US Army Corps of Engineers®

The Effect of Increasing the Antenna Height on Radio Signal Reception at Tom Bevill Lock and Dam: LOMA-AIS Data Case Study

by Kenneth W. Swan, James T. Kilroy, Brady A. Towne, and Marin M. Kress

PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) presents the effects on the reception of radio signals due to increasing the antenna height at Tom Bevill Lock and Dam (L&D) in Pickensville, Alabama. The signals are Automatic Identification System (AIS) broadcasts from commercial vessels operating along the Tennessee-Tombigbee Waterway. These AIS broadcasts are received by the Lock Operations Management Application (LOMA) radio equipment at Tom Bevill L&D.

INTRODUCTION: Vessel position information is broadcast via an AIS transceiver on board a vessel that can provide a set of position reports with high temporal resolution as often as every 2 sec.* These position reports are georeferenced and provide a rich data source for understanding waterway utilization by commercial vessels (most of which are required to carry AIS when transiting US waterways) and some recreational vessels (Tabbert et al. 2021). Details about AIS technical specifications and carriage requirements are available from multiple standard-setting bodies (IALA 2008; IEC 2001; ITU-R 2014; PIANC 2019; USCG, n.d.; Automatic Identification System 2020).

The USCG is responsible for setting AIS carriage requirements (Automatic Identification System. 2020) and for maintaining the Nationwide AIS (NAIS) archive of historic vessel position reports received from the network of AIS stations maintained by the USCG (USCG, n.d.). The NAIS also receives data from a network of AIS towers operated and maintained by the US Army Corps of Engineers (USACE) through the LOMA program. These LOMA towers are located primarily at lock-and-dam sites along inland waterways (ERDC 2017).† In addition to being sent to the NAIS, any AIS data collected through the LOMA network are visible to USACE staff via the LOMA viewer. The LOMA program is made of three parts: (1) over 160 field hardware sites that translate radio signals from AIS transceivers into data that are shared across the CorpsNet network, (2) the LOMA viewer software that allows users to visualize vessel positions on their computer screen, and (3) technical staff that manage and maintain the hardware, software, and data flow across network elements.

The USACE LOMA Program receives and handles AIS data as shown in Figure 1. This process starts at data acquisition (when vessels broadcast their AIS messages, shown as a *green line*, which are received by other vessels and shore sites), and continues by moving that data across multiple networks (*red-*, *blue-*, or *black-dashed lines*) to translate and deliver vessel position data to the end users

---

* For a full list of the spelled-out forms of the units of measure and unit conversions used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office 2016), 248–52 and 345–47.*https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf*.

† Marin M. Kress. "Lock Operations Management Application (LOMA) Program" (unpublished manuscript, 15 December 2023), Microsoft Word file.

(Figure 1) including the USCG NAIS archive. The geographic area from which a LOMA site can receive AIS signals from vessels (depicted as *solid green lines* in Figure 1) depends on factors such as antenna height and surrounding topography. In general, higher antenna heights allow for a wider coverage area.

