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Western Rivers Joint Capability Technical Demonstration

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N O T I C E

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16. Abstract (MAXIMUM 200 WORDS)

The Automatic Identification System (AIS) can be a means to transmit information to ships in port or underway that contributes to navigation safety and protection of the environment. U. S. Coast Guard (USCG) intent is to transmit this additional information from shore-side AIS base stations in a binary message format as part of an overall electronic Navigation (eNav) strategy.

Since 2007, the USCG Research and Development Center (RDC) has been working on an AIS Transmit project to determine what additional information is required by AIS users, recommend how the information should be transmitted, and test the transmission of the information at test lab sites. The information is transmitted using an AIS Application Specific Message (ASM). Several standard ASMs have been defined and prototype methods developed for message creation, routing, queuing, transmission, and monitoring.

The USCG, in concert with the U.S. Army Corps of Engineers (USACE), conducted a fifteen-month technology demonstration in a test area on the Ohio Valley, to provide electronic Maritime Safety Information (eMSI) to mariners in the test area.

This report identifies and explores areas needed to be addressed for a full AIS Transmit System and describes methods used by RDC, in collaboration with USACE, to achieve operational like AIS Transmit functionality.

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EXECUTIVE SUMMARY

A goal of the United States Coast Guard (USCG), as stated in the "NAIS Concept of Operations" (CONOPS), is to have the capability to transmit Environmental, Geographic Notice, Search and Rescue (SAR) / Law Enforcement (LE) patterns, and Target of Interest (TOI) type messages to mariners and USCG underway assets using the Nationwide Automatic Identification System (NAIS). The USCG **does** have the capability to transmit electronic Aids to Navigation (eAtoN) message types. These types of transmissions are accomplished by sending transmitter configuration messages automatically from U.S. Aids to Navigation (AtoN) Information Management System (USAIMS) to the individual transmitters.

In 2011 the USCG Research & Development Center (RDC) began initial testing of an AIS Transmit capability using a single base station at Louisville, KY - affecting mariners on the Ohio River. In 2013 and 2014, this work expanded to include eleven AIS AtoN transmitters located at U.S. Army Corps of Engineers (USACE) locks and dams, two RDC AIS base stations located at Battletown and Owensboro (USCG Obion Pier), and utilized one AIS base station already located at Vessel Traffic Service (VTS) Louisville. During the 15 month demonstration RDC discovered numerous gaps that needed to be addressed for a full transmit system. Solutions to these gaps were developed, implemented, and tested during the demonstration resulting in identification of the individual components shown in Figure 1. The demonstration successfully simulated an inter-agency (NAIS, USACE, and a VTS), full AIS Transmit System broadcasting electronic Marine Safety Information (eMSI) continuously throughout the test bed. Approximately 93,000 Application Specific Message (ASM) messages per day were transmitted.

The RDC project demonstration continued the initial AIS Transmit work and expanded the test area to include most of the Ohio River and part of the Mississippi River with the following goals:

- Demonstrate distribution of select navigation and eMSI information to mariners using the USCG and USACE network infrastructures.
- Identify how information moves now and make recommendations on how to move information more efficiently, including crossing Agency boundaries.

Both government and civilian AIS users were involved in the demonstration. During the demonstration, the AIS network was monitored to document the system's performance. Additionally, this report describes the elements of the RDC Test Lab and Ohio River demonstration protocols, including mobilization and test execution. The Western Rivers Joint Capability Technical Demonstration (JCTD) was a success. In addition, it illustrated the importance of addressing all eleven (11) components required to have a full AIS Transmit System.

This report outlines the framework (the way forward) and system architecture necessary to enhance USCG mission execution using AIS technology. Such a system would support all Prevention and Response missions by enabling the efficient distribution of a variety of Marine Safety Information (MSI) in electronic form (eMSI) to both the maritime public and USCG assets.

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ABK	AIS Addressed and Binary Broadcast Acknowledgement Message – NMEA 0183 Sentence
ABM	AIS Addressed Binary and Safety Related Message – NMEA 0183 Sentence
AC	Alternating Current
ACF	General AtoN Station Configuration Command - NMEA 0183 Sentence
ACG	Extended General AtoN Station Configuration Command - NMEA 0183 Sentence
AID	AtoN Identification Configuration Command - NMEA 0183 Sentence
AIS	Automatic Identification System
ASCII	American Standard Code for Information Interchange
ASM	Application Specific Message
ATO	Authority To Operate
AtoN	Aids to Navigation
ATONIS	Aids to Navigation Information System
BBM	Broadcast Binary Message - NMEA 0183 Sentence
BCG	Buffalo Computer Graphics
BNM	Broadcast Notice to Mariners
CBR	Configure Broadcast Rates for AtoN Station Message Command –NMEA 0183 Sentence replaces the AAR Sentence
CPU	Central Processing Unit
CRADA	Cooperative Research and Development Agreement
DAC	Designated Area Code
DNC	Democratic National Convention
eAtoN	electronic Aids to Navigation
eMSI	electronic Maritime Safety Information
ECS	Electronic Charting System
EM	Environmental Message
ENC	Electronic Navigational Chart
ERDC	(USACE) Engineer Research and Development Center
ESB	Enterprise Service Bus
FATDMA	Fixed Access Time Division Multiple Access
FI	Function Identifier
FSR	Frame Summary of AIS Reception
GIS	Geographic Information System
GN	Geographic Notice
GNC	Geographic Notice Creation (software
GPS	Global Positioning System
GUI	Graphical User Interface
HTML	Hypertext Markup Language
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IATT	Interim Authority to Test
IEC	International Electrotechnical Commission
IMO	International Maritime Organization
INI	Initialization (file)

LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS (Continued)

I/O	Input/Output
IT	Information Technology
ITU-R	International Telecommunications Union Radiocommunications Sector
IP	Internet Protocol
JCTD	(Western Rivers) Joint Capability Technical Demonstration
JSON	JavaScript Object Notation
LE	Law Enforcement
LOMA	Lock Operations Management Application
LPMS	Lock Performance Monitoring System
LRD	Great Lakes and Ohio Rivers Division
LSS	Logical Shore Station
METAR	Meteorological Aviation Report
MMSI	Maritime Mobile Service Identity
MPI	Multi-Protocol Interface
MSI	Marine Safety Information
MXAK	Marine Exchange of Alaska
NAIS	Nationwide Automatic Identification System
NAVCEN	(U.S. Coast Guard) Navigation Center
NMEA	National Marine Electronics Association
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
ORFC	Ohio River Forecast Center
OSC	Operations Systems Center
P-LAN	Project-Local Area Network
POC	Point of Contact
RATDMA	Random Access Time Division Multiple Access
RDC	(U.S. Coast Guard) Research and Development Center
RNC	Republican National Convention
RSS	Received Signal Strength
RTCM	Radio Technical Commission for Maritime Service
Rx	Receive
TAG Block	Transport, Annotate, and Group Block
SAR	Search and Rescue
SCC	Sector Command Center
STEDS	Sensitive but Unclassified Tactical Information Exchange and Display System
TCP/IP	Transmission Control Protocol / Internet Protocol
TFR	Transmit Feed-Back Report
TOI	Target of Interest
TV32	Transview (32-bit edition)
Tx	Transmit
UPS	Uninterruptible Power Supply
USACE	United States Army Corps of Engineers
US AIMS	U.S. AtoN Information Management System

LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS (Continued)

USCG	United States Coast Guard
USGS	United States Geological Survey
VDL	VHF Data Link
VDM	VHF Data Link Message - NMEA 0183 Sentence
VDO	VHF Data-Link Own-Vessel Report - NMEA 0183 Sentence
VHF	Very High Frequency
VNTSC	Volpe National Transportation Systems Center
VTS	Vessel Traffic Service
WMM	Waterways Management Message
XML	eXtensible Markup Language

1 OVERVIEW

The Automatic Identification System (AIS) is a real-time, Very High Frequency (VHF) radio based, automatic tracking system designed foremost for vessel collision avoidance. The United States Coast Guard (USCG) uses AIS at its Sector Command Center (SCC) and Vessel Traffic Service (VTS) facilities primarily for vessel tracking and monitoring. Current AIS Standards also support the transmission of electronic Maritime Safety Information (eMSI). Current AIS radios (transmitters and receivers) functionally support eMSI transmissions.

For the demonstration, a coverage analysis identified gaps which were filled with temporary AIS base stations to provide continuous coverage of the test bed.

The AIS Transmit System implemented by Research and Development Center (RDC), during its Western Rivers Joint Capability Technical Demonstration (JCTD), moves the message creation capability from the base station to authorized individuals (manual message creation) and organizations (automated message creation). RDC methods support not only the creation of eAtoN type messages, but also message routing, queuing, transmission, and monitoring of Environmental, Geographic Notice, SAR, LE, and TOI message types. The approach utilized by RDC requires a more robust AIS Transmit System architecture than currently employed by USCG and is summarized using the system architecture components shown in Figure 1 below. These components are discussed in detail in Section 2.

Benefits realized from the RDC prototype AIS Transmit System:

- Each base station (or AIS AtoN transmitter) is an agnostic message transmitter, independent of message type or message creator. This design supports a flexible system versus a tightly coupled system.
- In addition to eAtoN type messages, Environmental, Geographic Notice, SAR, LE, and TOI type message (encrypted and non-encrypted) transmissions are supported. Also, new messages under development can be supported without changes to the system design.
- Modification of each base station's configuration file is eliminated. This allows for a standard base station configuration across NAIS.
- Messages are routed, queued, monitored and managed using a robust and flexible transmit system architecture.

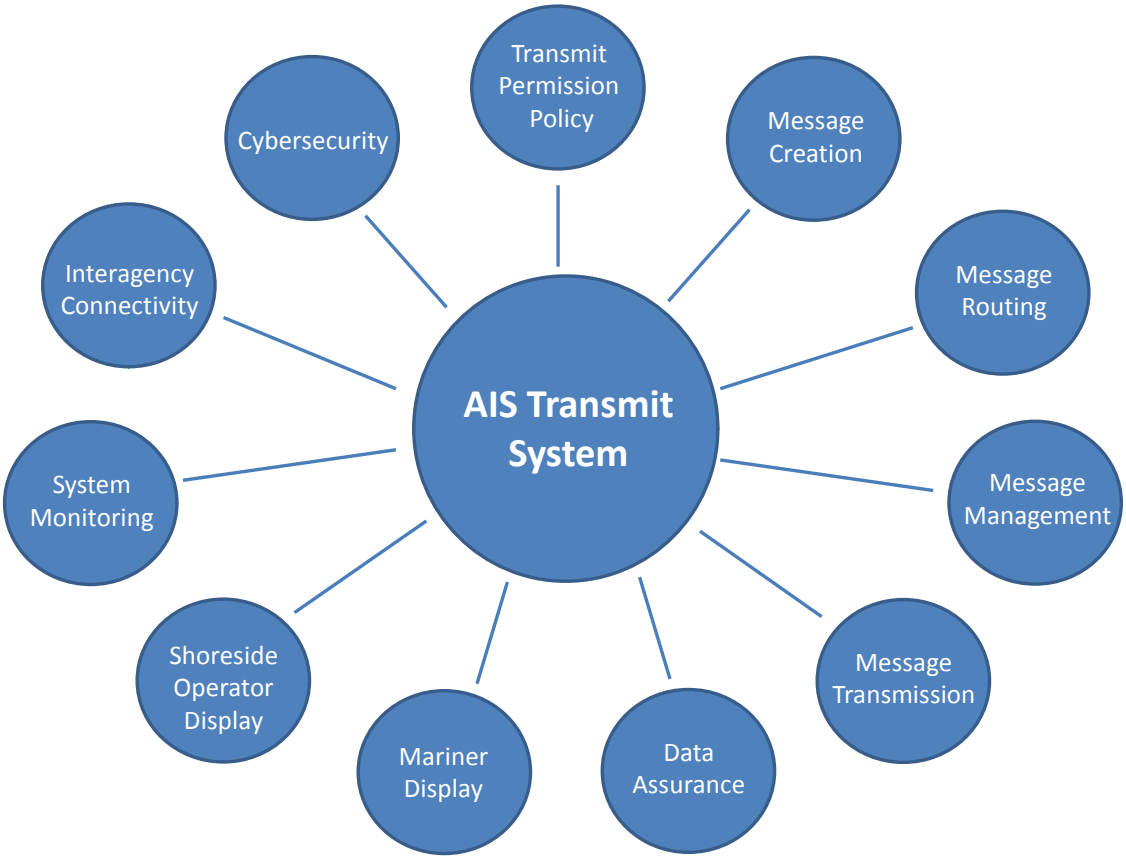

Figure 1. Components of a full AIS Transmit System.

NMEA sentences conform to a standard format for eMSI and are used as a common standard for communicating data between AIS system components. A backend network should be designed to streamline, not complicate, communications and thus should leverage existing communication standards.

At minimum, an AIS Transmit System requires the following components:

- Message Creation (automatic and/or manual). This feature does not exist within NAIS.
- Message Routing. NAIS uses CNS Systems DataSwitch software.
- Message Management (Queuing). This feature does not exist within NAIS.
- Message Transmission. L3 Technologies base stations are installed at 58 critical ports and waterways.
- System Monitoring (Very High Frequency Data Link [VDL] Monitoring). Active transmit monitoring is limited to places where overlapping base station coverage exists.
- Data Assurance (VHF Data Link (VDL) Monitoring). Today, the VDL consists of six VHF Channels: AIS1, AIS2, AIS3, AIS4, Application Specific Message (ASM) ASM1 and ASM2 that should all be monitored for integrity and interference. This feature does not exist within NAIS.

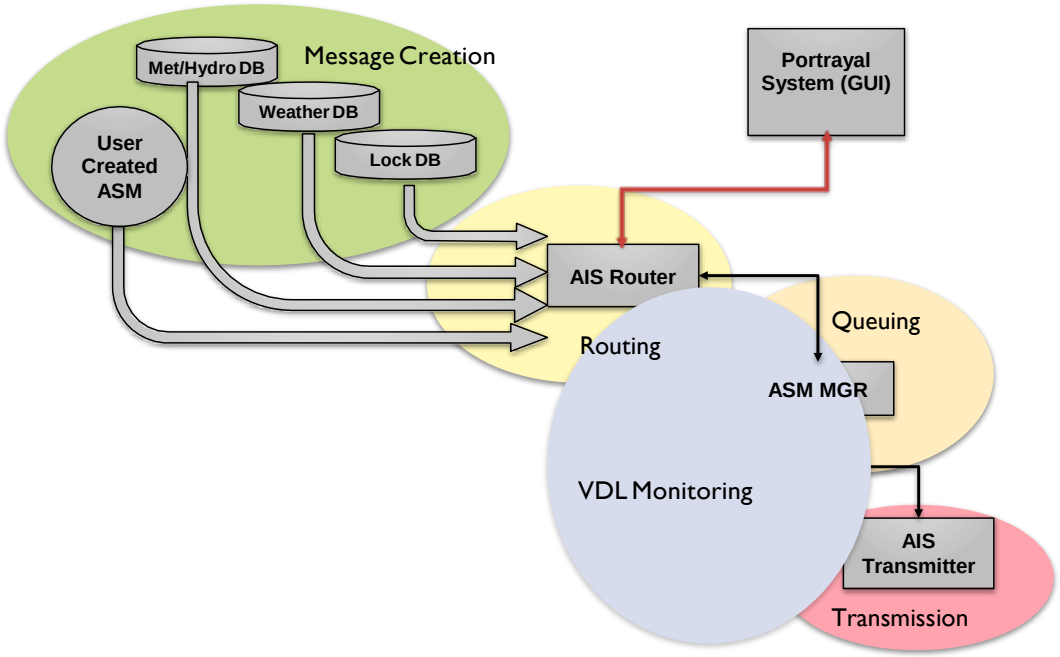

Figure 2. Prototype AIS Transmit System architecture.

In order to meet requirements outlined in the NAIS CONOPS document, a complete AIS Transmit and Monitoring System architecture needs to be funded, designed, developed and fielded. Alignment across Coast Guard Programs is necessary to ensure interoperability of an AIS Transmit System and its components - from watchstanders to end users. In addition, a final system should have interoperability with other agencies to leverage their AIS Transmit System(s) to increase coverage area.

Section 2 provides an overview of each component of a full AIS Transmit System (Figure 1 above), and serves as a way forward for creation of a full AIS Transmit System.

Section 3 details how each component of a full AIS Transmit System was implemented during the demonstration.

Section 4 contains a sampling of transmitted messages during the demonstration.

Appendix A contains a series of coverage plots of installed transmitters located throughout the test bed.

For the reader's understanding:

There are 27 different types of AIS messages. These are defined in International Telecommunications Union (ITU) 1371-5. AIS messages 6, 8, 25, and 26 provide data fields that allow "competent authorities" to define ASM subtypes. The data fields, limited in size, store data in binary format and are informally referred to as payload fields.

There are currently 167 unique ASMs – with more under consideration. For transmission, they are encapsulated within the payload portion of messages types 6, 8, 25, and 26. It is this AIS mechanism that forms the foundation from which this project demonstration is built upon. By leveraging this feature a host of new information (e.g., water levels, lock orders, and weather), can be conveyed to mariners and used to support the entire range of USCG missions.

For transmission, NMEA 0183 AIS [VHF Data Link Message (VDM), AIS Addressed Binary and Safety Related Message (ABM), and Broadcast Binary Message (BBM)] sentences are provided to an AIS Transceiver, which uses the information to create and transmit the appropriate AIS message using a communication method called Self Organizing Time Division Multiple Access (SOTDMA). SOTDMA organizes AIS transmitters in order to share usage of the same channel while minimizing transmission collisions, without using a central controller. The channel is divided into 2,250 26ms long time slots per minute (and there are two AIS channels for a total of 4,500 slots per minute). Each AIS message uses from 1 to 5 slots depending upon the length of the message. After subtracting off packet and message overhead, there is a maximum of 168 bits for a single slot binary message and up to about 1,000 bits for a 5-slot binary message.

2 AIS TRANSMIT SYSTEM COMPONENTS

Provided in this section is an overview of each component of a full AIS Transmit System (Figure 1 above). Each sub-section includes a definition of the component and a list of considerations for operational AIS Transmit System implementation.

2.1 Transmit Permission

The Transmit Permission component of an AIS Transmit System addresses policy and authority permissions concerning access and use of the system.

During the project demonstration, transmit permission was initially limited by the network architecture to RDC personnel and the CG-NAV detached position at Sector Ohio Valley. Later in the demonstration, once the direct DataSwitch-to-DataSwitch connections were made, USACE Engineer Research and Development Center (ERDC) personnel also gained transmit authority. Individual authentication functionality was not built into the demonstration due to the limited number of users. Network security protocols were implemented and served as transmit permission during the demonstration.

To provide Transmit Permission capability in an operational AIS Transmit System, the following items will need to be addressed:

- Policy and system architecture need to be developed for Intra-Coast Guard Transmit Authority.
  - Message Creation applications need to be networked into the transmit system architecture - allowing for authentication and approval of message transmission.
  - Two-way acknowledgement of message transmissions needs to be established to the message creator.

- Policy and system architecture need to be developed for Inter-Agency Transmit Authority.
  - Agencies must have the ability to route messages compatible with the USCG transmit system required format.
  - USCG must have a means to authenticate users at approved agencies authorized to transmit on USCG system.
  - Transmit systems belonging to third-party and other approved agencies must be able to authenticate approved USCG users.
  - Two-way acknowledgement of message transmissions needs to be established.

Other considerations for standup of an operational AIS Transmit System:

- Two-way acknowledgement may require additional standards development for full implementation. Transmitter standards need to be modified to require the transmitter to send replies (e.g., NMEA AIS Addressed and Binary Broadcast Acknowledgement Message (ABK) sentences) back to the message originator as identified by the source parameter(s) in the Transport, Annotate and Group (TAG) Block.

2.2 Message Creation

Message creation is the ability to draft messages for transmission either manually or automatically. A Graphical User Interface (GUI) display is used to manually generate messages. A software application is used to create messages automatically (typically using information from databases) for transmission.

