

Using High-Performance L1 GPS receivers w/WAAS for mapping/surveying

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What is Mapping?

- Mapping usually refers to:
- GIS (Geographic Information Systems) – merging spatial data (coordinates) with a database.
- Accuracy requirements depend on need, but generally 5 meters down to cm-level. Sub-meter accuracy has become the de facto standard.

What is Mapping?

- Example:



VS.



What is Mapping?



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One of My Mapping Projects



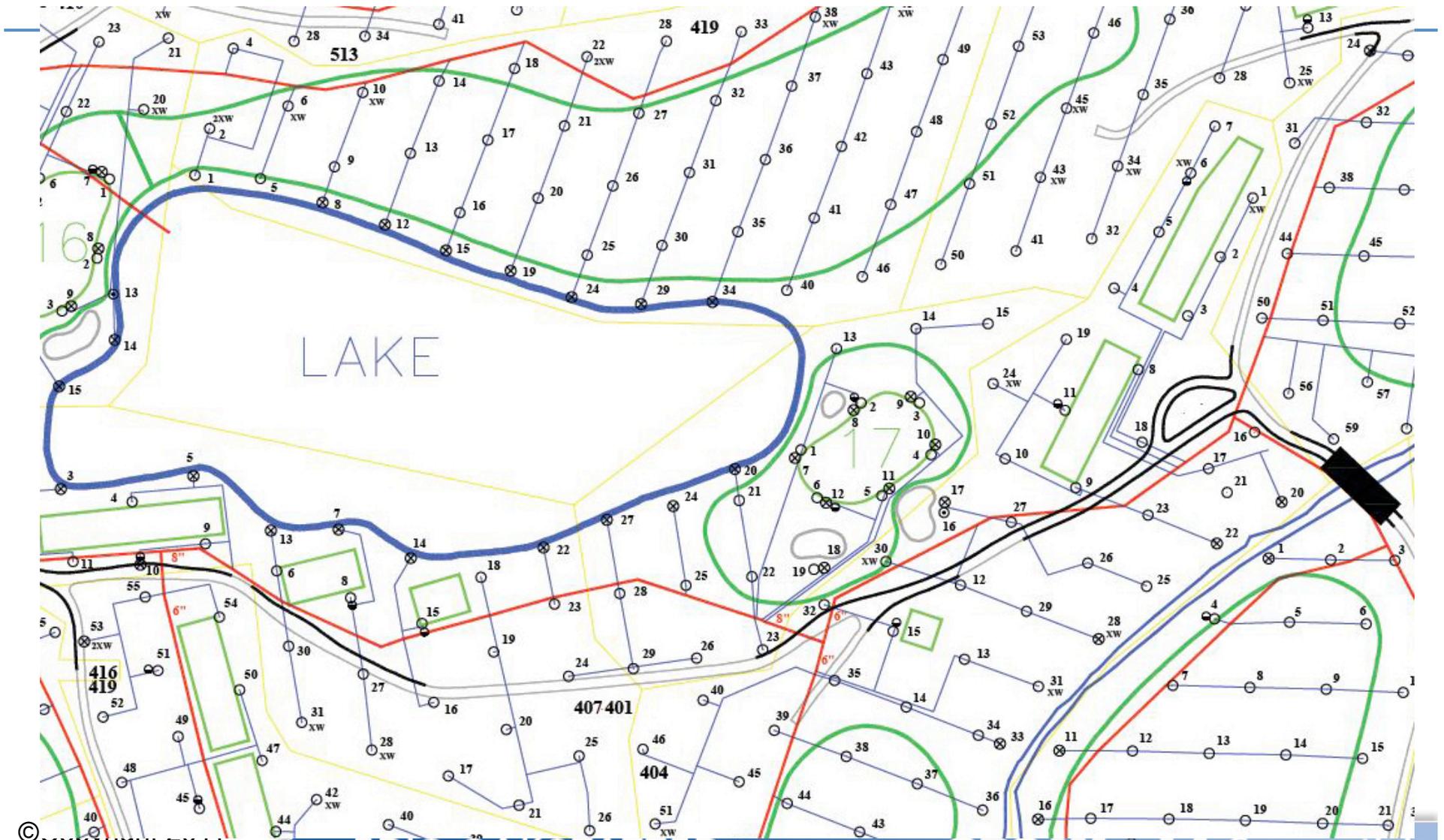
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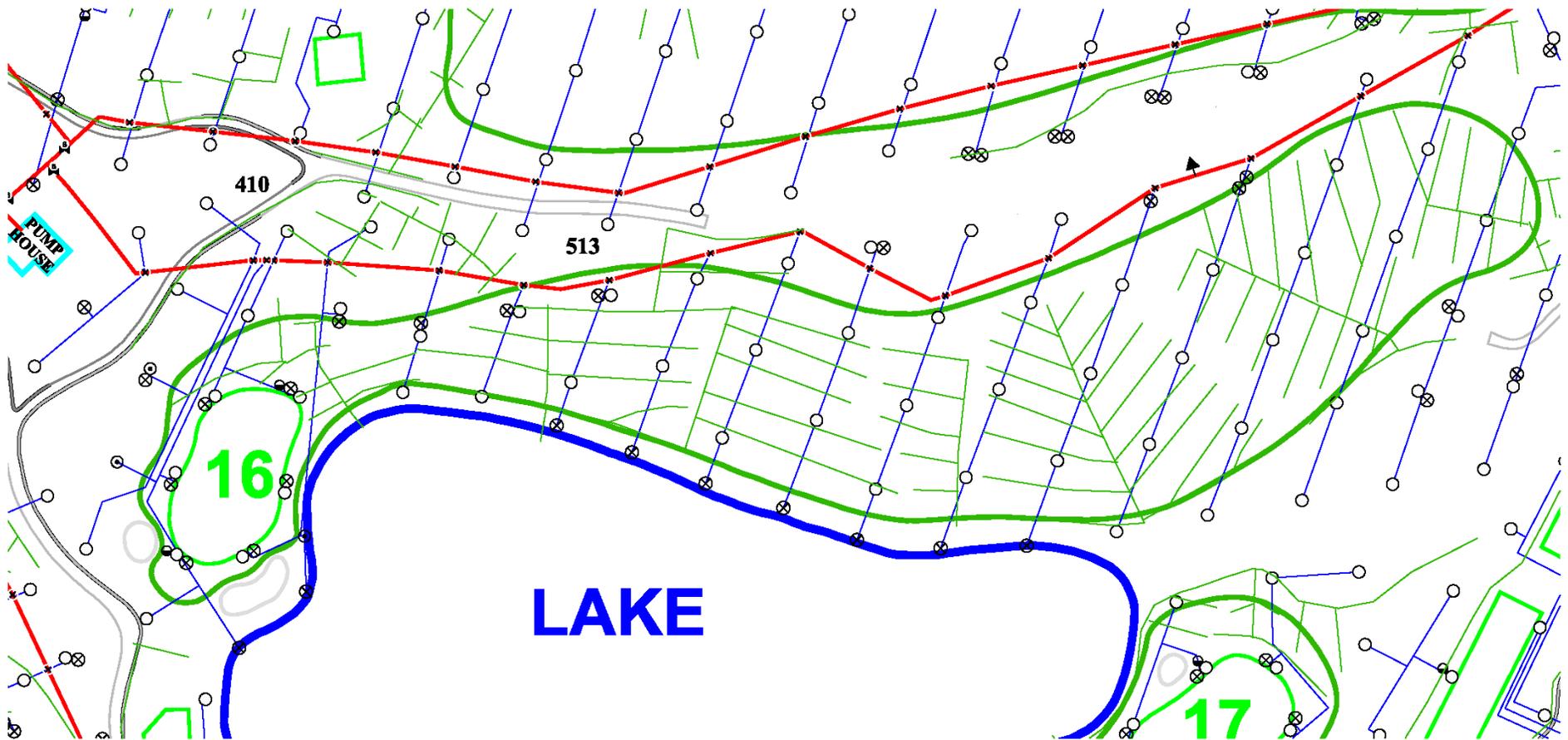
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- Drainage system mapped using GPS L1/WAAS



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What is Surveying?