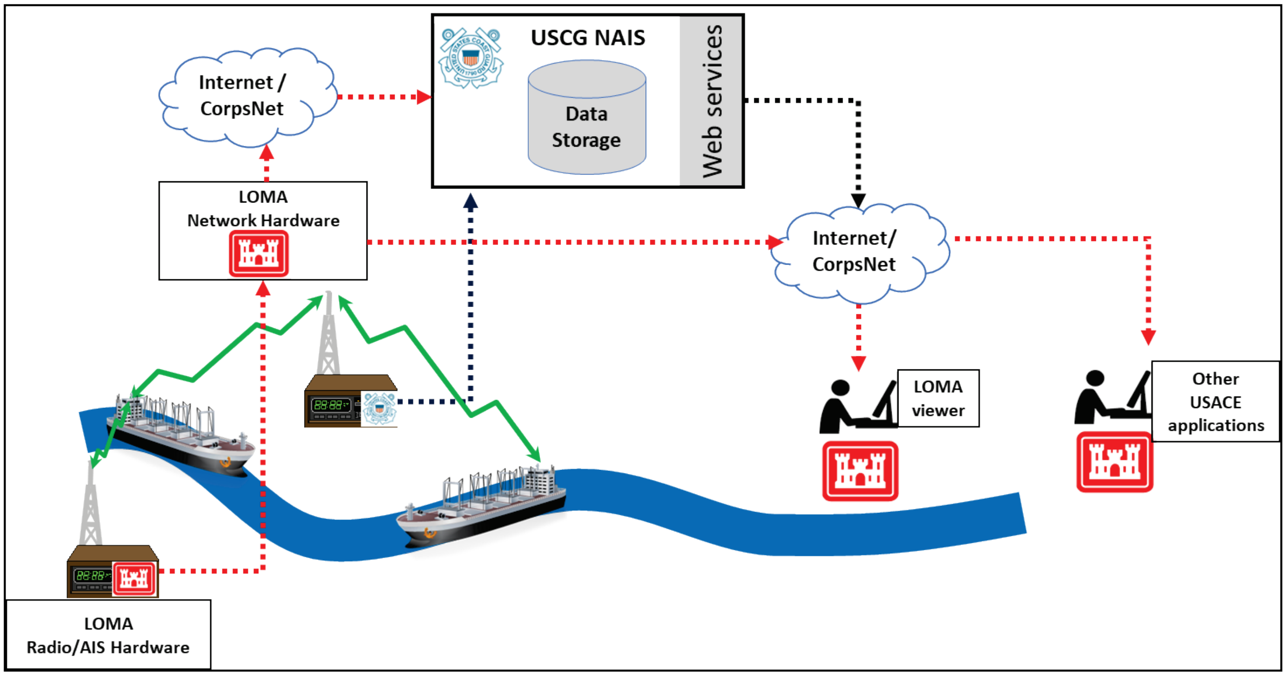

Figure 1. Diagram of Lock Operations Management Application (LOMA) program components. *Green lines* are raw Automatic Identification System (AIS) radio transmissions between vessels and tower sites. *Red dashed* lines are AIS data translated by LOMA hardware and moved across a network (CorpsNet and internet). *Dark-blue dashed* line is AIS data from USCG sites. *Black dashed line* represents any data from the USCG Nationwide Automatic Identification System (NAIS) shared via webservices to the US Army Corps of Engineers (USACE).

METHOD: The problem encountered was limited coverage, based on data received on the LOMA system, downstream of Tom Bevill L&D. The site of the initial installation of the LOMA antenna was on a tower on top of a roof of the lock control tower, but very near the surface of the roof. As a result of this antenna placement, the LOMA system was only able to communicate effectively for approximately 5 mi downstream. Figure 2 indicates where the original antenna was mounted.