During the project demonstration both manual and automatic methods were used to create messages. The TransView 32 (TV32) software application was used to create manually generated messages. Many ASMs were constructed using data available from online data providers. The Fetcher/Formatter application was used to fetch web based information then format and generate messages automatically. A limitation of accessing data this way, however is that a standardized data schema among service providers does not exist. To work around this gap, several variations of the Fetcher/Formatter application were developed. Each was modified to parse the unique data format of a specific provider's website.

The Ohio River demonstration used six Fetcher/Formatter applications to generate over 200 ASMs, and sent data to the fourteen transmitters located on the USACE and USCG networks.

To provide message creation capability in an operational AIS Transmit System, the following items will need to be addressed:

- USCG standup of message creation.
  - Policy needed: Identification of USCG organization(s) with authority to generate messages.

- Develop CONOPS for message creation. Organizational determination of "who" and "how" to create messages will need to be defined.
  - Determining what information is needed by the mariner community.
  - Determining which method, manual or automated, is best for message creation.
  - Determining if message creation should be done on a regional or national level.

- Build-out tools:
  - A standard workstation image tool to create ASMs is needed.
  - A ship-to-shore transmit capability is needed. Expand upon existing Vega capability to create messages.
  - Automatic message creation software tools need to be developed.
  - Message creation tools need to include:
    - provisions for repeating the messages at specified intervals;
    - ability to apply destination parameter(s) for routing;
    - ability to specify message priority; and,
    - the ability to preview messages before sending.

- Additional guidance needs to be developed covering the creation of ASMs; and, policy and procedures for getting ASMs approved, managed, and changed.
  - This guidance could be published as an additional appendix to International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Recommendation A-124, "On The AIS Service," ed 2.1 (Dec 2012), or possibly a separate IALA guideline.
  - Some ASMs have been defined in international documents such as ITU-R M.1371; and, International Maritime Organization (IMO) SN.1/Circ. 289. Others have been defined by regional authorities. Some of which are posted on the IALA registry web site (http://www.e-navigation.nl/asm). These ASMs can be used by any competent authority. The goal of the registry is to promote reuse of existing ASMs prior to creation of new ones.
  - Missing from publication in existing standards is a requirement or guidelines for the use of the registry to create, post, and adopt new ASMs.
  - The only existing standard is the draft Radio Technical Commission for Maritime Service (RTCM) Special Committee 121 standard, "RTCM Standard For The Creation And Qualification Of Application-Specific Messages (ASM)."

- The ESB needs to be able to accept and process all AIS message created.

Considerations for automated data message creation in an operational AIS Transmit System:

- Each data source is supported by a separate and unique instance of the Fetcher/Formatter application. In the event of an application or data source failure, loss is limited to that one data source.
- Most instances of the application are set to parse HyperText Markup Language (HTML) specific to a source provider's website. This parsing method is hardcoded into each variant of the application. If a data provider changes their website HTML the corresponding application will need to be updated, recompiled, and installed supporting the new HTML data structure. A standardized eXtensible Markup Language (XML) or JavaScript Object Notation (JSON) scheme would better serve this website-to-application retrieval process.
- In considering software for automated ASM creation, separation of the data retrieval process from data storage (database) and data formatting (using the newest database records), could be beneficial.
- Enterprise connectivity to provider-of-record sources could eliminate the need for Fetcher/Formatter type software.

2.3 Message Routing

The routing of ASMs to and from end-point transmitters and receivers can be simple or complex, depending on how related areas such as: Transmit Permission Policy; Interagency Connectivity; Cybersecurity, Geographic Area of Message Applicability, Transmission and Reception Effectiveness, etc., are implemented in an operational AIS Transmit System.

Message routing is a function of the AIS Logical Shore Station (LSS). The primary component that implements this is an "AIS Router;" so called, because it is responsible for routing the AIS data between the AIS service clients and the AIS Physical Shore Station (PSS).

AIS Routers move NMEA traffic around but were mostly designed for use in an architecture built around a network of AIS receivers. They primarily offer filtering of traffic to various clients and access control to

various sources of data, which is all that was needed for a shore side receive (VDL Monitoring) network. What is missing is support for routing of traffic to destinations for transmission. Most existing AIS Routers will route addressed messages based on the Maritime Mobile Service Identity (MMSI) of the intended recipient, but not much more. What is needed is true routing of messages to specified destinations, and the ability to route traffic back to the originator. NMEA has provided a protocol mechanism to allow for this routing with the TAG Block source and destination parameters but this has not been universally or consistently implemented within NAIS.

In the U.S. test beds, the AIS Router used is the CNS DataSwitch. This originally only provided routing support through a proprietary implementation. By default, messages to be transmitted that were sent to the DataSwitch client connection (called a top connection by CNS) were routed to all radio connections (called bottom connections). More recently, the USCG and USACE have worked with CNS to have standard NMEA 0183 TAG Block routing implemented and this is now in use in the test beds to enable transmit messages to be sent to the specified transmitter or transmitters based upon the TAG Block destination parameter. What is not currently possible (without custom software) is to route traffic back to the originator of a message, using standard NMEA 0183 protocol, as the current NAIS architecture has not required this and the IEC Base Station Standard is silent on this functionality. ***Important to note is that all IEC AIS equipment standards only reflect the very minimum requirements (they are minimum performance standards) for general use of AIS Stations (shipboard or shore based) and it is up to competent authorities to specify appropriate functionality beyond the minimum, as necessary for the intended application.***

The Coast Guard, USACE, and RDC have the same version of DataSwitch software. Message routing between USACE and RDC is accomplished using DataSwitch. The Coast Guard is currently not using DataSwitch for message routing. A routing function for the USCG can be accomplished by building-out functionality within the ESB or through use of the DataSwitch routing software.

During the project demonstration, RDC and USACE acted as data collection hubs and message distribution points. Data for creation of ASM and NMEA compliant messages were collected from the following sources and routed to various transmitters using the destination parameter: OSC, Davis weather stations, National Oceanic and Atmospheric Administration (NOAA), Ohio River Forecast Center (ORFC), Aids to Navigation Information System (ATONIS), Olmsted, USAIMS, and CG Sector Ohio Valley/VTS Louisville. While effective for demonstration purposes, this network design is not the ideal solution for an operational AIS Transmit System.

Note: CNS DataSwitch software is used to route messages from source to destination using destination parameter(s). Routing messages using DataSwitch is in only one direction at this time. Bi-directional message routing would allow for transmission verification to originator of transmission; ship-to-shore communication; and, ship-to-ship communication when outside the transmitter's VDL.

To provide Message Routing capability in an operational AIS Transmit System, the following items will need to be addressed:

- AIS Standards:
  - Better definitions of AIS router definitions and requirements are needed. The two-way routing process is neither defined nor required anywhere; IALA A-124 provides definitions of a LSS, but is primarily concerned with a shore-side receive network. This could be captured in a new Appendix to IALA A-124.

  - A document specifying full two-way routing process based upon destination parameters is needed. Current DataSwitch architecture is designed for outbound routing only. This could be captured in a USCG system architecture document or as an additional AIS appendix in the NMEA 0183 Standard.
  - Performance standards for AIS routers need to be developed that include full two-way routing capability. There are no performance standards (International Electrotechnical Commission [IEC]/RTCM/NMEA), covering what an AIS Router should do or how it could be certified.
  - Note that the following four items may not be suitable additions to the IEC Base Station and AtoN Standards as the topics are well above the minimum requirements. These items may be better suited to a USCG system architecture document or as a new AIS Implementation Appendix in the NMEA 0183 Standard.
    - Transmitter (base station and AIS AtoN) Standards (IEC 62320 for example) could be updated to support tracking of the source of a received message - so that responses can be routed back to the source.
    - Transmitter Standards could be updated to support message routing.
    - Standardized TAG Block usage.
    - Acknowledgement message management.

- Development of routing system network architecture:
  - Development of pathway parameters needed to route messages between USCG, USACE, NOAA, MXAK, 3rd Party DataSwitch type routers.
  - Identification of message parameters (based on message type) needed to have DataSwitch route messages to their intended transmitter.

2.4 Message Management

The Message Management component of an AIS Transmit System answers the questions of when and how often a message is transmitted and re-transmitted. This is needed to provide a reliable delivery service (ensure all messages are transmitted) and to ensure more efficient use of network bandwidth by controlling when messages are transmitted. If a message management service is not used, there is no capability to retransmit messages at a set interval or to ensure messages are transmitted.

The project demonstration utilized ASM Manager to provide this capability (Section 3.4). Neither current AIS routers nor base stations support message management. Regardless of the transmit mode - Fixed Access Time Division Multiple Access (FATDMA) or Random Access Time Division Multiple Access (RATDMA) - a high message arrival rate will result in a high probability of messages being discarded and not being transmitted. Buffering or queuing message management capability is beyond the scope of IEC AIS standards as IEC AIS equipment standards only reflect the very minimum requirements (they are minimum performance standards) for general use of AIS Stations (shipboard or shore based).

To provide Message Management capability in an operational AIS Transmit System, the following items will need to be addressed:

- Development of mechanism / tool to control when and how often messages are sent.
  - Many messages may need to be retransmitted on an interval basis.
  - Ability to schedule message transmission (e.g., to create broadcast zones ahead of time and schedule transmission when active).
  - Eliminate unnecessary use of VDL. Give priority to dynamic information over static.

  - Message queue management:
    - Message validation.
    - Message buffering.
    - Message repeating.
    - Message prioritizing.
    - Resolving duplicates.
    - Ensuring delivery on a per transmitter basis.

- Considerations for use in an operational AIS Transmit System:
  - The features of ASM Manager could be directly incorporated into DataSwitch (type) software. This would reduce software maintenance and centralize an aspect of the transmit system software architecture. However, doing so adds complexity to an already complex software component (DataSwitch) and limits where this capability resides – providing a single source of failure.
  - Message Transmission.

The Message Transmission component of an AIS Transmit System covers hardware, policy and guidelines of base stations and AtoN devices used for transmission on the VDL.

There are three ways to have a base station transmit an AIS message; each method has pros and cons, and some AIS messages are better suited to certain methods. Each of these methods and the recommended AIS messages are described below and the methods recommended for each transmit message type summarized in Table 1.

2.4.1 Method 1: Base Station Programming

A typical base station (such as the L-3 Protec) can be programmed to generate some AIS messages automatically. The AIS-Service Management layer does the programming – whether this is third-party software such as CNS's Maestro or the base station vendor's software (e.g., L-3 Base Station GUI). The messages are configured and assigned to a repetitive transmit schedule. Slots can also be reserved for these messages. There are some AIS messages that would be difficult to create and/or manage by one of the other two transmit methods and should be sent using this method. The messages that fall into this category are: AIS messages 4, 17, 20, 21^{5}, 22^{8}, and 24.

2.4.2 Method 2: NMEA Sentence Programming

A base station supporting NMEA 0183 version 4.0 can be configured to transmit most AIS messages using various NMEA 0183 sentences. In this case a client application could create the appropriate NMEA sentences and send them through the network to the base station. The base station uses the information in the sentences to create and transmit the AIS messages. Most messages that a base station can transmit can be configured and sent in this manner. The advantage of this method vs. Base Station Programming is that a client application (not just the AIS-SM) could request the transmission of the AIS message. The messages that are recommended to use this method are: AIS messages 6, 8, 10, 12, 14, 15, 16^{3}, 21^{6}, 22^{9}, 25, and 26.

2.4.3 Method 3: Directly Created AIS Message

A base station can be forced to transmit any AIS message by embedding the AIS message in a VHF Data Link Message (VDM) sentence and sending that to the base station. This allows tremendous flexibility; however, it puts the entire burden of the AIS message creation onto the client; which for some message types is difficult. However, if a competent authority wants to send messages using a virtual MMSI (to identify messages as coming from a single shore site (e.g., a vessel traffic service center) instead of from an

individual base station) then this method must be used. This method, in conjunction with the ASM Manager also allows for more precise control of virtual/synthetic AtoN transmissions and does not require the user to be aware of the current base station slot reservations. The L-3 Protec Base Station and L-3 AIS AtoN will generate a NMEA 0183 Transmit Feed-Back Report (TFR) Sentence that reports the status of the VDM message delivered to the transceiver (e.g., whether it was successfully scheduled for transmission) back to the client which is very helpful. However, this is beyond the minimum requirements of the IEC AIS Standards and thus cannot be expected to be implemented in all commercial-off-the-shelf AIS transceivers. There are several AIS messages that would be very difficult to create and manage using this method, and thus are not recommended for this transmission method (AIS 4, 17 and 20 for example). The messages that are recommended to use this method are: AIS messages 6[1], 8[2], 16[4], 21[7], and 24[10].

None of this is fully addressed in existing standards. The mechanics of what methods should be used under various operational scenarios are **not** included in any IALA guidelines. The USCG should develop these specifications and publish them either in a USCG document or within a NMEA or RTCM Standard.

Table 1. Mapping of AIS messages to transmit methods.

R = recommended, N = not recommended or not possible, O = optional.

		Method		
AIS MSG	**Description**	**1**	**2**	**3**
4	base station report	R	N	N
6	addressed binary message	N	R	R[1]
8	broadcast binary message	N	R	R[2]
10	request Universal Time Coordinated (UTC) date/time	N	R	O
12	addressed safety-related text	N	R	O
14	broadcast safety-related text	N	R	O
15	request for specific message(s) (base station will generate an ABK for this so gives additional status)	N	R	O
16	assignment mode	N	R[3]	R[4]
17	Differential Global Navigation Satellite System (DGNSS) corrections broadcast	R	N	N
20	data link management	R	N	N
21	AtoN	R[5]	R[6]	R[7]
22	channel management	R[8]	R[9]	N
24	extended base station information	R	N	R[10]
25	short unscheduled binary transmission	N	R	O
26	scheduled binary transmission	N	R	N

[1] If a virtual MMSI is needed.

[2] If a virtual MMSI is needed.

[3] Especially if assigning slots that then need to be reserved.

[4] For assigned rate mode only.

[5] If only a few virtual or synthetic aids, with static parameters.

[6] For virtual or synthetic aids, with parameters that need to be changed by the client application periodically – perhaps due to monitoring, or if trying to program the base station from a database driven application.

[7] For virtual or synthetic aids, if too many for the base station to manage using other methods, also allows more precise control of transmission timing.

[8] If using Area-based channel management.

[9] If used for specific station channel management.

[10] If base station does not support sending the message automatically.

Currently, USCG is only transmitting message 21 via direct configuration of base stations. The current transmit system consists only of L3 base stations.

During the project demonstration, message transmission was conducted on L3, Saab, and CNS base stations and L3 AtoN units. The demonstration used method 2, using NMEA Broadcast Binary Message (BBM) sentences and method 3, using VDM sentences to transmit messages. This enabled a variety of different ASMs to be transmitted throughout the test bed during the demonstration. (Section 3.5)

To provide a Message Transmission capability in an operational AIS Transmit System, the following items will need to be addressed:

- For policy consideration – deciding how transmission will be implemented for different message types and data types, which dictates use of BBM, VDM, or configuration sentences. Some message types are better suited for transmission (see Table 1).
- Limitations on configurations of virtual / synthetic aids base stations and AtoN's (50 for L3 base stations and 15 for L3 AtoN units). No direct control of message scheduling.
- Base stations have limited buffering capacity – limiting the number of queued messages for transmission.
- Base stations cannot acknowledge a message back to the originator.
- Transmitters have no ability to repeat Broadcast ASMs.
- Transmitter placement needs to consider its VDL.
- There is some ambiguity in the transmitter Standards. This has resulted in different vendor's products functioning differently during transmission.
- Guidelines for the transmission of the various message types in an operational environment need to be developed.
- Current IEC Minimum Performance Standards don't require the capabilities listed above. An additional appendix to A-124 and/or an addition to IEC 62320 may be needed.

Other considerations for standup of an operational AIS Transmit System:

- Identifying areas subject to message broadcast coverage.
  - Development of message protocols for path distribution of messages and rules for who can receive and send messages, and under what conditions.

2.5 Data Assurance

The Data Assurance component of an AIS Transmit System addresses the integrity of data being delivered to the mariner or Coast Guard asset over the AIS VHF Data Link Channels. It is used to ensure that the data being received has only been transmitted by competent authority and has not been modified or spoofed.

During the demonstration the RDC conducted limited data assurance – by verifying the messages prior to message transmission. No post transmission real-time or automated data assurance monitoring was performed. Coverage analysis was conducted before the test bed demonstration was initiated and two additional RDC AIS base stations were installed to minimize the gaps. Additionally, an AIS receiver was collocated with every test bed transmitter. This provided a manual method to ensure transmission was completed and validated.

To provide a Data Assurance capability in an operational AIS Transmit System, a system will need to be developed to provide (near) real-time automated data assurance.

2.6 Mariner Display

The Mariner Display component of an AIS Transmit System supports the viewing of ASMs following message transmission.

During the project demonstration RDC established a Cooperative Research and Development Agreement (CRADA) with commercial company Rose Point to decode and display (draft and not yet finalized) ASMs broadcast throughout the test demonstration.

To provide a Mariner Display capability in an operational AIS Transmit System, the following items will need to be addressed:

- The majority of ASMs developed by RTCM with USCG input published by USCG on the IALA ASM registry web site have not been finalized and are published as "drafts" or in "testing." These need to be finalized to spur industry acceptance as few display manufacturers will develop commercial products based on draft ASM structures that are likely to change.
- Currently no ASMs are approved or mandated for use by USCG. IALA guidelines are not finalized for ASMs creating a problem for commercial charting companies to decode and display ASMs.
- No Carriage Requirements for Electronic Charting System (ECS) for Inland Waters. Carriage Requirements are necessary for full implementation of eMSI. Current rules allow for the use of ECS in place of paper charts, but do not require usage. There is a proposed rule to mandate carriage requirements under review.
- eMSI is only being broadcast using ASMs in limited areas for test purposes; this limits display vendors' desire to implement these ASMs within their software.
- Portrayal standards need to be expanded to include all approved ASMs.

Other considerations for standup of an operational AIS Transmit System:

- If ships are not using a Heading sensor, the ship outlines displayed on ECS could be incorrect.
- If a two-way transmit system is desired, the mariner display would need to have the capability of generating Acknowledgement and other ASMs (e.g., AtoN discrepancies, weather sensor reports).

2.7 Shoreside Operator Display

The Shoreside Operator Display component of an AIS Transmit System is used to display vessel position information and supports the viewing of ASMs during manual message creation, and following ASM transmission.

During the project demonstration, RDC used the TV32 application for its Shoreside operator display. In addition to displaying all AIS type messages, it can also create, decode, display and route ASMs for transmission.

To provide a Shoreside Operator Display capability in an operational AIS Transmit System, the following items will need to be addressed:

- Standards work and portrayal needs to continue (also applies to shipboard displays). USCG Shoreside systems do not accept and decode all AIS messages.
- Portrayal standards need to be expanded to include all approved ASMs. Note that the majority of ASMs developed by RTCM with USCG input published by USCG on the IALA ASM registry web site have not been finalized and are published as "drafts" or in "testing." These need to be finalized.
- USCG maintains and operates multiple software display tools – complicating implementation of ASMs Transmit capability.

Other considerations for standup of an operational AIS Transmit System:

- Time and message timestamp concerns.
  - Vessel position messages only contain a time value between 0 and 59 seconds.
  - Receiver time is used by most systems and fluctuates when not connected to Global Positioning System (GPS).
  - Time fluctuation issues can cause ghost tracks and other display issues.

2.8 System Monitoring

The System Monitoring component of an AIS Transmit System is necessary to ensure proper management of the VDL, proper message transmission, data assurance, operation of transmitters and receivers, and all shore-side components.

During the project demonstration RDC utilized custom software (dashboard GUI) to monitor and ensure message transmission. Message content was monitored manually using the TV32 software application. The VDL usage was controlled using an in-house developed message management software application (ASM Manager). To ensure message transmission, RDC installed receivers at each transmitter site. This was necessary as USCG uses half-duplex radios which cannot listen during transmission. A full duplex radio is needed for this capability. A gap is that there is no automatic acknowledgement from the transmitter back to the sender that a message was successfully transmitted. This was done by observing transmissions on display software.

To provide System Monitoring capability in an operational AIS Transmit System, the following items will need to be addressed:

- Monitoring of all six of today's AIS VDL channels simultaneously (this does not include the additional VDES channels being developed) for interference and proper operation.
- Management of the VDL:
  - Ensure sufficient slots are reserved for the desired number of messages.
  - Ensure transceivers are configured correctly.
  - Track AIS channel frame loading.