- Surveying typically encompasses:
 - Property boundary determination.
 - Land development – topographic surveys
 - Construction layout.
- Accuracy requirements typically at the centimeter level (horizontal).

Surveying Project using GPS



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WAAS

WAAS for Mapping/Surveying

WAAS

wide area augmentation system

GPS Satellites



Source: FAA

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WAAS for Non-Aviation Users

- Consumer GPS receivers largely ignore WAAS.
- Even though WAAS was designed for aviation use, mapping/surveying users are likely its largest user base.
- Agriculture has transitioned from using DGPS beacon/OmniSTAR VBS service to WAAS for sub-meter accuracy applications.

WAAS benefits for Mapping/Surveying Users?

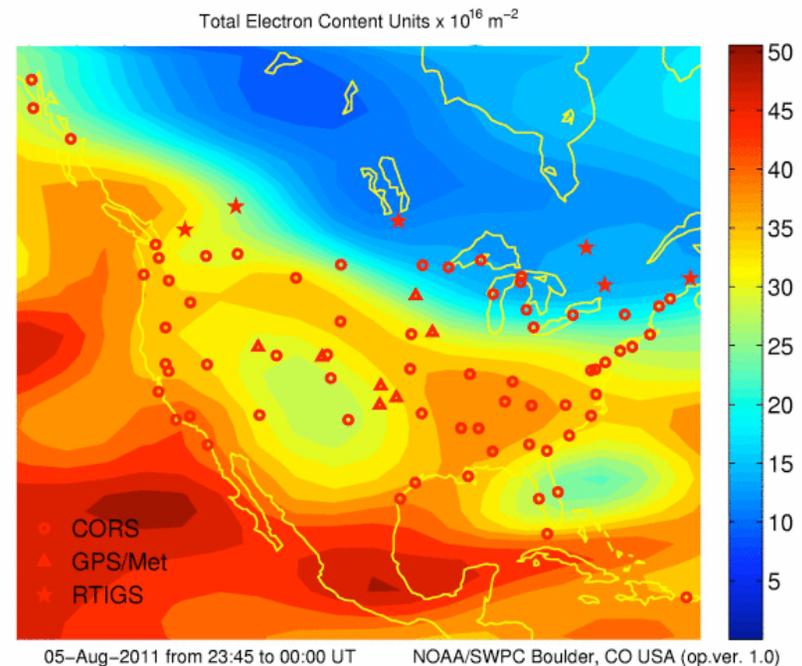
- Accurate source of GPS L1 corrections.
- No user fee.
- Nationwide coverage.
- Excellent ergonomics (no additional hardware).
- Very reliable.
- Additional observable(s) from the GEO(s), particularly for low-cost L1 RTK systems.
- Can trade integrity for accuracy.

2011 Webinar Audience Survey

- **What is your source of DGPS/SBAS Corrections?**
- 53.8% = Public SBAS (WAAS/MSAS/EGNOS)
- 28.6% = RTK Network
- 7.6% = DGPS beacon
- 5% = Commercial SBAS (OmniSTAR/Starfire)
- 5% = Other

WAAS Gotchas for Non-Aviation Users?

- Line-of-sight required to one of three WAAS GEOs.



- Relies on a well-behaved ionosphere.

WAAS Accuracy Expectations from Non-Aviation GPS L1 Receivers

- Just like you wouldn't expect to win the Indianapolis 500 driving a VW Bug, don't expect a consumer GPS receiver to deliver optimal accuracy using WAAS.
- With a high-performance, WAAS-enabled L1 GPS, receiver and a good quality antenna, consistent positioning under one meter is possible.

GPS L1 Accuracy Test Comparing High-Performance vs. Consumer Receiver

- Test site – Scottsdale, AZ. Rooftop, clear-sky visibility.
- All data collected @ 1Hz for 24 hours (~86,400 epochs).
- 2,000 epochs randomly sampled from 24 hr data set.
- Accuracy statistics computed using National Standard for Spatial Data Accuracy (NSSDA) standards with software designed specifically for the Dept of Interior.
- **Test Receivers:** Hemisphere Crescent L1 GPS receiver, Hemisphere Eclipse (L1-only), Garmin Extrex Vista.