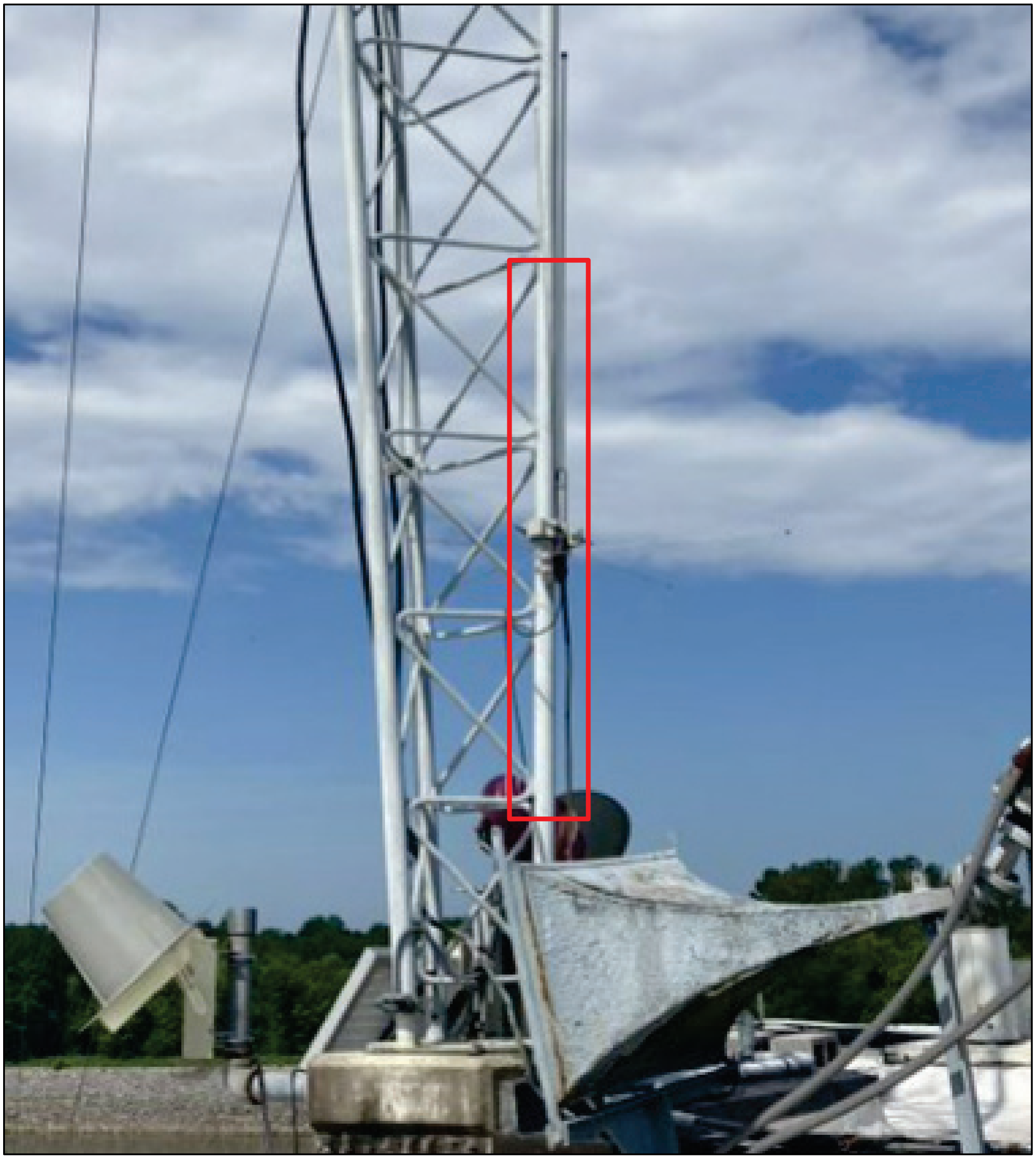

Figure 2. Original LOMA antenna (inside *red box*) mounted just above the roof alongside the base of the tower.

On the right side of the tower, the antenna was mounted just above the roof of the lock control building. The goal of the project was to raise the antenna to increase range of reception and transmission. The tower is approximately 30 ft tall, as measured from the top of the roof, with other antennas and guy wire mounts in the upper 10 ft shown in Figure 3.