- General system monitoring:
  - Check for errors, generate and respond to alerts.
  - Provide logging capabilities.
  - Display of message queue and queue size.

  - Display of message information.
  - Deleting of messages from the queue.
  - Stopping program execution.
  - Maintaining queue statistics – with the capability to display on demand and email a queue statistics report.

- Detect Transmission of Non-Authorized Messages:
  - Continuous monitoring of VDL for non-authorized messages.

- Monitoring of all USCG AIS VHF transmissions,
  - to confirm transmission(s) made in expected geographic area or by the expected transmitters,
  - to confirm transmission contents matched the contents of the requested transmission,
  - to confirm the transmission was or was not authorized,
  - to confirm reception in the correct geographical area(s) was achieved,
  - to provide feedback to originator about success or failure of transmission request, and
  - to include actions to be performed and mitigating remedies when any of the above items fail.

- System monitoring is beyond the scope of the AIS standards themselves and should be specified by the competent authority for the system (such as NAIS).
- A system capability to detect Spoofing, Interference, Malfunction Detection And Countermeasures (SIMDAC) improving USCG's Cyber Security Stance and fundamental data integrity of information received from the "open" Automatic Identification System.

Other considerations for standup of an operational AIS Transmit System:

- All transmit messages (i.e., VDO and ABK) need a TAG Block Source Parameter Code applied to know which transmitter sent the message.
- Transmitter unable to "hear" own transmission. Options to address this include: overlapping transmitters and/or additional receivers, all with sufficient VDL channel support, currently six VHF channels.

2.9 Inter-Agency Connectivity

The Inter-Agency Connectivity component of an AIS Transmit System addresses the ability to share Transmit resources between agencies.

During the project demonstration, RDC established inter-agency connectivity with USACE. This was accomplished by prototyping a DataSwitch-to-DataSwitch connection and using NMEA standards for all messages. Other RDC projects had connectivity with third-party providers such as MXAK and Columbia River Pilots. A detached resource at Louisville was responsible for and had the authority to transmit manually generated messages during the test bed. RDC created messages automatically that were transmitted through inter-agency transmitters.

To provide Inter-Agency Connectivity capability in an operational AIS Transmit System, the following items will need to be addressed:

- Policy needs to be established to allow inter-agency connectivity.

- Policy/guidelines need to be established to determine "who" has authority to send messages across agencies and to which transmitters.
- Policy/guidelines need to be established to identify "what" is transmitted and at what traffic rate.
- Standardized messages, such as those published by NMEA, will need to be implemented to enable inter-agency communication.

2.10 Cybersecurity

The Cybersecurity component of an AIS Transmit System addresses the issue of protection against criminal or unauthorized use of electronic data.

During the project demonstration, RDC cybersecurity followed Interim Authority to Test (IATT) and Authority to Operate (ATO). All hardware within the RDC Project-Local Area Network (P-LAN) environment maintained current security patches. An authorized user list was maintained to control access. Strict firewall configurations were established and maintained to control and minimize in-bound and out-bound data traffic. All Information Technology (IT) equipment was kept within a physically secured location – in accordance with COMDTINST M5500.13D, Security and Information Assurance Manual.

To provide cybersecurity capability in an operational AIS Transmit System, the following items will need to be addressed:

- Development and implementation of an AIS Transmit System cybersecurity plan.
  - Internal closed-network.
  - Inter-agency.

3 RDC DEMONSTRATION

During the project demonstration, the RDC Test Lab was used to conduct transmit testing of AIS messages. The lab was used to demonstrate use of commercial, USCG, and RDC developed software applications for data retrieval and message creation - both manual and automated; data routing; and, transmit monitoring and management. During the project demonstration, both IALA Approved and IALA AIS ASMs were used.

The RDC Transmit network was designed to simulate an inter-agency AIS Transmit System using transmitters similar or identical to those in use by USCG and USACE. The network system's functions, housed at RDC, represented functions that would be located at OSC and NAVCEN. Field level message creation functions were located at Sector Ohio Valley and performed by a CG-NAV detached billet. Inter-agency connectivity was established from the RDC to USACE Engineer Research & Development Center (ERDC). Field transmitters consisting of base stations and AtoN units were installed throughout the test bed representing NAIS, VTS, and USACE AtoN units.

Functional testing of all hardware, software, network connectivity, and internal/external interfaces was conducted. Aspects of the demonstration that were tested range from message creation to routing, queuing, and transmission. In addition, the integrity of source data was reviewed and all monitoring and logging capabilities tested.

Provided in this section is an overview of methods employed by RDC, and description of software applications used to support each component of a full AIS Transmit System (Figure 1 above). Each sub-section includes a description of how each functional element was implemented for testing. The software applications used during the project demonstration are a mix of commercial, USCG, and RDC developed applications. Each application serves a specific function with respect to message creation, routing, display, and monitoring. Some applications are still being updated to better support ASM Transmit. None of the software applications should be considered a best or final solution for its intended use; they do however serve as an example of the functionality needed.

Figure 3 below shows site locations along the Ohio River used to conduct transmit testing during the project demonstration. Figure 4 shows the RDC lab hardware architecture. Figure 5 shows the architecture for the full JCTD.

A complete lab infrastructure simulating the Field Demonstration network was established prior to initiating any live broadcasts for quality control and assurance. The RDC Project Demonstration room served as both the simulated Field Demonstration and Command Center for the Ohio River test bed. The majority of the AIS transmit functions performed within the RDC Command Center served as a surrogate for OSC's future role.

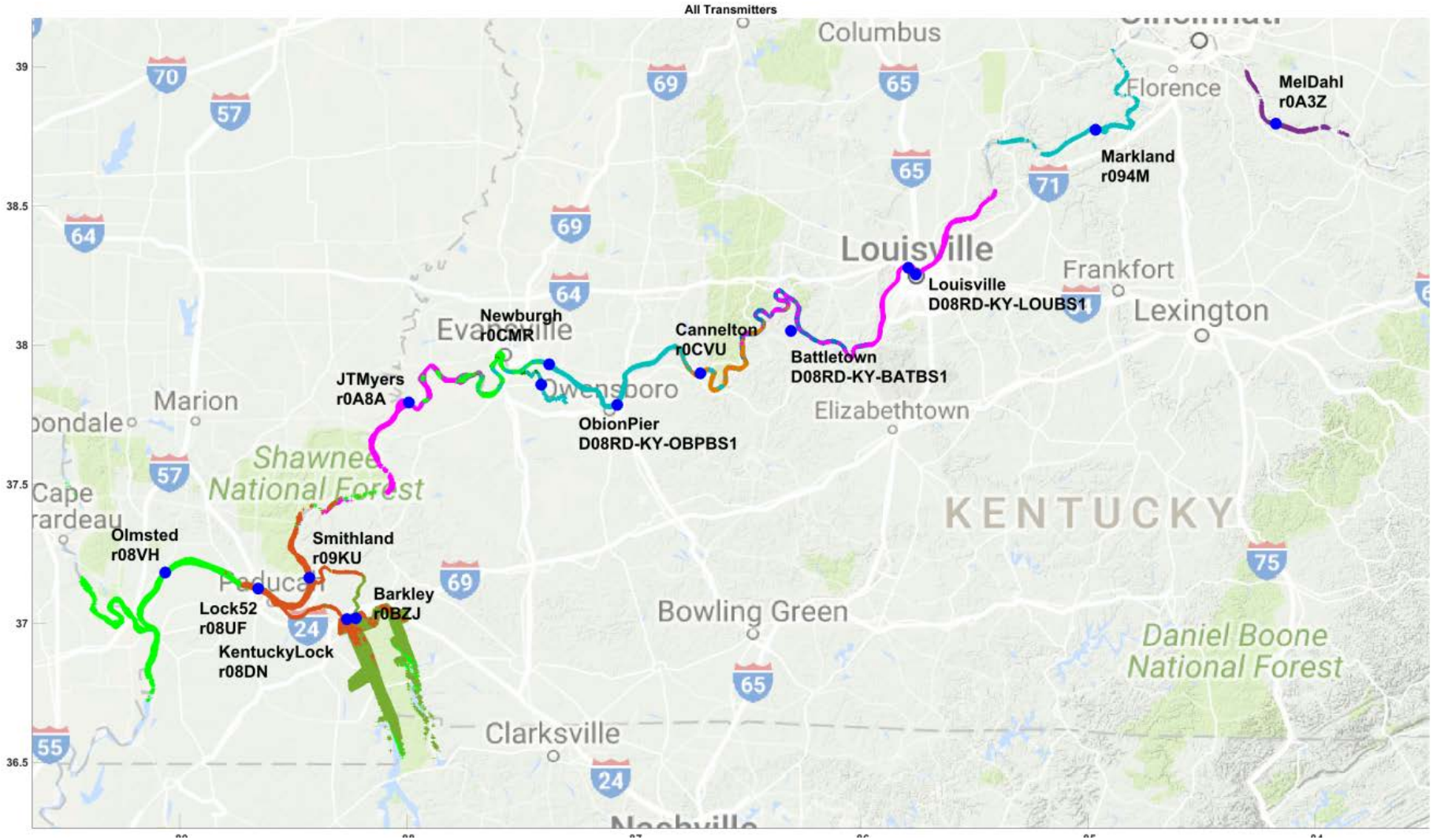

Figure 3. eAtoN test demonstration area.

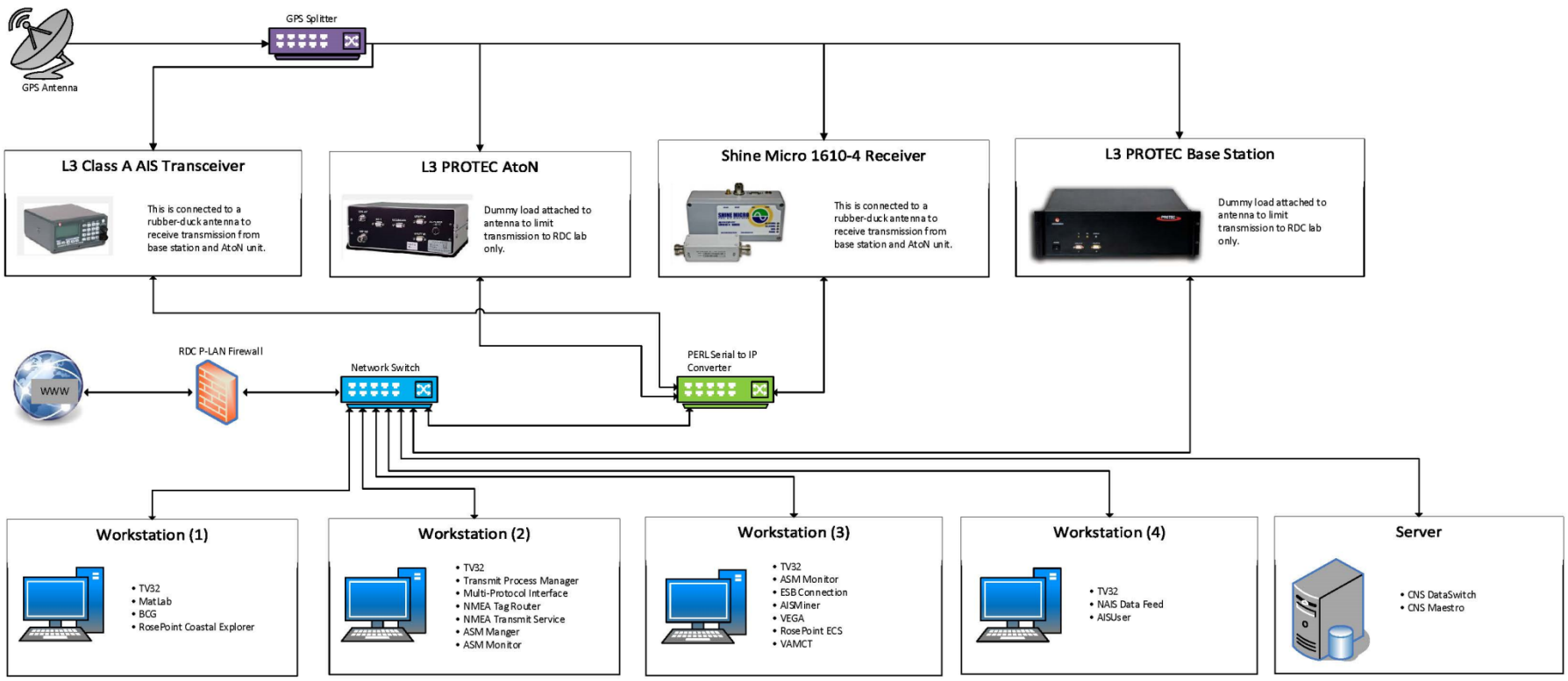

Figure 4. RDC test lab architecture.

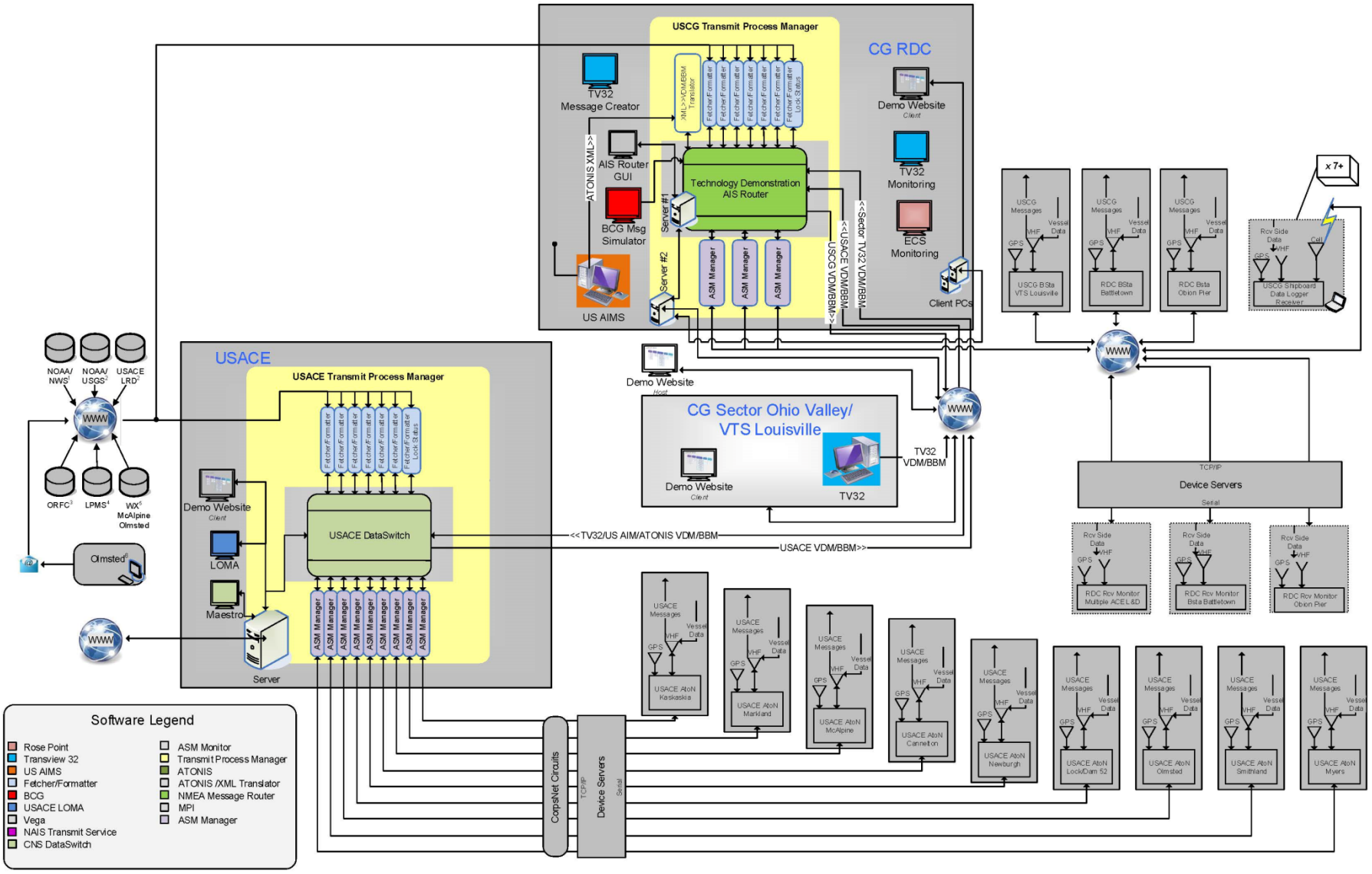

Figure 5. JCTD demonstration architecture.

3.1 Transmit Permission

During the project demonstration, initial transmission permission was limited to RDC personnel and the CG-NAV detached position at Sector Ohio Valley due to routing configuration. Once a direct DataSwitch-to-DataSwitch connection was established, USACE personnel also had transmit permission across the entire test bed. Individual authentication functionality was not built into the demonstration due to the limited number of users. Network security protocols were implemented and served as transmit permission during the demonstration.

3.2 Message Creation

Provided in this section are descriptions of the message creators, data sources, and automated and manual software applications used to support the Message Creation component of the AIS Transmit System during the project demonstration.

3.2.1 Creators

During the project demonstration the following organizations were responsible for sending the associated message types:

- USCG Sector Ohio Valley/VTS Louisville:
  - AtoN and manually generated ASMs (i.e., Geographic Notices) were created and transmitted.
- RDC:
  - RDC collected, formatted, and transmitted weather, water level, currents, lock queue, and lock status ASMs automatically using the Fetcher/Formatter application.
- USACE:
  - USACE collected, formatted, and transmitted weather, water level, currents, lock queue, and lock status ASMs automatically using the Fetcher/Formatter application.
  - AtoN and manually generated ASMs (i.e., Geographic Notices) were created and transmitted.

3.2.2 Data Sources

During the project demonstration, data from the following sources were used to create ASMs.

3.2.2.1 NOAA/National Weather Service (NWS)

NOAA/NWS provides weather information. The information is in Meteorological Aviation Report (METAR) format. It is collected from the following website - where “KFTK” is a specific station identification: ftp://tgftp.nws.noaa.gov/data/observations/metar/stations/KFTK.TXT

3.2.2.2 NOAA/NWS/United States Geological Survey (USGS)

NOAA/NWS/USGS provides water level information. The information is collected from the following website - where “vckm6” is the specific water level site identification: http://water.weather.gov/ahps2/hydrograph_to_xml.php?gage=vckm6&output=tabular

USGS also provides water current information. The information is collected from the following website - where "03381700" is the specific water level site identification: http://waterservices.usgs.gov/nwis/iv/?format=rdb&sites=03381700&period=PT2H&parametrCd=00055,00065

3.2.2.3 USACE Great Lakes and Ohio River Division (LRD) Gauge Sites

The USACE LRD provides water level information from gauge sites located at each lock and dam. The information is collected from the following website: http://www.lrd-wc.usace.army.mil/text/navrpti.txt

3.2.2.4 Ohio River Forecast Center (ORFC)

The ORFC provides predicted river current information. The information is collected from the following website: http://www.erh.noaa.gov/ohrfc/flows.shtml

3.2.2.5 USACE Lock Performance Monitoring System (LPMS)

The USACE LPMS provides lock queue management information. The information is collected from the following website - where "river=OH" and "lock =42" identify the appropriate river/lock: http://corpslocks.usace.army.mil/lpwb/xml.lockqueue?in_river=OH&in_lock=42

3.2.2.6 Davis Weather Stations

Davis weather stations are installed at McAlpine Lock, the Olmsted Lock and Dam project, and other government/private sites. The information is collected from the following website - where "rmrweather" specifies the station name: http://www.weatherlink.com/user/rmrweather/index.php?view=summary&headers=0&type=1

3.2.2.7 Sector Ohio Valley/VTS Louisville

During the project demonstration, the USCG Sector/VTS was the message creator and a data source for transmission of AIS messages related to local Broadcast Notice to Mariners (BNM), security zones and work areas.

