershed-monitoring-section/documents/wms-gnss-basics-manual>



THANK YOU

Tom Biernacki

Division of Environmental Assessment and Restoration
Florida Department of Environmental Protection

Contact Information:
850-245-8515

Thomas.Biernacki@FloridaDEP.gov