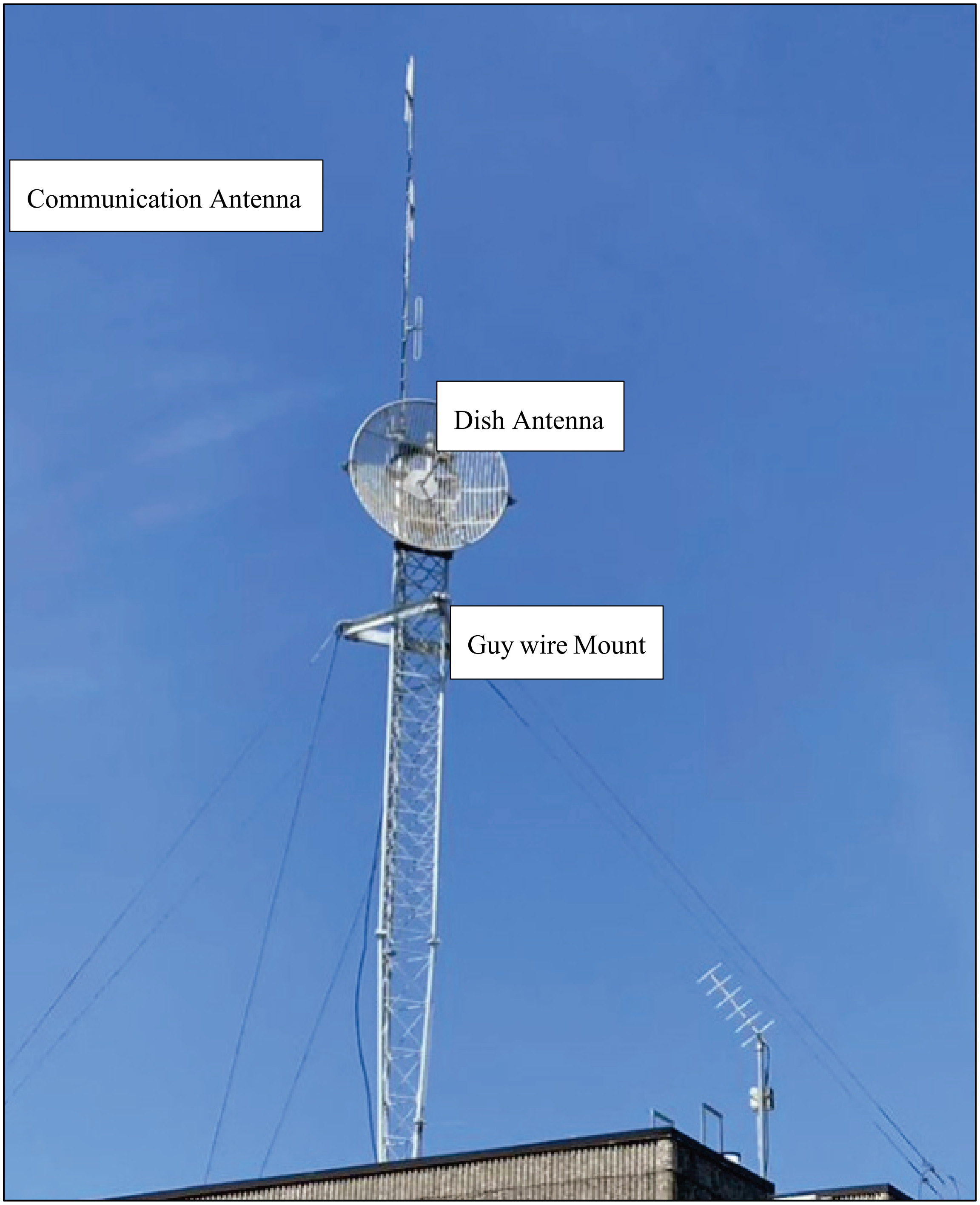

Figure 3. Full view of the tower showing dish antenna and a separate communications antenna mounted in the upper section of the tower before installing the new mount to hold the LOMA antenna.

A minimum spacing between antennas of at least 4 ft was desired to prevent radio signal interference with the existing communication antenna on the tower; more spacing may be required depending on the installation conditions and signal type (Miller 2024). Based on this recommendation the new location for the LOMA antenna mount was identified as just under the guy wire bracket. The new antenna mount consists of two pieces of aluminum angle iron 10 ft long (to space out from the tower), a 10 ft stanchion pole (to raise the antenna), and the antenna itself is 4 ft tall. The angle iron allowed for adequate spacing from current antennas and the metal tower itself to reduce any possible interference. The stanchion pole allowed for additional rise in elevation to increase the reception and transmission as much as possible. The final mount managed to raise the antenna from approximately 3 ft above the roof to approximately 30 ft above the roof shown in Figure 4.

Figure 4. The new LOMA antenna location on the left side of the tower.

RESULTS: The results of this effort can be seen by examining the before and after heat maps of AIS coverage showing signals received at the site. The lock operators for the site stated that the coverage north of Tom Bevill L&D was good almost all the way to John C. Stennis L&D, but the coverage to the south was weak, estimating 4–5 mi of coverage before the change in antenna height. The Figure 5 heatmap used data for 4 days prior to the antenna change; this shows the previous coverage extent.