3.2.2.8 USACE Louisville District

The USACE Louisville District publishes a Notice to Navigational Interests with river information as needed. A list of notices is available at the following: http://www.lrl.usace.army.mil/Missions/CivilWorks/Navigation/Notices.aspx

The USCG Sector/VTS was the message creator for this data and used TV32 (non-AtoN-related) and US AIMS (AtoN-related) to create AIS messages from these notices. Only information that can be transmitted in AIS as AtoN message 21, AtoN discrepancies, and Area Notice messages were encoded.

3.2.2.9 Olmsted Lock and Dam Project

The Olmsted Lock and Dam Project publishes information in the form of an email about work areas, channel changes, and buoy locations as they relate to the construction project. The email includes the detailed latitude/longitude position data needed in order to generate AIS messages.

Various virtual AtoN were transmitted for the construction project by USACE.

3.2.3 Automated Software (Fetcher/Formatter)

Many ASMs can be constructed using data available from online data providers. A limitation of accessing data this way, however, is that a standardized data schema among service providers does not exist. RDC developed a software application used to retrieve ("fetch") authoritative data, and then format the data into an ASM embedded in a NMEA BBM. To work around the standardized data schema gap, several variations of the Fetcher/Formatter application were developed. Each was modified to parse the unique data format of a specific provider website. The application retrieved data using one of the Internet connections listed in 3.2.2. The list of Fetcher/Formatter applications developed and used, including version number, is provided in Table 2. Each variant is described in the sub-section below.

Table 2. Fetcher/formatter software and versions.

Description	Name	Version
Waterways Management ASM	AISWMGen.exe	4.02
Environmental ASM	AISEnvGen.exe	3.07
Environmental Weather ASM	AsmWxRpt.exe	1.06
Environmental Water Depth ASM	AsmH2OLvlRpt.exe	3.04
Environmental Predicted Current ASM	FlowEncoder.exe	6.05
Environmental Current ASM	ASMCurRpt.exe	1.04

To keep the application simple, a new instance of the application was used for each sensor site (as opposed to one complex application accessing data for multiple sites). Each running instance routes messages to multiple base stations or AtoN AIS transmitters using destination parameter TAG Blocks. The application retrieves and formats data into an ASM then embeds it in a NMEA VDM or BBM Sentence. It applies destination parameters for each intended transmitter(s), and forwards formatted messages to an AIS router. Each application service is configured before runtime using an initialization (INI) file. File parameters include: data provider website address; IP address and port number for sending messages; and destination parameters for the message TAG Block.

The data being retrieved ("fetched") were all relevant to a specific geographic locale. For example, the McAlpine Lock queue data corresponded to vessels awaiting lockage through McAlpine lock. In order to disseminate the information over a broader area, each piece of information was transmitted from multiple transmitters. For example, the McAlpine information was transmitted from the Louisville base station, Cannelton Lock transmitter, and the Markland Lock transmitter. The complete mapping of data sources to transmitters is shown in Table 3.

3.2.3.1 Waterways Management

The Waterways Management named variant of Fetcher/Formatter reads waterways management data from a website and generates Waterways Management messages for transmission. The information gathered is first encoded then encapsulated in the Binary Data (payload) field of AIS BBM Sentence (AIS Message Type 8) - with a Function Identifier (FI) number of 35.

The program reads the lock queue information from the USACE website http://corpslocks.usace.army.mil/. The program uses a lookup file, which contains a list of MMSI numbers and corresponding vessel names, to attempt to match a vessel name to a known MMSI number. This is necessary because the website only provides vessel names and the Waterways Management message requires a vessel's MMSI number. Partway through the demonstration, USACE updated their website to also provide MMSIs for the AIS-equipped vessels; at that time the Fetcher/Formatter application was updated to make use of that information.

The program is designed to generate all Waterways Management messages associated with a river lock. The messages include:

- The subtype 1 message to describe the lock location and description;
- The subtype 0 message that lists the vessels waiting at the lock; and,
- The subtype 2 messages to report the names of vessels where the MMSI is unknown.

A user can edit a configuration text file, read by the application at startup, to set various parameter values. Waterways Management messages are used to facilitate vessel traffic movement in confined waters. Following is a list of Waterways Management messages:

- Vessels awaiting lockage.
- Procession order.
- Enter/exit port.
- Bridge.
- Narrows.
- Gate.

3.2.3.2 Environmental

The Environmental named variant of Fetcher/Formatter reads environmental data from several websites and generates Environmental messages for transmission. The information gathered is first encoded then encapsulated in the Binary Data (payload) field of AIS BBM Sentence (AIS Message Type 8) - with a FI number of 33.

Water level type data is gathered from a USACE website. Weather information data is gathered from either NOAA METAR station or a Davis weather station.

This program is designed to generate water level reports (Type 3) for sensor locations above and below a river lock, and wind (Type 2) and weather (Type 9) reports for a weather station.

The program generates a total of 10 separate reports:

- Three sensor site location (Type 0) reports – one for each site (i.e., above lock, below lock, and weather station);
- Three station ID (Type 1) reports for each site;
- Two water level (Type 3) reports for the lock (above and below);
- One wind (Type 2) report for the weather station; and,
- One weather (Type 9) report for the weather station.

A user can edit a configuration text file, read by the application at startup, to set various parameter values. Environmental messages are used to report met/hydro information. Following is a list of Environmental messages:

- Water levels (pool gauges).
- Water current.
- Wind speed/direction.
- Temperature.

- Weather.
- Air gap.

3.2.3.3 Environmental Weather

The Environmental Weather named variant of Fetcher/Formatter reads weather data from a website and generates Environmental Weather and Wind messages for transmission. The information gathered is first encoded then encapsulated in the Binary Data (payload) field of AIS BBM Sentence (AIS Message Type 8) - with a FI number of 33.

The program is designed to generate a weather and wind report for each sensor site listed on a METAR website, such as: ftp://tgftp.nws.noaa.gov/data/observations/metar/stations/KM30.TXT where 'KM30' specifies the METAR site for which data should be collected.

Another example is the Davis weather site: http://www.weatherlink.com/user/olmsteddam/index.php?view=summary&headers=0&type=1 where 'olmsteddam' specifies the weather site from which data should be gathered.

The program generates a total of four (4) reports:

- One sensor site location (Type 0) report;
- One station ID (Type 1) report;
- One wind (Type 2) report; and,
- One weather (Type 9) report.

A user can edit a configuration text file, read by the application at startup, to set various parameter values.

3.2.3.4 Environmental Water Level

The Environmental Water Level named variant of Fetcher/Formatter reads water level data from a website and generates Environmental Water Level messages for transmission. The information gathered is first encoded then encapsulated in the Binary Data (payload) field of AIS BBM Sentence (AIS Message Type 8) - with a FI number of 33.

The program is designed to generate three (3) water level reports from a maximum of four (4) sensor sites. The water level information is gathered from a NOAA website, such as: http://water.weather.gov/ahps2/hydrograph_to_xml.php?gage=mluk2&output=tabular where 'mluk2' specifies the source sensor site.

The program generates a total of three (3) reports for each sensor site:

- One sensor site location (Type 0) report;
- One station ID (Type 1) report; and,
- One water level (Type 3) report.

A user can edit a configuration text file, read by the application at startup, to set various parameter values.

3.2.3.5 Environmental Predicted Current

The Environmental Predicted named variant of Fetcher/Formatter reads environmental data from a website and generates Environmental predicted (forecast) messages for transmission. The information gathered is first encoded then encapsulated in the Binary Data (payload) field of AIS BBM (Type 8) - with a FI number of 33.

A user can specify either the vertical current (2D) report (Type 4) or the horizontal current report (Type 6). The information is gathered from the NOAA website: http://www.erh.noaa.gov/ohrfc/flows.shtml which contains the Ohio River Forecast Center river current predictions.

The program generates a total of 12 reports:

- Four sensor site location (Type 0) reports for each sensor site;
- Four station ID (Type 1) reports for each site; and,
- Four current (Type 4 or 6) reports for the sites.

A user can edit a configuration text file, read by the application at startup, to set various parameter values.

3.2.3.6 Environmental Current

The Environmental Current named variant of Fetcher/Formatter reads environmental data from a website and generates Environmental Current messages for transmission. The information gathered is first encoded then encapsulated in the Binary Data (payload) field of AIS BBM Sentence (AIS Message Type 8) with a FI number of 33.

A user can specify either the vertical current (2D) report (Type 4) or the horizontal current report (Type 6). The information is gathered from the website http://waterdata.usgs.gov/nwis using the web services at http://waterservices.usgs.gov/.

The program generates a total of three (3) reports for each sensor site:

- One sensor site location (Type 0) report;
- One station ID (Type 1) report; and,
- One current (Type 4 or 6) report.

A user can edit a configuration text file, read by the application at startup, to set various parameter values.

Table 3. Mapping of data to transmitters.

Data Source \ Transmitter	Meldahl , Felicity OH	Markland, Warsaw, KY	Louisville, KY	Canneltonn, IN	Obion Pier, Owesboro KY	Newburgh, IN	Green River 1, Spottsville KY	J T Myers, Mt Vernon, IN	Smithland, IL	Kentucky Lock, KY	Barkley lock, KY	Lock 52, Brookport, IL	Olmsted, IL	Battletown, KY
Meldahl Lock Queue Information (1)	X	X												
Markland Lock Queue Information (1)	X	X	X											
McAlpine Lock Queue Information (1)		X	X	X										X
Cannelton Lock Queue Information (1)			X	X		X								X
Newburgh Lock Queue Information (1)				X	X	X		X						
Green River 1 Queue Information (1)						X	X							
J T Myers Lock Queue Information (1)						X		X	X					
Smithland Lock Queue Information (1)								X	X	X		X		
Kentucky Lock Queue Information (1)									X	X	X	X		
Barkley Lock Queue Information (1)									X	X	X	X		
Lock 52 Lock Queue Information (1)									X	X		X	X	
Olmsted Lock Queue Information (1)												X	X	
Markland Dam Current (2)		X	X	X										X
Louisville, KY Current (3)		X	X	X										X
McAlpine Upper Pool Current (2)		X	X	X										X
McAlpine Lower Pool Current (2)		X	X	X										X
Cannelton Dam Current (2)		X	X	X										X
Evansville, IN Current (2)				X		X		X						
J T Myers Dam Current (2)						X		X	X					
Shawneetown, IL Current (2)						X		X	X					
Golconda, IL Current (2)						X		X	X					
Spottsville KY Current (3)						X	X							
Smithland Dam Current (2)						X		X	X					
Olmsted, IL Current (3)												X	X	
Meldahl Upper Pool Depth (4)	X	X												
Meldahl Lower Pool Depth (4)	X	X												
Markland Upper Pool Depth (4)	X	X	X											
Markland Lower Pool Depth (4)	X	X	X											
McAlpine Upper Pool Depth (4)		X	X	X										X
McAlpine Lower Pool Depth (4)		X	X	X										X
Cannelton Upper Pool Depth (4)			X	X	X	X								X
Cannelton Lower Pool Depth (4)			X	X	X	X								X
Newburgh Upper Pool Depth (4)				X	X	X		X						
Newburgh Lower Pool Depth (4)				X	X	X		X						
J T Myers Upper Pool Depth (4)						X		X	X					
J T Myers Lower Pool Depth (4)						X		X	X					
Smithland Upper Pool Depth (4)								X	X	X		X		
Smithland Lower Pool Depth (4)								X	X	X		X		
Kentucky Upper Pool Depth (4)									X	X	X	X		
Kentucky Lower Pool Depth (4)									X	X	X	X		
Barkley Upper Pool Depth (4)									X	X	X	X		
Barkley Lower Pool Depth (4)									X	X	X	X		

Table 3. Mapping of data to transmitters.

Data Source \ Transmitter	Meldahl , Felicity OH	Markland, Warsaw, KY	Louisville, KY	Canneltonn, IN	Obion Pier, Owesboro KY	Newburgh, IN	Green River 1, Spottsville KY	J T Myers, Mt Vernon, IN	Smithland, IL	Kentucky Lock, KY	Barkley lock, KY	Lock 52, Brookport, IL	Olmsted, IL	Battletown, KY
Lock 52 Upper Pool Depth (4)									X	X		X	X	
Lock 52 Lower Pool Depth (4)									X	X		X	X	
Olmsted Upper Pool Depth (4)												X	X	
Olmsted Lower Pool Depth (4)												X	X	
Cairo, IL Water Depth (4)													X	
Cape Girardeau, MO Water Depth (4)													X	
Thebes, IL Water Depth (4)													X	
New Madrid, MO Water Depth (4)													X	
Covington, KY Weather (5)	X													
Warsaw, KY Weather (5)		X	X											
Louisville, KY Weather (5)		X	X	X										X
Fort Knox, TN (KFTK) Weather (6)			X	X	X	X								X
Newburgh, IN Weather (5)				X	X	X		X						
Henderson KY Airport Weather (6)						X	X							
Slim Island KY Weather (5)						X		X						
Marion, KY (K5M9) Weather (6)								X	X	X				
Reidland, KY Weather (5)									X	X		X		
Springville, TN Weather (5)									X	X	X	X		
Metropolis, IL Weather (5)									X	X		X	X	
Olmsted, IL Weather (5)												X	X	
Cape Girrardeau, MO (5)													X	
Pinhook, Mo (5)													X	

Table 4. Data rate update table.

Source	Information	Update Rate
USACE Lock Management Data Base	Vessels awaiting lockage, Lock status	As updated by lock master
NOAA	Weather	Hourly
Weather Stations	Weather	Every minute
NOAA/NWS/USACE	Water Depth	Hourly
ORFC	Predicted Current	Daily
Olmsted Notice to Navigation Interest	Restricted areas, traffic patterns	As needed
USGS	Water levels, currents	Daily?

3.2.4 Manual Software

During the project demonstration the following software applications were used to manually create AIS Messages 6 and 8 ASMs listed in Appendix B "Transmit Message Master List." A description of each application, along with considerations for its use, is provided.

3.2.4.1 Transview 32 (TV32)

TV32 is a Volpe National Transportation Systems Center (VNTSC) developed software application that has been in use by USCG for over 20 years. TV32 provides an Electronic Navigation Chart (ENC) display and is used primarily for viewing and tracking AIS equipped vessels. Since 2010, the application has been upgraded several times - to support manual creation (field values and NMEA compliant formatting) and display of ASMs.

During the Ohio River demonstration, TV32 was used to create Geographic Notice type ASMs. The window used to create a Geographic Notice message is accessible using the TV32 menu bar (see Figure 6). A Geographic Notice message can be generated as an NMEA BBM Sentence - with TAG Block destination values sent into the transmit system. RDC set up Sector Ohio Valley with this capability during the demonstration. All messages that were created were sent into the TAG Router application for proper routing using the message's destination parameter values. Initially, the TAG Router software was used to get the messages to the correct DataSwitch. Once a direct DataSwitch-to-DataSwitch connection was implemented the messages were all sent to a top connection on the local DataSwitch.

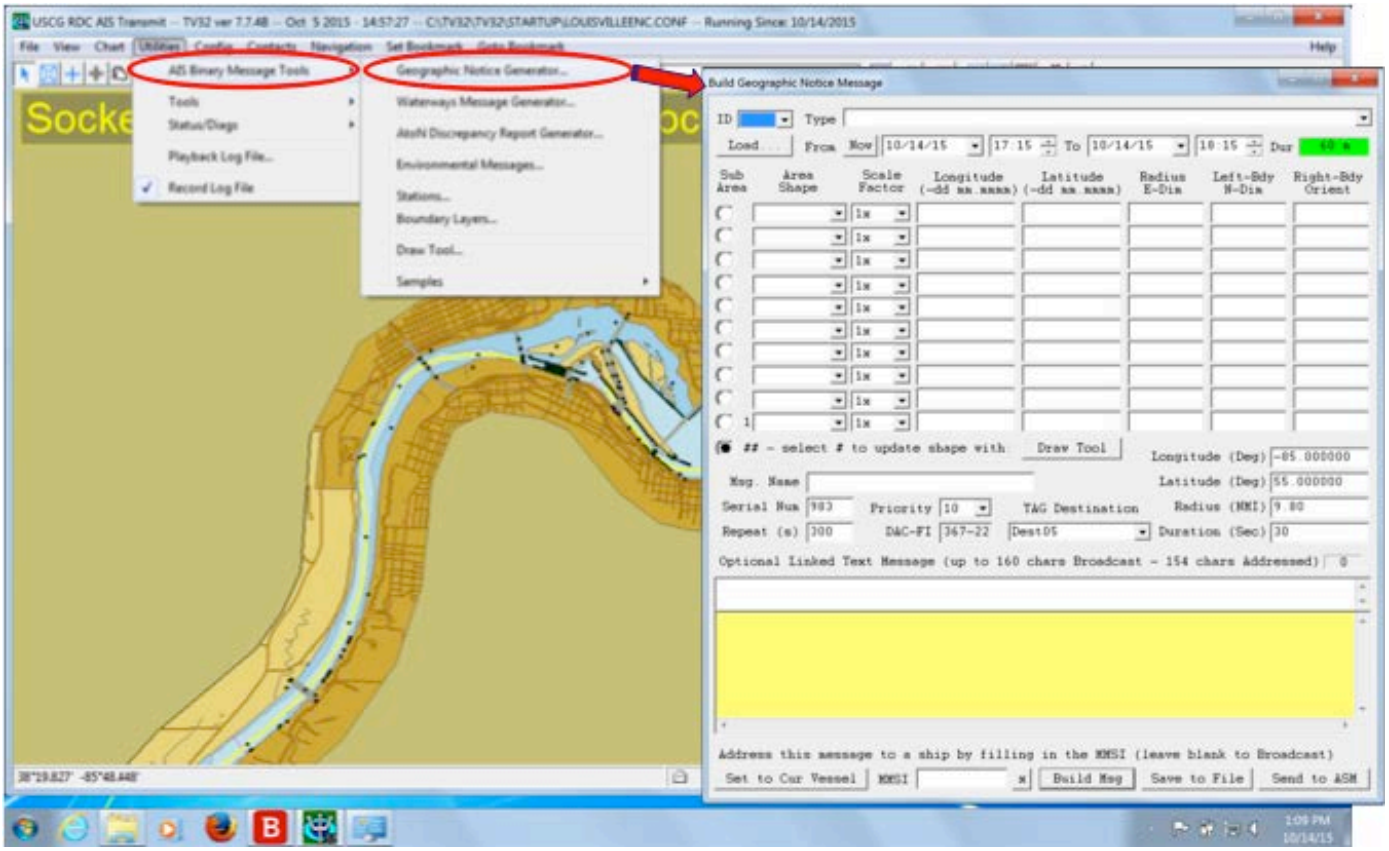

Figure 6. TV32 Build Geographic Notice message window.

Geographic Notice messages are used to transmit time-critical information linked to an area. Following is a list of Geographic Notice messages types:

- Safety zone.
- Security zone.
- Caution area.
- Hazards to navigation.
- Routes.
- Distress.
- Areas can be:
  - Circles, Rectangles, Sectors.
  - Polygons, Polylines.

3.2.4.2 USAIMS/Virtual ATON Creation Tool

Development is in progress at OSC to implement the AIS capability within USAIMS. The interface will allow the user to output all of the data needed to create the AIS message 21's and the new AtoN Discrepancy ASM, along with the desired transmit locations, in XML format. The system is being designed to send this information through the ESB to an OSC developed message translation software service that will convert the XML data into VDM/ BBM sentences with TAG Blocks applied. These NMEA sentences will be sent to the NAIS DataSwitch for transmission.

The USAIMS/ATONIS interface was not operational in time to meet the demonstration schedule requirements. The RDC created a software application to create and transmit AtoN-related AIS messages. The Virtual AtoN Creation Tool (Figure 7) was used to configure AIS AtoN transmitters to autonomously transmit AIS AtoN messages (message type 21) for virtual aids. It was designed for and tested with L-3 AIS AtoNs transmitters only.