Results – Garmin Etrex Vista using WAAS

- 100% of data WAAS-corrected.
- Internal antenna used.
- 2,000 of ~86,400 epochs randomly sampled
- 68% confidence (horizontal) = **3.04 meters**
- 95% confidence (horizontal) = **4.69 meters**
- 99% confidence (horizontal) = **5.81 meters**

- Manufacturer accuracy claim: None



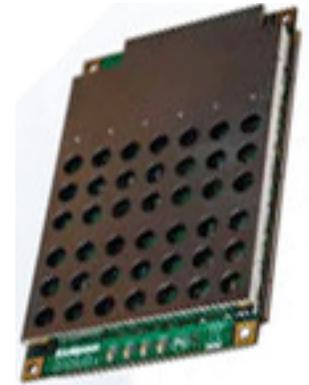
Results – Hemisphere Crescent L1 GPS using WAAS

- 100% of data WAAS-corrected.
 - External antenna used.
 - 2,000 of ~86,400 epochs randomly sampled.
 - 68% confidence (horizontal) = **0.45 meters**
 - 95% confidence (horizontal) = **0.69 meters**
 - 99% confidence (horizontal) = **0.86 meters**
-
- Manufacturer accuracy claim: 60cm 95% (horizontal)



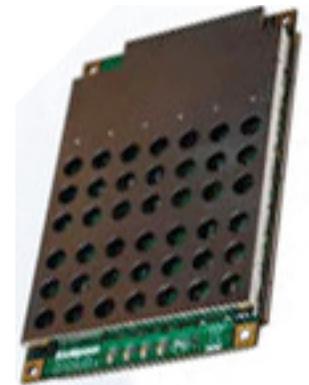
Results – Hemisphere Eclipse GPS (L1-only) using OmniSTAR VBS

- 100% of data OmniSTAR VBS-corrected
 - External antenna used.
 - 2,000 of ~86,400 epochs randomly sampled.
 - 68% confidence (horizontal) = **0.28 meters**
 - 95% confidence (horizontal) = **0.43 meters**
 - 99% confidence (horizontal) = **0.53 meters**
-
- Manufacturer accuracy claim: 60cm 95% (horizontal)



Results – Hemisphere Eclipse GPS (L1-only) using DGPS beacon

- 100% of data DGPS-corrected. 174km baseline*.
- External antenna used.
- 2,000 of ~86,400 epochs randomly sampled.
- 68% confidence (horizontal) = **0.64 meters**
- 95% confidence (horizontal) = **0.98 meters**
- 99% confidence (horizontal) = **1.20 meters**



- Manufacturer accuracy claim: 60cm 95% (horizontal)

*Reference station HAE = 2,136 meters

Summary

- Non-aviation GPS users are the largest user base of WAAS, particularly mapping/surveying users.
- Some GPS receiver manufacturers are exploiting WAAS for non-aviation users to optimize accuracy and availability.
- A non-aviation GPS L1 receiver designed to exploit WAAS is capable of delivering consistent sub-meter positioning.

Other Non-Aviation WAAS Users

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Columbia River Pilots

- CRP provide ship piloting services covering 320 nautical miles of the Columbia River along the border of Oregon and Washington.
- The longest straight stretch of channel is two miles.
- River channel is maintained to a depth of 43 feet and 600 feet wide.
- Columbia River Pilots pilot ships up to 900 feet in length.
- They carry their own Portable Pilot Units (PPU) for navigating since they pilot a wide variety of ships.