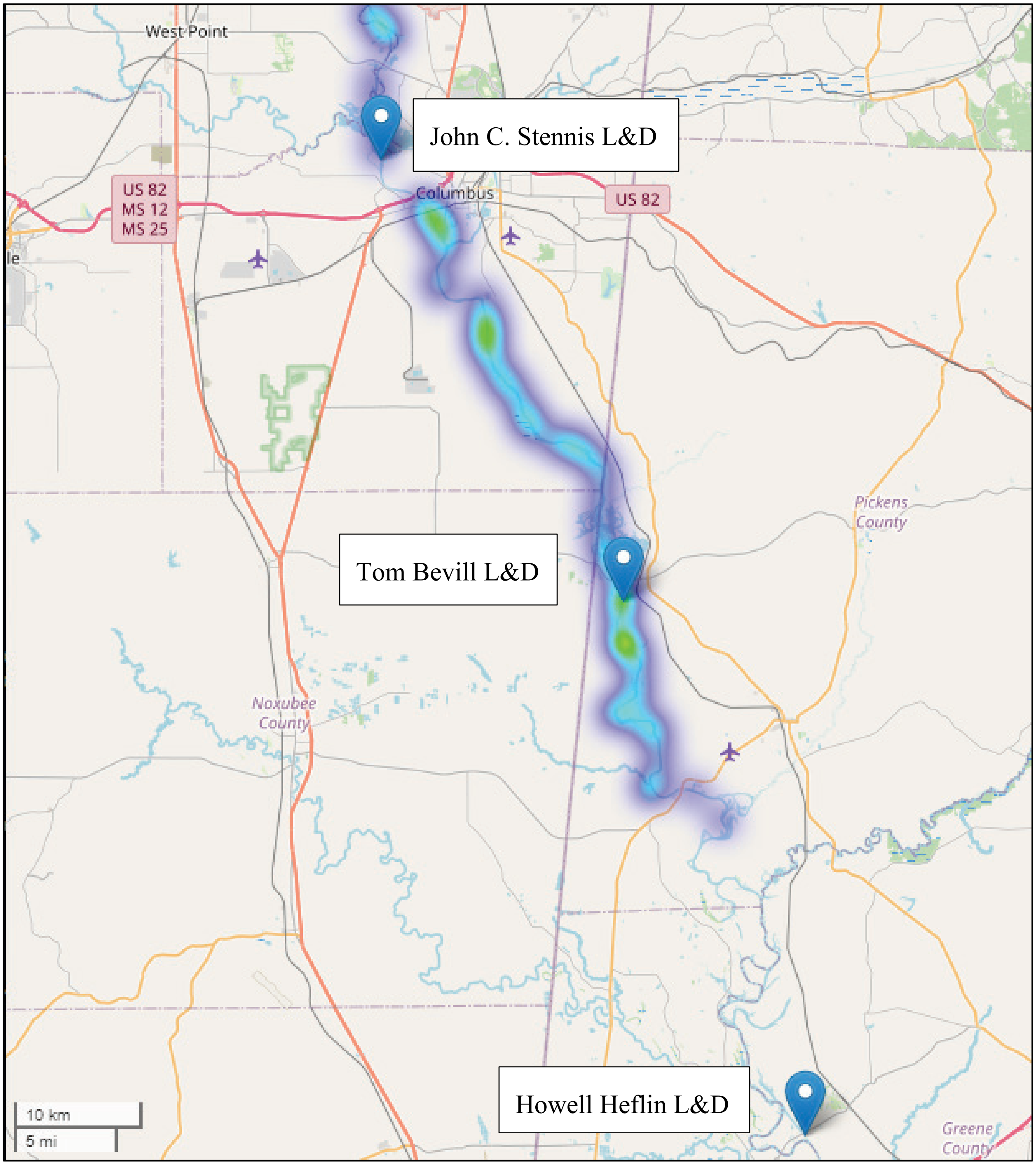

Figure 5. Tom Bevill Lock and Dam (L&D), the *center blue marker*, with coverage highlighted before the antenna height changes. Image source: GateHouse Maritime; USACE LOMA program.

Examining the same area for 4 days after the change in antenna height shows that approximately an additional 3 mi of coverage was gained from the increased antenna height (Figure 6).