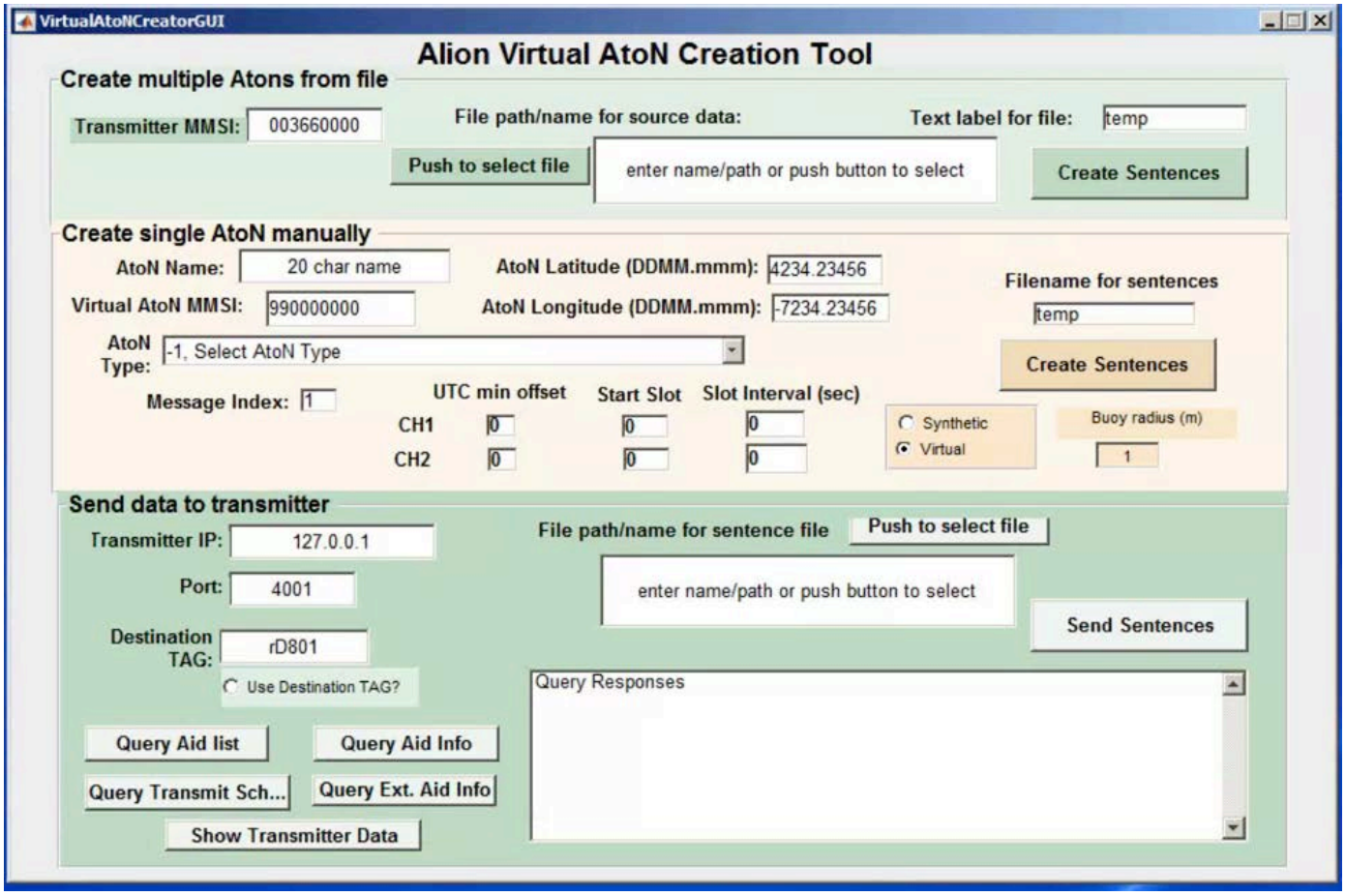

Figure 7. Virtual AtoN Creation Tool software.

To program a transmitter to generate virtual AtoN reports, four NMEA Sentences are needed: one to set the MMSI of the virtual AtoN; two to configure the virtual AtoN parameters; and one to set the transmission schedule. (See NMEA 0183 Manual V4.1 for additional information)

There are two ways to create AtoN reports using the software. One is to use information from a file and the other is to enter it manually. If only one AtoN report needs to be created, then the manual method is easiest. If multiple AtoN reports need to be created then the file mode should be used.

Working with the application requires construction of two files. The first contains NMEA Sentences used to create AtoN reports the second file is used to remove AtoN reports. Once built, both files are then sent to the desired transmitter. Note that both files can be used multiple times as needed.

3.2.4.3 MatLab

MatLab™ is commercial software developed by MathWorks, Inc. From MathWorks Website: “MatLab is a high-level language and interactive environment used to explore and visualize ideas and collaborate across disciplines including signal and image processing, communications, control systems, and computational finance.” Specific to this project it was used for manual creation of ASMs.

3.2.4.4 Geographic Notice Tool

The Geographic Notice Creation (GNC) tool is used to configure AIS transmitters to transmit AIS Geographic Notice messages. These are ASMs that are used to communicate information related to a specific area for a defined time interval, such as channel obstructions, closures, safety zones, etc. These ASMs are intended to be displayed as an overlay on an ECS. The GNC tool (Figure 8) generates a message based on a data file of polygon points (nodes) and other parameters set by the user. The parameters determine the type of message, where it is sent, when the message starts, and when it should end.

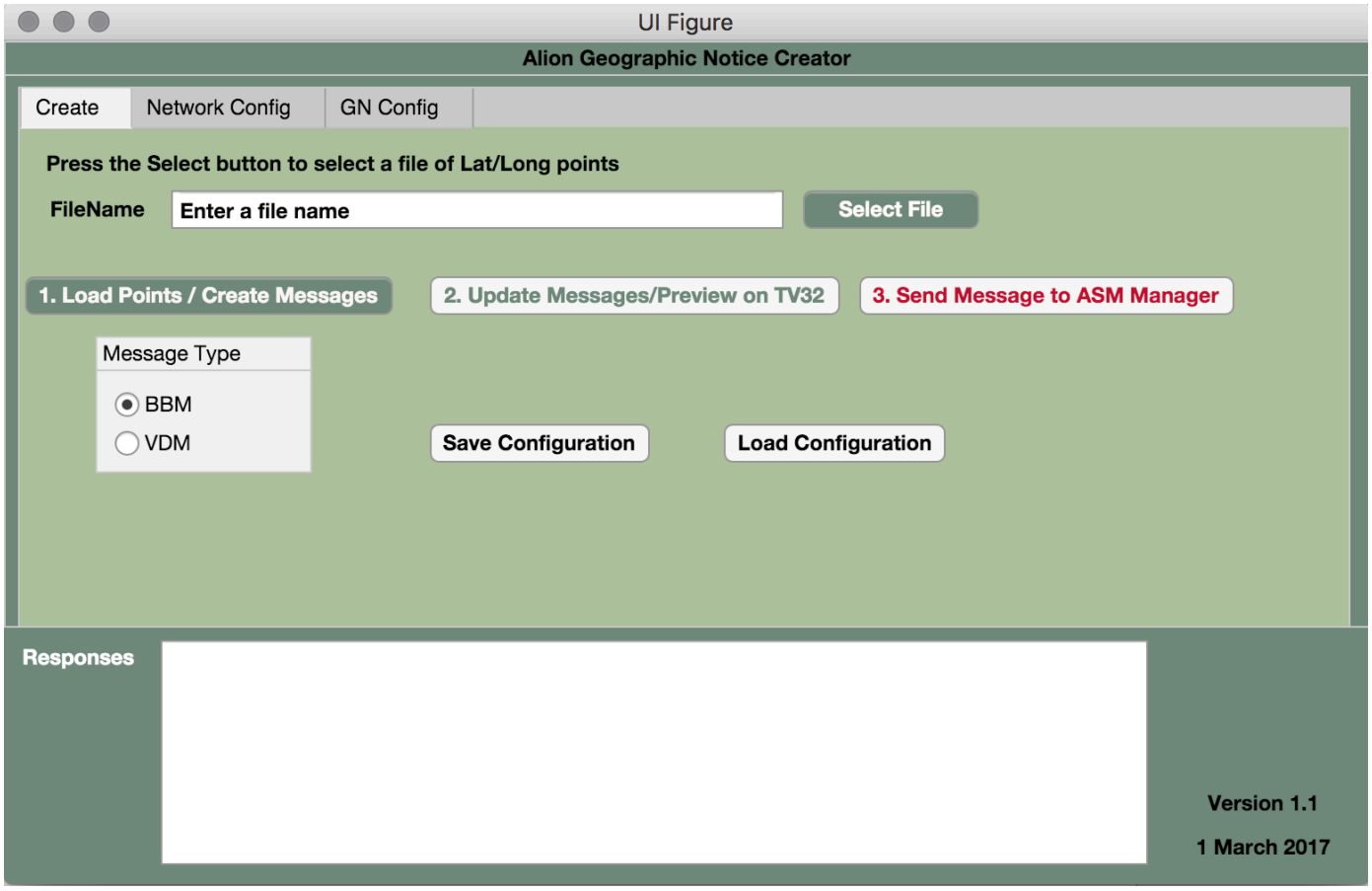

Figure 8. Alion GNC Tool Main Screen, "Create" Tab.

The "Create" tab displays when the application is launched. The general sequence to creating messages is to follow the steps in order, 1, 2, and then 3. The application will create the Geographic Notice ASM using the points for the polygon listed in a file and information specified on the "GN Config" tab. This tab should be completed prior to executing steps 1 through 3. The settings that control where messages are sent is on the "Network Config" tab. This should also be completed prior to executing steps 1 through 3.

3.3 Message Routing

Provided in this section are a list and description of the software applications and hardware used to support the Message Routing component of an AIS Transmit System during the project demonstration.

3.3.1 Software

During the project demonstration the following software applications were used in the routing of ASMs. A description of each application, along with considerations for its use, is provided.

3.3.1.1 DataSwitch

DataSwitch is a commercial software application developed by CNS Systems. Specific to this project it is used as an AIS router for distribution of ASMs to the correct transmitters.

DataSwitch is a data routing and management application that provides a reliable flow of data to your environment. DataSwitch supports the functionality defined in IALA Recommendation A-124, LSS Layer, Part IV. It is ideal for the collection, filtering, logging, and sharing of AIS data over networks. For shore based networks, DataSwitch enables the flow of information from one or more AIS base stations and/or receivers to a VTS center. Similarly, a VTS center can send vital information to a regional headquarters, and then on to a national entity via another DataSwitch. For a vessel-based network, DataSwitch can send information from attached NMEA devices (sensors) to a number of stations on the vessel. The distribution of both standard and proprietary data messages from one central location to shared locations makes DataSwitch essential in many diverse environments.

An AIS router is used to route AIS messages between clients and transmitters/receivers. This is architecturally part of the LSS functionality. The USCG and USACE both used the CNS DataSwitch software to perform this function. During the Ohio River demonstration, two DataSwitch systems were used to manage the USCG base stations. One existing system is part of the USACE AIS network; and a second new DataSwitch application was installed at RDC. The USACE DataSwitch system is comprised of four DataSwitch applications connected in a hierarchal manner. The AIS AtoN transceivers were distributed between three DataSwitch applications, each feeding one top-level DataSwitch application. A client connection was made at the top-level DataSwitch. The RDC used a single DataSwitch application to manage three base stations.

The DataSwitch application starts by initiating connections to ASM Manager applications – one connection for each transmitter. These are named “bottom connections.” The bottom connections for the USACE DataSwitch used during the demonstration are shown in Figure 9.

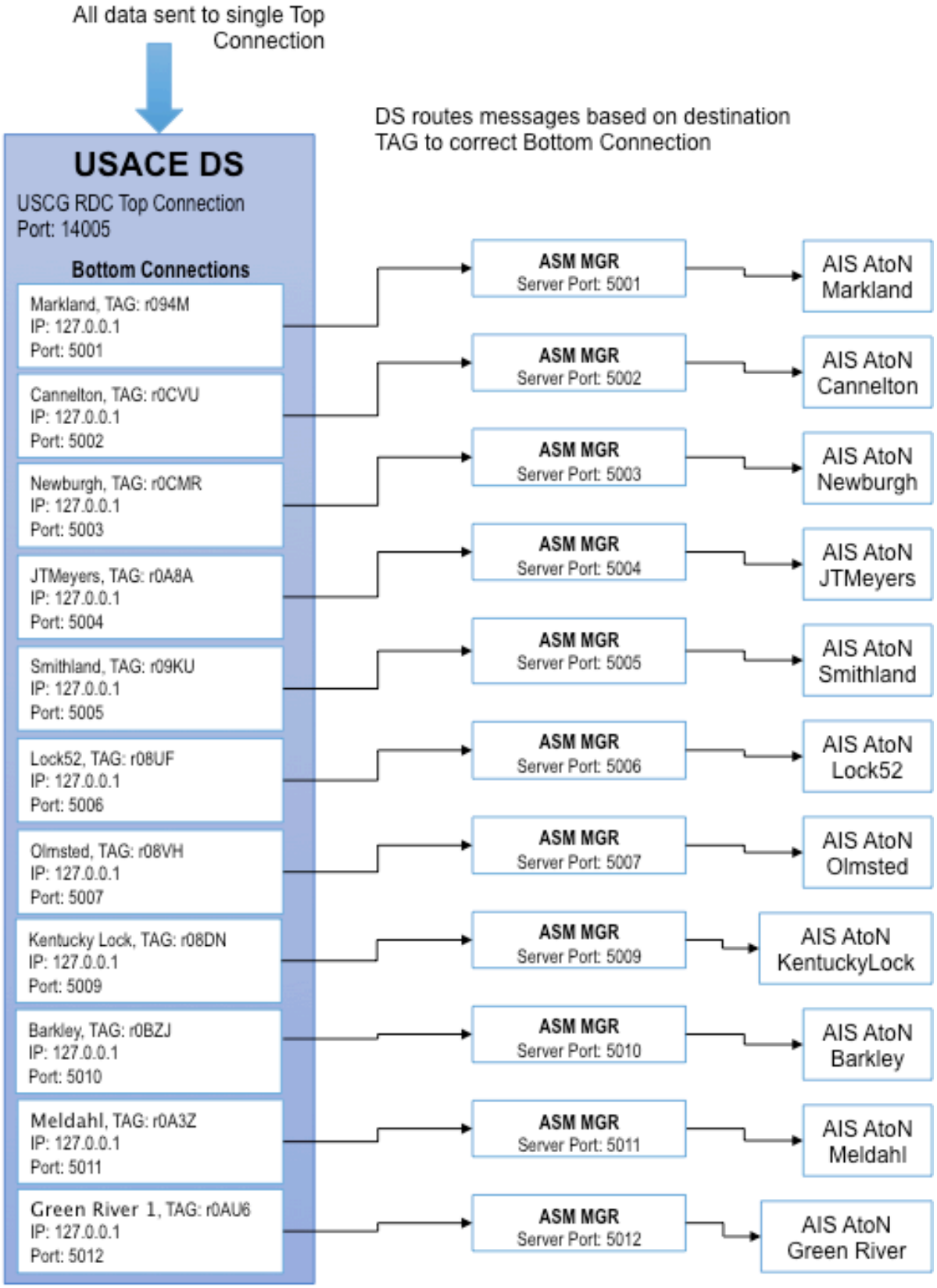

Figure 9. USACE DataSwitch configuration for the Ohio River demonstration.

The DataSwitch application acts as a server for client connections, these are named "top connections." For both the USACE top-level DataSwitch and RDC DataSwitch a single top connection was used during the demonstration. All data transmitted and received went through this single connection on each DataSwitch application. ASM messages were routed through DataSwitch application(s) based on destination parameter values in its TAG Block.

The DataSwitch application is configured using the CNS online web tool Maestro.

3.3.1.2 Process Manager

Process Manager is an RDC developed software application used to manage the Fetcher/Formatter and ASM Manager applications. The application makes better use of Central Processor Unit (CPU) resources by running the Fetcher/Formatter and ASM Manager applications as background services. This is useful for when the applications need to be run on a system that is not logged in all the time. Process Manager, itself runs as a service, acting as a wrapper application that starts and monitors multiple instances of the Fetcher/Formatter and ASM Manager application and shuts down each application service when needed.

Considerations for use in an operational AIS Transmit System:

- Process Manager was developed to support operation of the Fetcher/Formatter and ASM Manager applications on systems that do not allow an active GUI application when a user is not logged on.
- Process Manager resides locally with the Fetcher/Formatter and ASM Manager applications. A separate install of the application is required if the Fetcher/Formatter and ASM Manager applications are not installed on the same machine.

3.3.1.3 Multi-Protocol Interface (MPI)

MPI is an RDC developed software application that allows monitoring and controlling devices and programs across multiple interfaces and networks. MPI supports the following interfaces: Serial, Transmission Control Protocol / Internet Protocol (TCP/IP) Server, TCP/Client, Standard Input/Output (I/O) and File. MPI supports the following I/O modes: blocking and non-blocking read/writes, duplex and non-duplex interfaces, time-tagging and time-tagged playback. MPI provides the ability to reconnect broken connections and to buffer data while a connection is broken or if one of the interfaces is slower than the other. MPI multiplexes data between all of its interfaces, so whenever data is received on any of the interfaces, it gets broadcast on all other connected interfaces. Specific to the project demonstration, MPI was inserted in-between several of the connections in order to log data.

3.3.1.4 TAG Router

TAG Router is an RDC developed software application. The TAG router manages a TCP/IP connection for receiving NMEA Sentences, as well as managing user specified outgoing TCP/IP connections. Incoming sentences are parsed for TAG Block destination parameter codes and routed appropriately based upon a user specified routing table. The TAG router can either discard sentences without a destination parameter code, or route it to a user specified default destination. The TAG router will discard sentences if any of the Sentence or TAG Block checksums fail.

The TAG Router application was used in the JCTD to accept AIS messages from various Fetcher/Formatter programs, and other sources, and route the messages to specific DataSwitch applications, based on each message's NMEA 0183 TAG Block destination parameter code (see Table 5). TAG Router was used in this capacity to limit messages sent to DataSwitch applications. Instead of sending all messages to all connected DataSwitch applications it instead forwarded each message to its intended DataSwitch application. The DataSwitch application then routed the message to the proper transmitter. The system architecture with the Tag Router is shown in Figure 10.

Table 5. Ohio River TAG routing table.

Output Connection	Destination Parameter	Transmitter Name
0	r0A3Z	Meldahl
0	r0A8A	J T Myers
0	r094M	Markland
0	r09KU	Smithland
0	r0AU6	Green R. Lock & Dam 1
0	r0CVU	Cannelton
0	r08UF	L&D 52
0	r0CUX	McAlpine
0	r0CMR	Newburgh
0	r08VH	Olmsted
0	r08DN	Kentucky Lock
0	r0BZJ	Barkley
1	D08RD-KY-BATBS1	Battletown
1	D08RD-KY-LOUBS1	Louisville
1	D08RD-KY-OBPBS1	Obion Pier

During the Ohio River demonstration two outgoing connections were made - one with the USCG RDC DataSwitch and one with the USACE DataSwitch. The routing table was used to assign destination parameter code values for three base stations to the USCG outgoing connection and destination parameter code values for USACE AtoN transmitters to the USACE outgoing connection. The TAG Router application reads destination code parameter values from a message's TAG Block and routes the message accordingly.

The TAG Router application uses two configuration files. One file is used to specify the input Internet Protocol (IP) address for AIS messages; the other is used to specify the output IP addresses for all DataSwitch applications. The configuration file also contains the routing table. The TAG Router also logs all incoming messages, including each messages routing destination.