Columbia River Pilots



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Columbia River Pilots



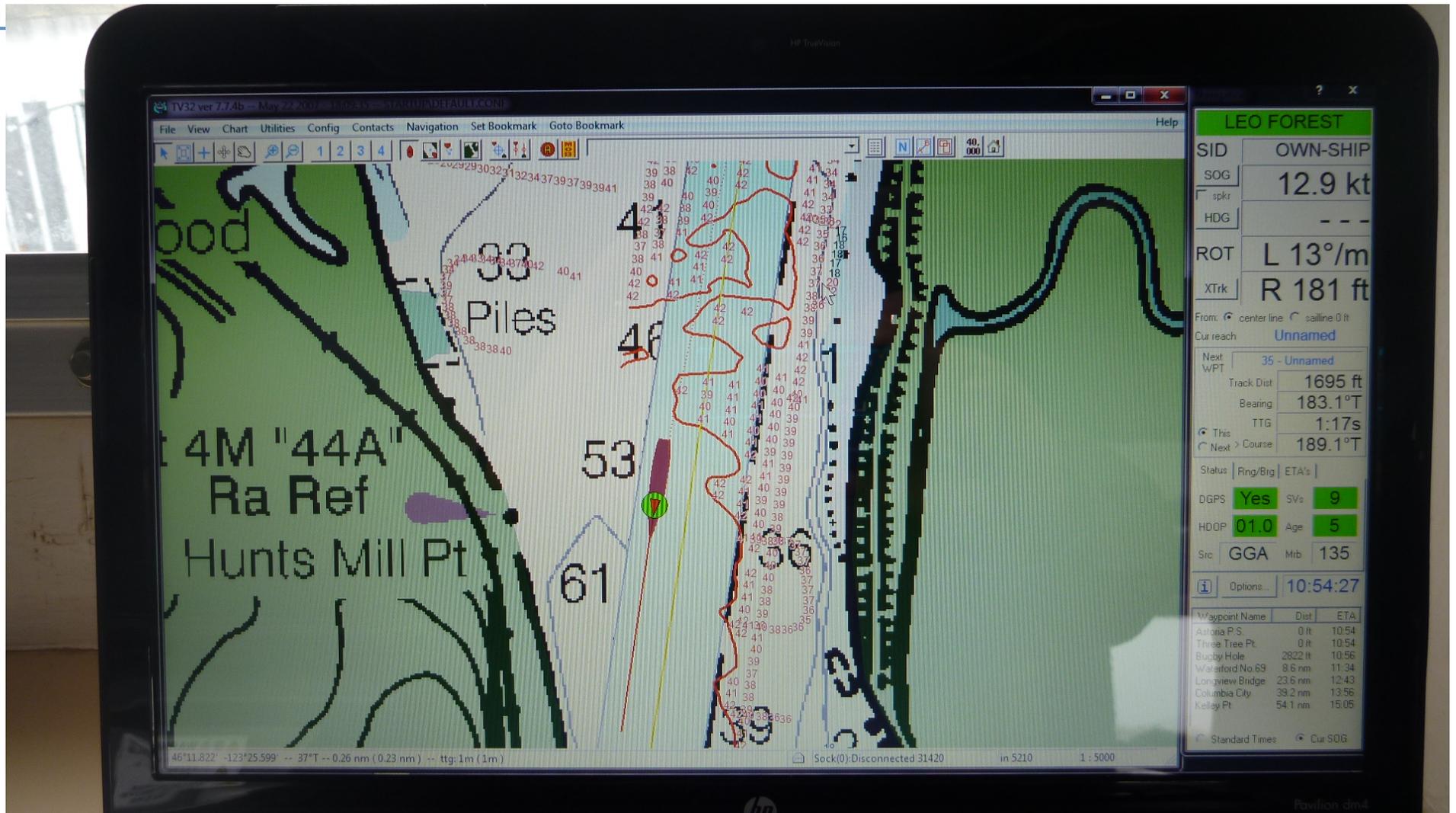
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Columbia River Pilots

- At times, there's only two feet separating the hull of the ship and the bottom of the river channel!
- Ships have onboard GPS nav systems the pilots can plug into, but in their experience, the accuracy of those nav systems is poor.
- Formerly used low-cost Garmin bluetooth GPS receivers. Accuracy error exceeded 100 feet at times.
- Transitioned to high-performance GPS L1 receiver using WAAS optimized for non-aviation users. After the first 15 trips, accuracy is "spot on".

QUESTIONS?



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