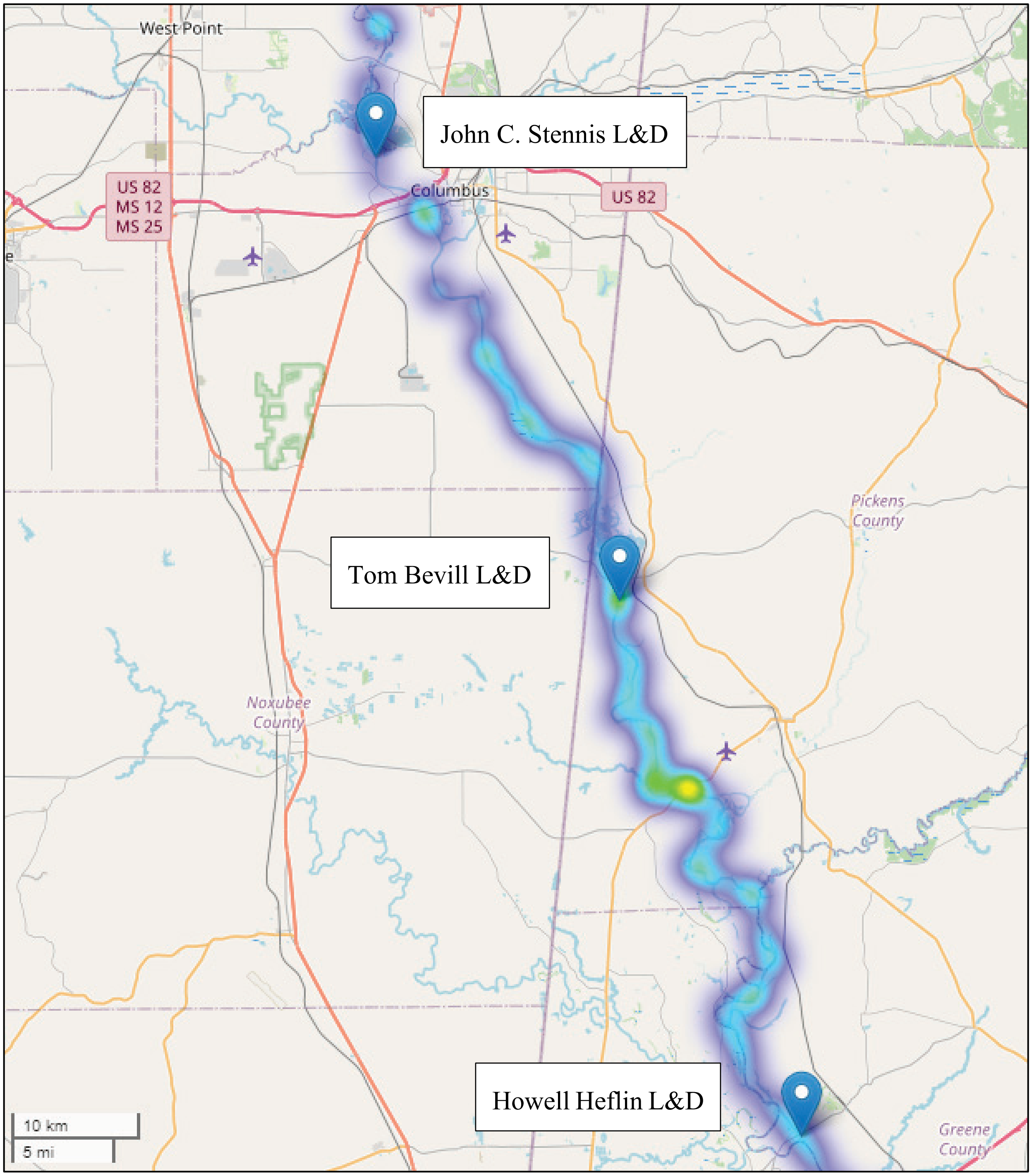

Figure 6. Tom Bevill L&D, the *center blue marker*, with coverage highlighted after the changes. Image source: GateHouse Maritime; USACE LOMA program.

SUMMARY: The change in reception coverage demonstrates the importance of optimizing antenna placement given existing site limitations. It shows that improvements in signal coverage can be gained without the need to purchase new equipment. This improved signal reception not only provides lock operators with more advance notice of vessels moving towards the Tom Bevill lock site from downstream but also allows the LOMA administrative group to transmit Virtual Aids to Navigation (VAtoN) over a larger geographic area if needed. These VatoNs serve as virtual navigation buoys (visible on electronic navigation charts) until a buoy-tending vessel can place physical buoys in the waterway to mark the navigation channel. VatoNs are also used to mark underwater hazards such as shoals or sunken vessels (Kress et al. 2020). VatoNs are especially important in times of emergency low-water situations or flooding when updated navigation information time is of the essence for the safety of the vessels and their crews. At present, the LOMA network is the only way that USACE can transmit VatoNs to the navigation community via their onboard AIS units. VatoNs may be utilized to mark the channel and underwater structures for this area. Not all waterways are within range of a LOMA site; however, additional sites can be installed. Interested parties should contact the LOMA administrative team at *LomaAdmin@usace.army.mil* to discuss their local requirements.