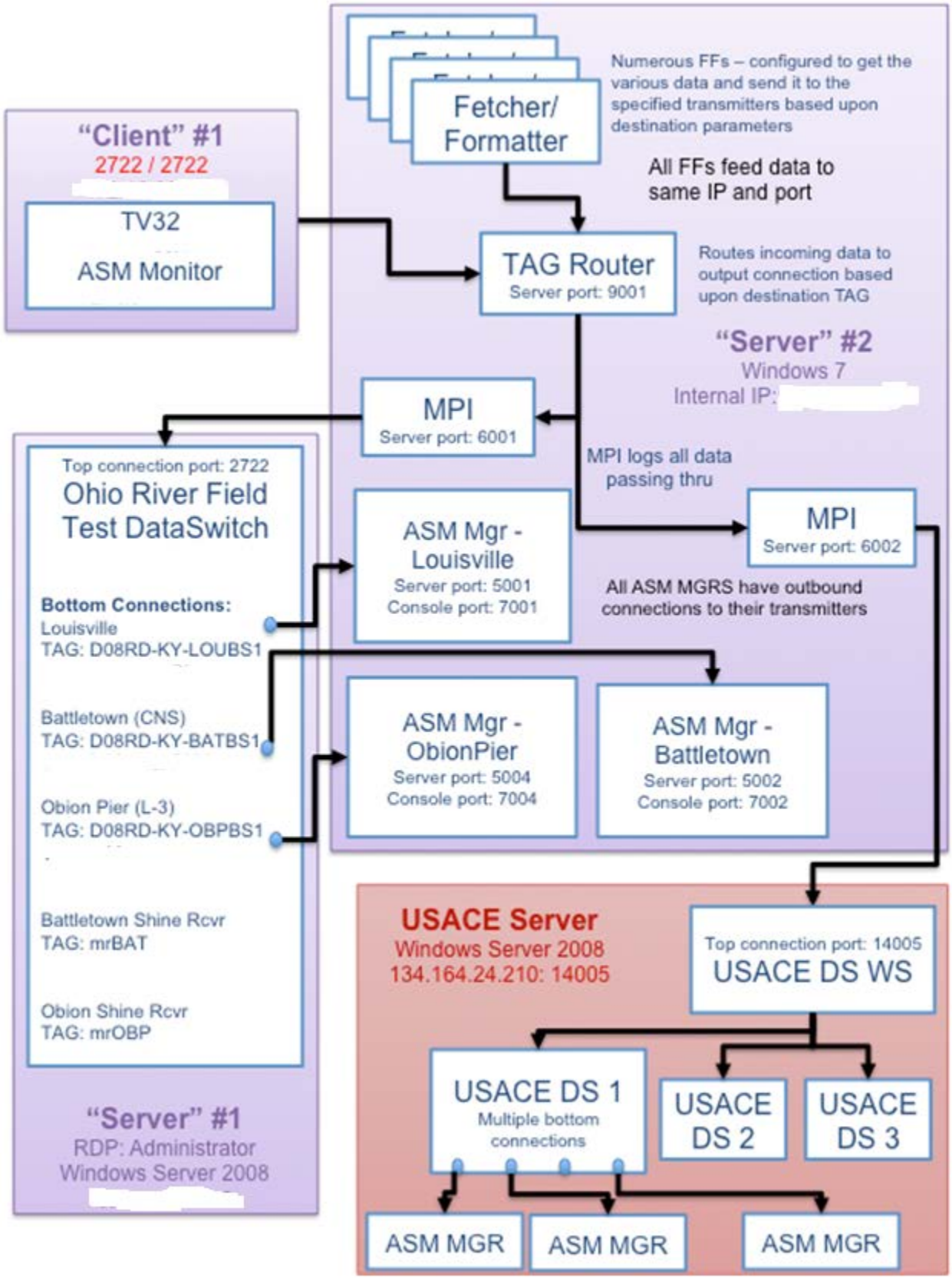

Figure 10. Initial transmit architecture for Ohio River demonstration.

3.3.2 NAIS Transmit Service

The NAIS Transmit Service is an enterprise level service connected to ESB housed at OSC which provides message handling for NAIS. The NAIS Transmit Service was not available during this demonstration.

3.3.3 DataSwitch-to-DataSwitch Interconnection

During the project demonstration, an architecture flow diagram to interconnect two DataSwitch systems was developed and tested. Each system included a hierarchy of DataSwitch routers - such as used by the NAIS and USACE for their receive networks. The goal of the test was to demonstrate an interconnected system that would allow for all cases of message flow:

- Receive messages from internal receivers and DataSwitch applications.
- Receive messages from external DataSwitch applications (and all nested DataSwitch applications and receivers).
- Transmit messages using internal transmitters (connected anywhere in the DataSwitch hierarchy).
- Transmit messages using external transmitters (connected anywhere in the DataSwitch hierarchy).

3.3.3.1 Connections

The test consisted of two DataSwitch systems (see Figure 11):

- **Local DataSwitch:** labeled "RDC DS", located at RDC on the P-LAN with three base stations in the Ohio River eMSI test bed connected.
- **External DataSwitch:** labeled "USACE DS", the master DataSwitch located at USACE ERDC in Vicksburg, VA - with four DataSwitch applications connected below it; and a total of 130 receivers connected to the hierarchically connected DataSwitch applications.

The interconnections are shown in Figure 12. The four connection points are numbered and described.

- **Top connection for USACE**: The local DataSwitch (RDC DS) has a top connection (server connection) set up for the external DataSwitch (USACE DS). The USACE DataSwitch initiates the connection to this server. A filter must be configured to exclude the USACE DataSwitch bottom connection and this filter must be applied to the top connection with a rule so that the USACE DataSwitch only receives RDC traffic through this connection. If this is not done, a loop will be set up where the data from the USACE DataSwitch is sent back to it.
- **Bottom connection for USACE**: The local DataSwitch (RDC DS) has a bottom connection (client) configured to connect to a top connection (server) on the external DataSwitch (USACE DS). On the connection, routing must be enabled, but no source TAG parameters added. The RDC DataSwitch will initiate the connection and receive all traffic. As traffic is received on this bottom connection, the RDC DataSwitch will build up its internal routing table using the TAG Block source parameter codes on the received traffic. Traffic with TAG Block destination parameter codes matching these source parameter codes will be routed to this bottom connection.
- **Top connection for RDC**: The external DataSwitch (USACE DS) has a top connection (server) set up for the local DataSwitch (RDC DS). The RDC DataSwitch initiates the connection to this server. A filter must be configured to exclude the RDC DataSwitch bottom connection and this filter applied to the top connection with a rule so that the RDC DataSwitch only receives USACE traffic through this connection. If this is not done, a loop will be set up where the data from the RDC DataSwitch is sent back to it.

- **Bottom connection for RDC**: The external DataSwitch (USACE DS) has a bottom connection (client) configured to connect to a top connection (server) on the local DataSwitch (RDC DS). On the connection, routing must be enabled, but no TAG Block source parameter codes are added. The USACE DataSwitch will initiate the connection and receive all traffic. As traffic is received on this bottom connection, the USACE DataSwitch will build up its internal routing table using the Tag Block source parameter codes on the received traffic. Traffic with destination parameter codes matching these source parameter codes will be routed to this bottom connection.

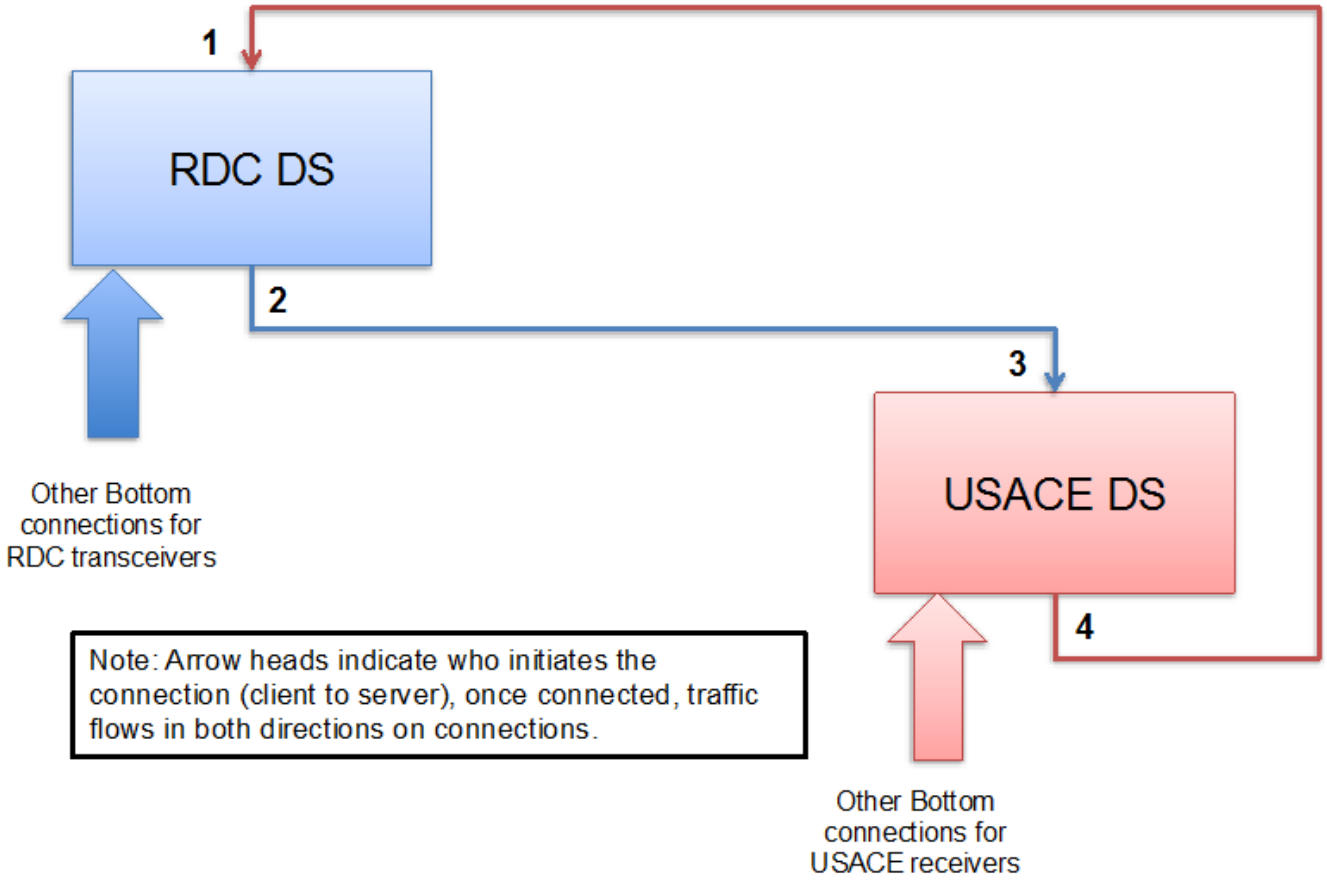

Figure 11. DataSwitch-to-DataSwitch interconnection diagram.

3.3.3.2 Testing

The configuration described above was put into place and successfully tested. Within the Ohio River eMSI test bed, AIS messages were received from locally connected receivers (the three base stations connected to the RDC DataSwitch) and from the USACE DataSwitch. The messages from the USACE DataSwitch originated from receivers connected to multiple DataSwitch applications in the USACE hierarchy. AIS Transmit messages were also successfully routed using TAG Block destination parameter codes to the correct transmitters on both the RDC DataSwitch and the USACE DataSwitch hierarchy. From the USACE perspective, messages were received from both the USACE hierarchy and the RDC DataSwitch. Transmit messages were successfully routed using destination parameter codes to the correct transmitters on the USACE DataSwitch hierarchy. The only item not tested, was to generate an AIS Transmit message on the USACE side and have it routed to a transmitter on the RDC DataSwitch. This was successfully tested by the USACE in April, 2017.

3.3.3.3 Recommendations

The interconnection of DataSwitch applications to enable the exchange of both transmit and receive messages has been successfully prototyped. This configuration should be implemented to interconnect the NAIS and USACE systems in place of the current method that requires the use of AIS Source and AIS MultiServer and numerous top connections on the USACE DataSwitch. This configuration can also serve as a model for interconnection of NAIS with other AIS systems, such as Marine Exchange of Alaska.

3.3.4 Maestro

Maestro provides top layer control for the AIS network, supporting the functionality defined in IALA Recommendation A-124, Functionality of the AIS Service Management, Part V. It is a graphical display interface and configuration utility for the AIS network.

Maestro monitors all AIS network components including status & failure of all components, warnings about failover and backup systems, user account status, and all other relevant events. From the single interface accessed via a web browser, Maestro users can monitor, maintain, and manage all elements of the AIS network. Maestro is an independent process that runs without affecting the other AIS services.

Note: USACE and USCG currently use CNS DataSwitch as an AIS router. Both USCG and USACE DataSwitch have been upgraded to same version with destination TAG routing capability. During the demonstration, the TAG router application was replaced with the updated DataSwitch (see Figure 12). Throughout the demonstration, extensive testing was completed.

Considerations for use in an operational AIS Transmit System:

- DataSwitch was designed as a data filter and routing application. Data routing is done in a top-down hierarchical fashion. A hub and spoke data routing capability may be required for an operational AIS Transmit System solution.

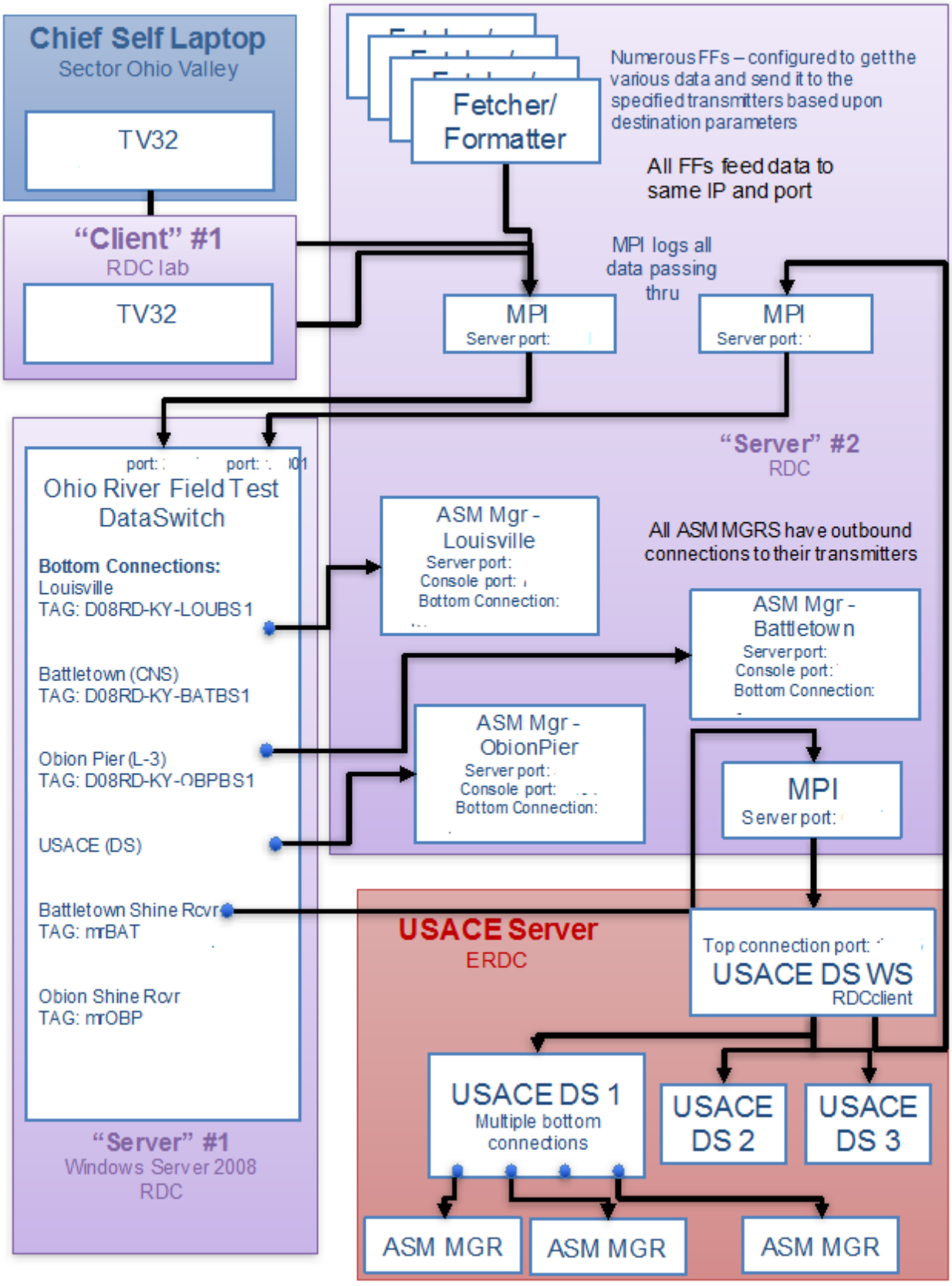

Figure 12. Ohio River demonstration architecture after DataSwitch-to-DataSwitch connection.

3.4 Message Management

Provided in this section is a description of the software application used to support this component of an AIS Transmit System during the project demonstration.

3.4.1 Software

During the project demonstration the following software applications were used in the management of ASMs. A description of each application, along with considerations for its use, is provided.

3.4.1.1 ASM Manager

ASM Manager is a RDC developed software application that adds additional necessary functionality to a Transmit System's "AIS router." ASM Manager is used to manage AIS messages and creates a transmit queue for an AIS transmitter. ASM Manager resides logically between an AIS router (DataSwitch) and an AIS transmitter. The ASM Manager application manages the flow of messages and is configurable based on the type of transmitter (FATDMA for an AIS base station and RATDMA for an AIS AtoN), to ensure proper queuing with respect to slot configurations.

The program was designed to shield a message creator from the details of base station locations and manage ASM transmissions by performing the following functions:

- Validation of messages before transmission.
  - ASM Manager processes ABM, BBM, and VDM NMEA sentences, and manages AIS message 6, 8, 21, 26, and certain Designated Area Code (DAC) and FI's. Messages that are not of the valid type are discarded to ensure only proper ASMs are transmitted.

- Incoming message Buffer.
  - All managed messages are added to the transmit queue; the maximum number (user specified based upon slot reservations and expected VDL loading) of messages are sent from the queue to the transmitter at a user-specified interval. The transmitters used in the demonstration have a limited buffering capability. The created transmit queue prevents message loss from the numerous ASM generators/creators.

- Message prioritization.
  - Messages have a default priority based upon message type and content, which can be over-ruled by a user-specified message priority contained in metadata. Prior to sending messages to the transmitter the queue is sorted by priority.

- Geographic restriction.
  - ASM Manager determines if a message should be transmitted from a given transmitter based upon location, using position information contained in metadata.

- Manages the message queue.
  - Detects and purges expired messages (all messages are time-stamped based on the information in the ASM or an arrival timestamp and all messages have either a message-specified or default expiration time). In addition, if a message is received that is identical to one already in the queue, but is more recent, it replaces the older message. Message priority, number of times the message was delayed, number of times the message failed to transmit and the next send time are carried over from the obsolete message to the updated message.

- Ensures all messages are transmitted.
  - Message priority, number of times the message was delayed, number of times the message failed to transmit, and the next send time are tracked for each message in the queue. If a message fails transmit it is put back into the queue. If a message is passed over in the queue by higher priority messages then its priority is increased by 1 each time this happens so that it will eventually be selected for transmission.

- Guarantees transmission.
  - Messages are not removed from the queue until they have been successfully transmitted, as identified by message from the transmitter (ABK or TFR sentence).

- Sender acknowledgments.
  - Allows for acknowledgement messages to be routed back to the sender.

- Message repetition.
  - Manages the repetition of messages that need to be retransmitted on a periodic basis as well as those that fail transmission for any reason. The repetition rate is specified by the sender. Without the message repetition functionality the messages would only be transmitted once by the transmitter (e.g., a Geographic Notice message valid for a certain period of time would only be transmitted once at the beginning).

Since each transmitter has its own VDL, a running instance of ASM Manager is required for each transmitter (AIS AtoN or base station). ASM Manager acts as a server and accepts incoming connections from a DataSwitch application. ASM Manager also initiates a client connection to transmitters that it is managing on the VDL. There is a separate configuration file for each instance of ASM Manager. Each configuration file contains all of the settings needed to manage connections and message queuing for the transmitter.

3.5 Message Transmission

During the project demonstration message transmission was tested on L-3, Saab, and CNS base stations and L-3 and Vesper AtoN units. The demonstration used BBM and VDM sentences to transmit messages. These sentences were generated by the message creators (manual and automatic), routed by the DataSwitch(s) to the individual transmitter queues managed by ASM Manager and delivered at a steady rate to each transmitter. This enabled a variety of different ASMs to be transmitted throughout the test bed during the demonstration.

Following are the primary AIS transmitters installed and used during the demonstration.

3.5.1 Transmitter Hardware

3.5.1.1 L-3 Protec Base Station

L-3 Protec base stations (see Figure 13) were used at the Louisville, Battletown, and Owensboro (CGC Obion Pier) sites. The L-3 Protec base station is the currently fielded base station for the USCG NAIS.