ADDITIONAL INFORMATION: This CHETN was prepared by Mr. Kenneth W. Swan, *kenneth.w.swan@usace.army.mil* (ORCiD *https://orcid.org/009-0000-7592-2032*), Mr. James T. Kilroy, *james.t.kilroy@usace.army.mil* (ORCiD *https://orcid.org/0009-0001-0310-3385*), Mr. Brady A. Towne, *brady.a.towne@usace.army.mil*; and Dr. Marin M. Kress, *Marin.M.Kress@usace.army.mil* (ORCiD *https://orcid.org/0000-0002-5835-5686)* US Army Engineer Research and Development Center. The study was funded by the USACE LOMA Program.

This CHETN should be cited as follows:

Swan, K. W., J. T. Kilroy, B. A. Towne, and M. M. Kress. 2024. *The Effect of Increasing the Antenna Height on Radio Signal Reception at Tom Bevill Lock and Dam: LOMA-AIS Data Case Study.* ERDC/CHL CHETN-IX-69. Vicksburg, MS: US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory. *http://dx.doi.org/10.21079/11681/48730*.

REFERENCES

Automatic Identification System. 2020. 33 C.F.R. § 164.46. *https://www.govinfo.gov/content/pkg/CFR-2022-title33-vol2/pdf/CFR-2022-title33-vol2-sec164-46.pdf*.

ERDC (US Army Engineer Research and Development Center). 2017. *Lock Operations Management Application (LOMA)*. Software package. *https://loma.usace.army.mil.*

IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities). 2008. *G1062 Establishment of AIS as an Aid to Navigation.* *https://www.iala-aism.org/product/establishment-of-ais-as-an-aid-to-navigation-1062/.*

IEC (International Electrotechnical Commission). 2001. *EC 61993-2: 2001-12 Maritime Navigation and Radiocommunication Equipment and Systems–Automatic Identification Systems (AIS)–Part 2: Class A Shipborne Equipment of the Universal Automatic Identification System (AIS)–Operational and Performance Requirements, Methods of Test and Required Test Results*. *https://webstore.iec.ch/publication/34277*.

ITU-R (International Telecommunications Union–Radiocommunication Sector). 2014. *Recommendation ITU-R M.1371: Technical Characteristics for an Automatic Identification System Using Time Division Multiple Access in the VHF Maritime Mobile Frequency Band.* *https://www.itu.int/rec/R-REC-M.1371/en.*

Kress, M., B. Tetreault, K. Mitchell, M. Balazik, and M. Booton. 2020. *AIS Data: Real-Time Operation Support, Incident Investigations, and Waterway Use Analysis.* ERDC/CHL CHETN-IX-53. Vicksburg, MS: US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory. *https://dx.doi.org/10.21079/11681/36395*.

Miller, D. 2024. "VHF Antenna: The Most Important Factor for Getting AIS to Work Well." *Milltech Marine*. *https://www.milltechmarine.com/VHF-Antenna-The-most-important-factor-for-getting-AIS-to-work-well_b_32.html*.

PIANC (The World Association for Waterborne Transport Infrastructure). 2019. *Guidelines and Recommendations for River Information Services. InCom Working Group*. Report Number 125/I-2019. *https://www.pianc.org/publications/inland-navigation-commission/wg125-1*.

Tabbert, C. R., J. C. Vest, and M. M. Kress. 2021. "Waterway Engineering Applications of Automatic Identification System Data along the Mississippi River and at Lock Structures." *Journal of Waterway, Port, Coastal, and Ocean Engineering* 147 (5): 04021020. *https://doi.org/10.1061/(ASCE)WW.1943-5460.0000658*.

USCG. n.d. "Automatic Identification System (AIS) Overview." *Navigation Center*. Accessed 03 April 2024. *https://www.navcen.uscg.gov/automatic-identification-system-overview*.