Figure 13. L-3 Protec base station.

VTS Louisville, KY, part of USCG Sector Ohio Valley, has a single AIS base station as part of their communications equipment. The base station has been used by the RDC for AIS transmit testing since 2011. It was reconfigured for use during the demonstration test.

An additional base station was installed at the Battletown, KY Rescue 21 tower site, and a third at USCG Obion Pier in Owensboro, KY. Exact locations for each site are listed in Table 6. The base stations served to provide coverage in areas between USACE AIS transmitter sites.

Table 6. Base station information.

Site Name	Site Label	Latitude	Longitude
Louisville	D08RD-KY-LOUBS1	38.254883 N	85.75813 W
Battletown	D08RD-KY-BATBS1	38.05250 N	86.30810 W
Obion Pier	D08RD-KY-OBPBS1	37.7865856 N	87.0733394 W

The Louisville base station is located in the Aegon building with a dedicated network link connecting it to the Federal Building location of Sector Ohio Valley. The Transmit/Receive (Tx/Rx) antenna was located on the roof of the Aegon building at a height of 923 feet above sea level. A serial connection to the base station was used. The serial connection was split at the Sector to provide a serial feed to the NAIS site controller.

The equipment installations at Battletown and the Obion Pier were comprised of an AIS base station; an AIS receiver as a local monitor; an Uninterruptible Power Supply (UPS); and, network equipment. Both installed sites were configured similarly - the primary difference being that the base station at Obion Pier used a single antenna for transmit and receive while the one at Battletown used separate antennas.

For each site, a connection was initiated by the RDC DataSwitch to the base stations over the network. The base stations were all configured for FATDMA usage only and slots reserved for the expected traffic. The slot reservations made for each base station are listed in Table 7.

Table 7. Base station slot reservations.

Base Station	Channel	Start Slot	# Slots	Increment	Ownership	Intended use
***Obion* Pier**	A	45	2	750	Local	Message 4, Message 20
	A	111	3	225	Local	Binary messages
	B	170	2	750	Local	Message 4, Message 20
	B	121	3	225	Local	Binary messages
Battletown	A	25	2	750	Local	Message 4, Message 20
	A	202	3	225	Local	Binary messages
	B	150	2	750	Local	Message 4, Message 20
	B	77	3	225	Local	Binary messages
Louisville	A	226	2	750	Local	Message 4, Message 20
	A	396	2	0	Remote	Message 21
	A	21	3	225	Local	Binary messages
	B	101	2	750	Local	Message 4, Message 20
	B	20	2	750	Remote	Message 21
	B	11	3	225	Local	Binary messages

3.5.1.2 L-3 Protec-D AtoN

The L-3 Protec-D AtoN unit has limited capability compared to the L-3 Protec base station, but is fully capable of transmitting AIS message 6, 8, and 21. It is currently the fielded unit for USACE sites. The specific sites used as part of the demonstration are listed in Table 8.

Figure 14. L-3 Protec-D AtoN.

Table 8. USACE transmitter locations.

Site Name	Site Label	Latitude	Longitude
Meldahl	r0A3Z	38.79725000	-84.17178900
Markland	r094M	38.77441300	-84.96617200
McAlpine	r0CUX	38.27790300	-85.79257500
Newburgh	r0CMR	37.93221900	-87.37348400
Cannelton	r0CVU	37.89968000	-86.70653500
Green R. Lock & Dam 1	r0AU6	37.85919000	-87.40864167
J T Myers	r0A8A	37.79484800	-87.99241500
Olmsted	r08VH	37.18372000	-89.06370000
Smithland	r09KU	37.16430300	-88.43039800
L&D 52	r08UF	37.12673000	-88.65484700
Barkley	r0BZJ	37.01969700	-88.22479800
Kentucky Lock	r08DN	37.01493300	-88.26518200

The USACE sites consist of a L-3 Protec-D AIS AtoN unit assembled into a waterproof box along with power conditioning and network attachment equipment (see Figure 15). This is referred to as their LOMA box.

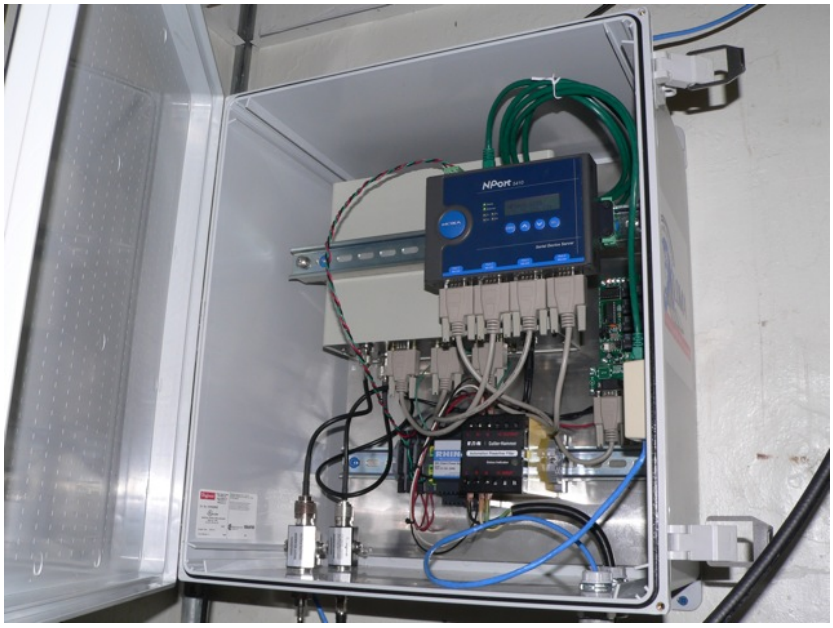

Figure 15. Inside of USACE LOMA box.

3.5.1.3 Vesper AIS Beacon VAB 1252

The Vesper VAB 1252 (see Figure 16) is a newer AIS AtoN unit. It has similar capability to the L-3 Protec-D; although the current software only supports accepting a single message for transmission at a time. This difference is accommodated by adjusting the ASM Manager settings to only send it one message at a time, and to connect to the unit at shorter time intervals. Part-way through the demonstration period, the L-3 base station at Obion pier failed (power supply failed) and it was replaced with a VAB 1252. The same antennas were used, the only change was that the VAB 1252 was used in RATDMA mode while the base station had been in FATDMA mode.

Figure 16. Vesper VAB 1252.

3.5.1.4 L-3 Protec-M AIS Unit

The L-3 Protec-M AIS unit (see Figure 17) was used within the RDC simulated Test Bed to receive transmissions and send to charting display software. The L-3 Protec-M is the fielded unit on majority of Coast Guard underway assets.

Figure 17. L-3 Protec-M AIS Class A Transceiver.

3.6 Data Assurance

Data assurance was accomplished through a combination of receivers, data loggers, and data analytic software. The receivers served as real-time monitors of the system and the data loggers provided data collected from vessels transiting throughout the test bed to verify reception of the messages. During the demonstration, dedicated receivers were installed in the field with connectivity back to the RDC allowing for confirmation of transmissions. Additional hardware was installed at each location as the transmitters used by the USCG and USACE are half duplex – and cannot receive while transmitting. This was accomplished by installing Shine Micro 1610 receivers throughout the test bed to serve as monitors. A receiver was installed inside each of the LOMA boxes (Figure 18) and along with each base station to monitor transmissions from the AtoN transmitters located at the locks. The Shine Micro receivers were connected to the USACE DS and their data forwarded to RDC for independent monitoring and testing.

Figure 18. Shine Micro 1610-4 AIS receiver.

Self-contained data loggers were constructed and installed on seven vessels (listed in Table 9). The first five were installed by the project team, the last two were shipped to the companies and installed by the ship's personnel. In all cases, the installation consisted of mounting a VHF whip antenna and GPS antenna to the rail on top of the pilothouse (see Figure 19), and connecting the data logger to the ship's alternating current (AC) power, usually in the pilothouse (see Figure 20). Antenna cables were run through existing stuffing tubes to connect the antennas with the box.

Table 9. Vessles with data loggers installed.

Vessel Name	Company
USCGC Chippewa	USCG
Float to Float	CG Auxiliary
Nashville Hunter	Hunter Marine
Bill Berry	Ingram Barge
Dru Lirette	AEP
Mark Dougherty	ACL
Patsy Coleman	Crounse

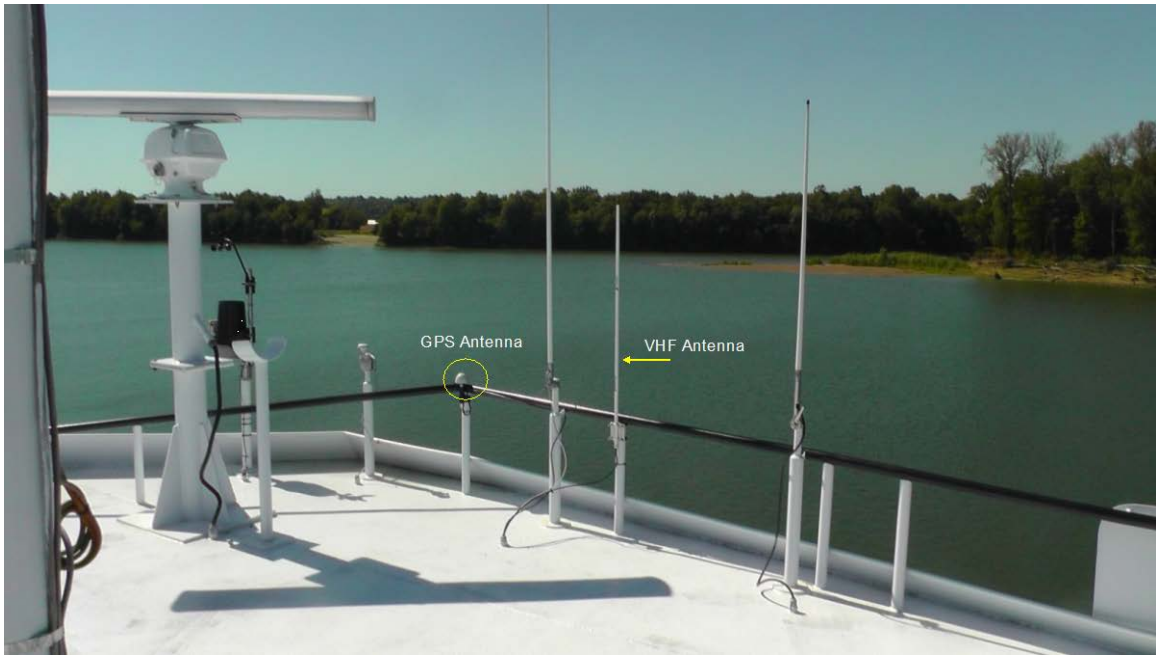

Figure 19. VHF and GPS mounted antennas.

Data loggers were also used to assess transmitter performance and coverage area. Each logger box contained a Shine Micro 1610 AIS receiver and a Moxa embedded processor (see Figure 21 and 22). Custom software on the Moxa device recorded received AIS data onto a flash drive. The flash drives were swapped-out every one to two months and the data post-processed. The GPS positions from the AIS receiver were used to geo-locate where the AIS transmissions from the various transmitters were received. Transmit coverage plots were created from data received from each data logger (see Appendix A).

Figure 20. Data logger box (red circle) placed under console in the pilot house.

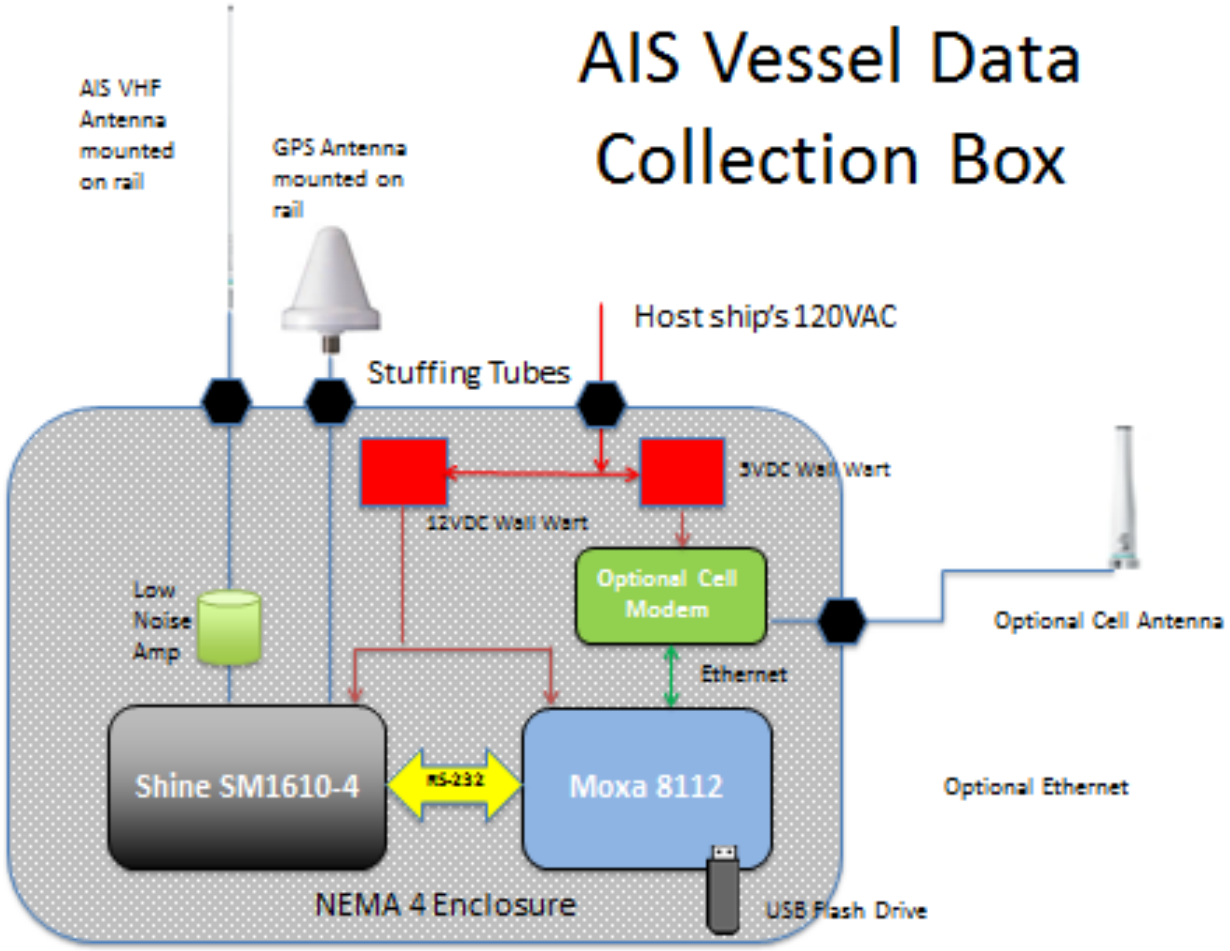

Figure 21. AIS data logger diagram.

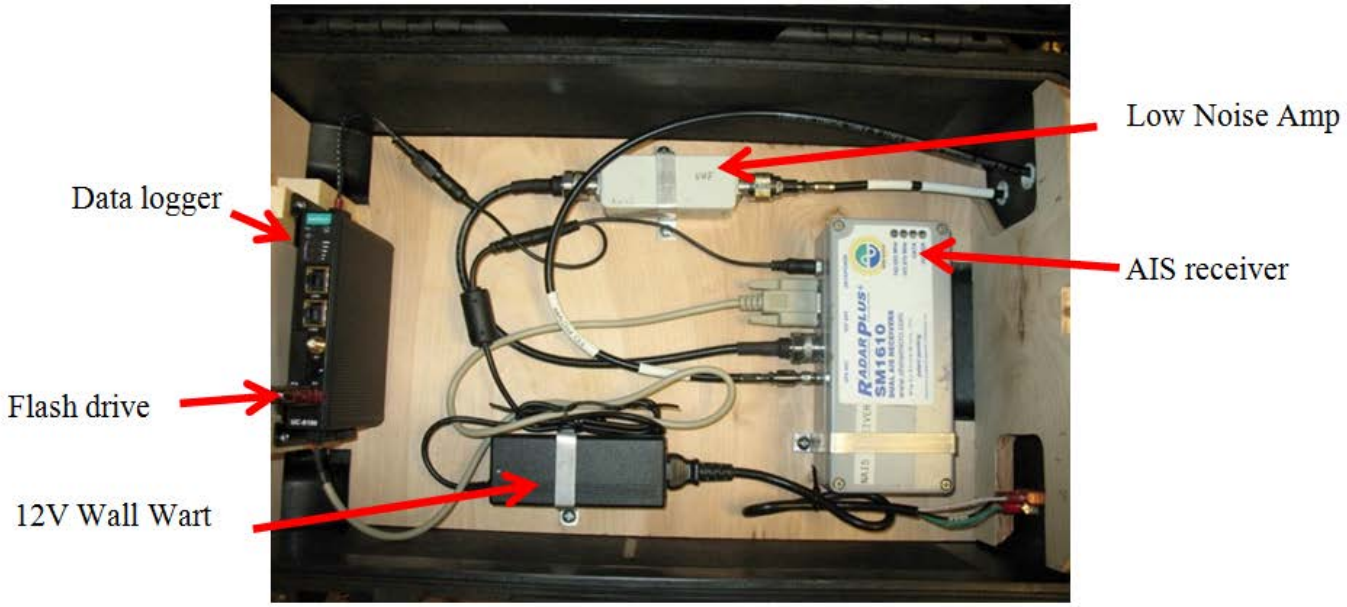

Figure 22. AIS data logger in pelican case.

3.6.1 Software

During the project demonstration the following software application was used to support Data Assurance capability.

3.6.1.1 AIS Miner

The AISMiner application allows a user to monitor, filter, and analyze live and archived AIS data. The application is designed to accept and process AIS data formatted in either RDC proprietary or NMEA v4.0 protocol.

The AISMiner application allows a user to monitor, filter, and analyze live and archived AIS data. The application is designed to accept and process AIS data formatted in either RDC proprietary or NMEA v4.0 protocol.

3.6.1.2 MatLab

MatLab™ is commercial software developed by MathWorks, Inc. From MathWorks Website: “MatLab is a high-level language and interactive environment used to explore and visualize ideas and collaborate across disciplines including signal and image processing, communications, control systems, and computational finance.” Specific to this project, custom scripts were written to analyze and display the data from the data loggers.

3.6.1.3 Systems Tool Kit (STK)

STK is commercial software developed by AGI, Inc. From AGI Website: “ Systems Tool Kit is used to analyze and visualize complex systems with dynamic datasets in 4D (X, Y, Z, Time).” For this project, STK with the Terrain Integrated Rough Earth Model (TIREM) was used to do VHF coverage predictions for each of the transmitter sites.

3.7 Mariner Display

Provided in this section are a list and description of the software applications used to support this component of an AIS Transmit System during the project demonstration. The commercially available Rose Point ECS and USCG Vega electronic charting software were used to display message transmission.

3.7.1 Software

During the project demonstration the following software applications were used to support a Mariner Display capability. A description of each application, along with considerations for its use, is provided.

3.7.1.1 Rose Point

Rose Point ECS is commercial software developed by Rose Point Navigation Systems. Rose Point ECS is currently the predominantly used navigation software by inland vessels in the United States. Specific to this project it was used to display the ASMs being transmitted in the JCTD (see Figure 23). RDC established a CRADA with Rose Point to decode and display transmitted ASMs. This was necessary as the ASM data contents (RTCM standard) have not been finalized. Without the CRADA, manufacturers are not incentivized to update their software to decode ASMs until they are finalized.

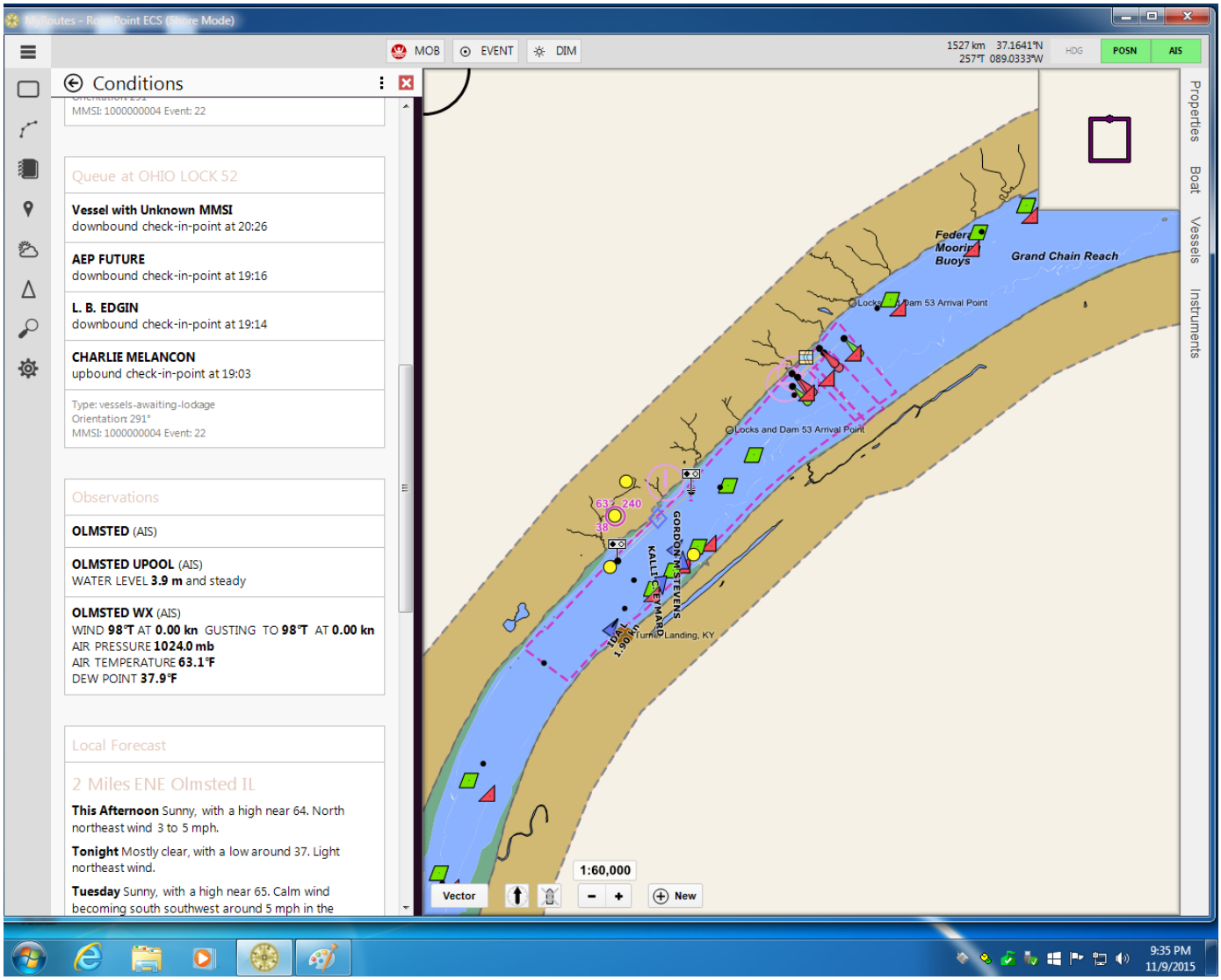

Figure 23. Rose Point display showing eMSI transmission.

3.7.1.2 VEGA

Vega is a USCG developed electronic charting tool used on a variety of USCG underway assets (see Figure 24). During the demonstration version 0.9B of this software was installed to display transmission of ASMs. None of the ASMs were properly decoded and displayed using this software. The next version of this software is expected to support proper decoding and display of all ASMs.

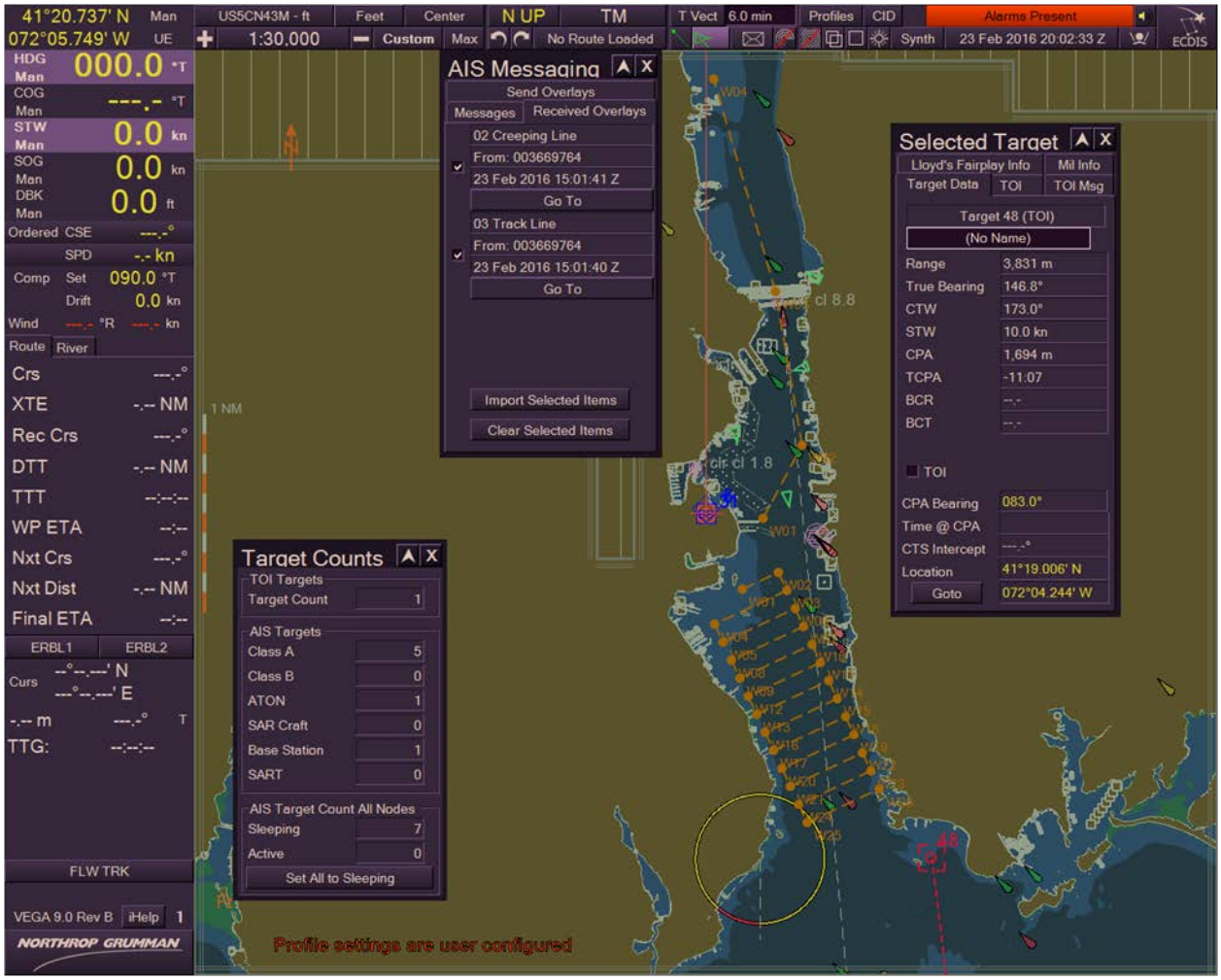

Figure 24. Sample screen capture of VEGA.

3.8 Shoreside Operator Display

Provided in this section is a description of the software application used to support this component of an AIS Transmit System during the project demonstration.

3.8.1 Software

During the project demonstration the following software applications were used to support a Shoreside Operator Display capability. A description of each application, along with considerations for its use, is provided.

3.8.1.1 Transview 32 (TV32)

TV32 is a VNTSC developed software application (see Section 3.2.4.1 for complete description). In addition to serving as a message creation tool during the demonstration, TV32 was also used for shoreside display. Transmitted messages are shown on the TV32 map display (Figure 25 and 26).

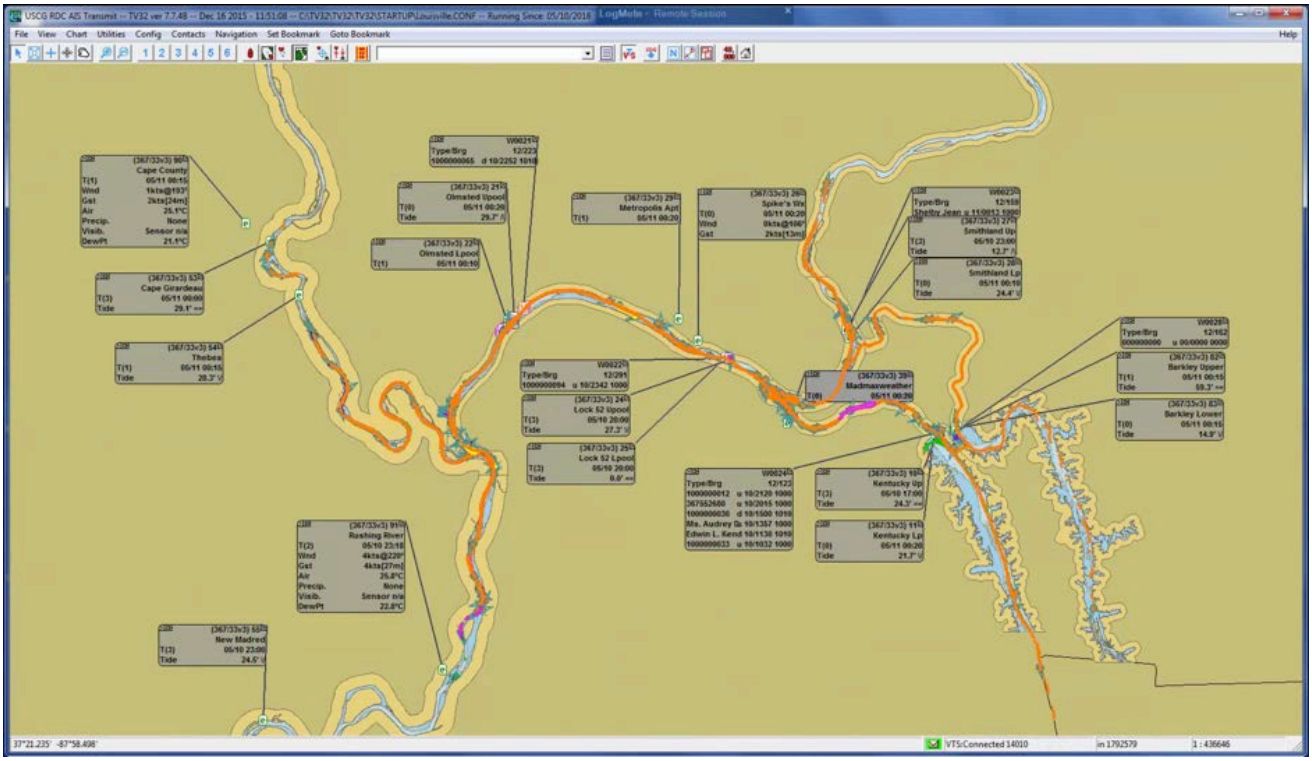

Figure 25. TV32 map display showing ASMs transmitted over lower Ohio River.

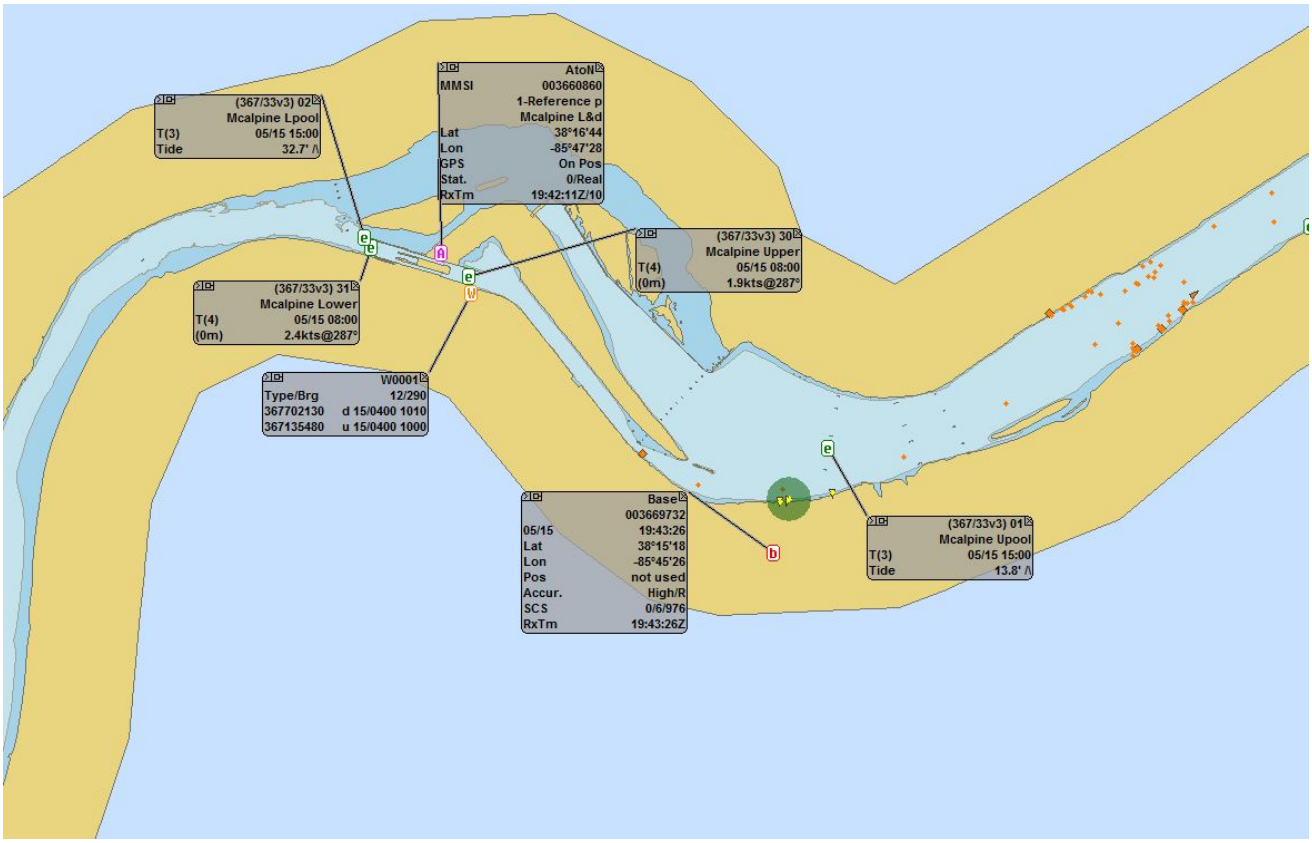

Figure 26. TV32 map display showing ASMs transmitted over Louisville.

3.8.1.2 Lock Operations Management Application (LOMA)

The LOMA was developed by CNS for the USACE to provide an operational real-time information system to support USACE lock operations. LOMA consists of a set of web-based applications and works along with DataSwitch and DataStore. The LOMA website provides operators with a tool to improve and increase real time situational awareness by providing real-time AIS information on a web-based plotter, provide event playback, and aid in lock queuing (see Figure 27 for a sample screen capture showing a Geographic Notice).

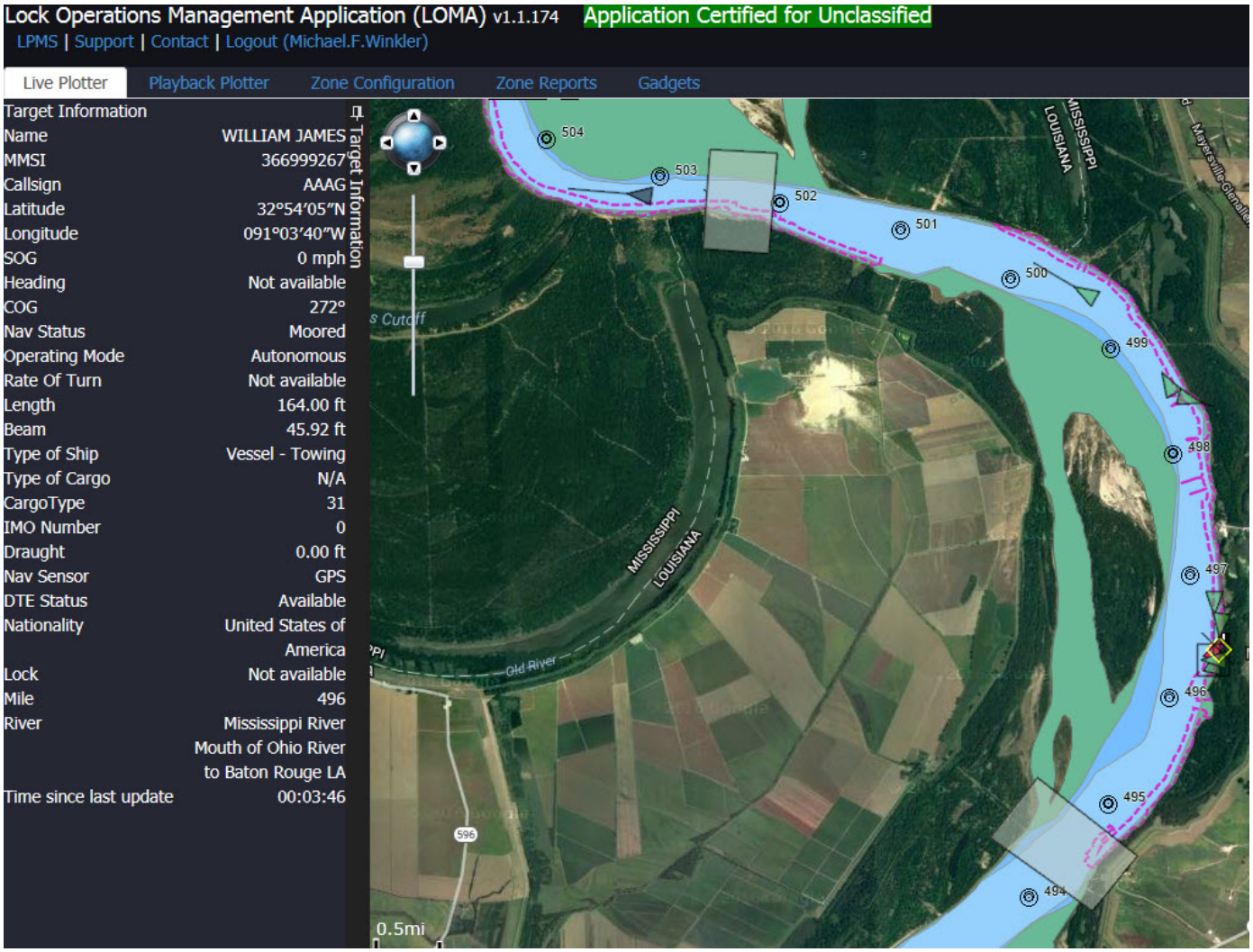

Figure 27. Sample screen capture of LOMA display.

3.9 System Monitoring

Provided in this section are a list and description of the software applications used to support the System Monitoring component of an AIS Transmit System during the project demonstration.

3.9.1 Software

During the project demonstration the following software applications were used for System Monitoring of ASM transmissions. A description of each application, along with considerations for its use, is provided.

3.9.1.1 Transview 32 (TV32)

TV32 is a VNTSC developed software application (see Section 3.2.4.1 for complete description). In addition to serving as a message creation tool during the demonstration, TV32 was also used for visual system monitoring.

3.9.1.2 ASM Monitor

ASM Monitor is an RDC developed software application used to monitor transmission of ASMs from an AIS transmitter (see Figure 28). ASM Monitor software was used during the demonstration for system monitoring of transmitted ASMs. This tool provides a "dashboard" type display showing how many messages were transmitted, including time of transmission of the last message for each transmitter listed in its configuration file. The autonomous messages (message Type 4 for base stations and message Type 21 for AIS AtoN) are tracked separately from ASM Type 8 messages. A Green box indicates messages actively being transmitted; a yellow box indicates no messages have been transmitted within the time threshold set in the configuration file; and red box indicates no messages have been transmitted with ten times the threshold specified in the configuration file.

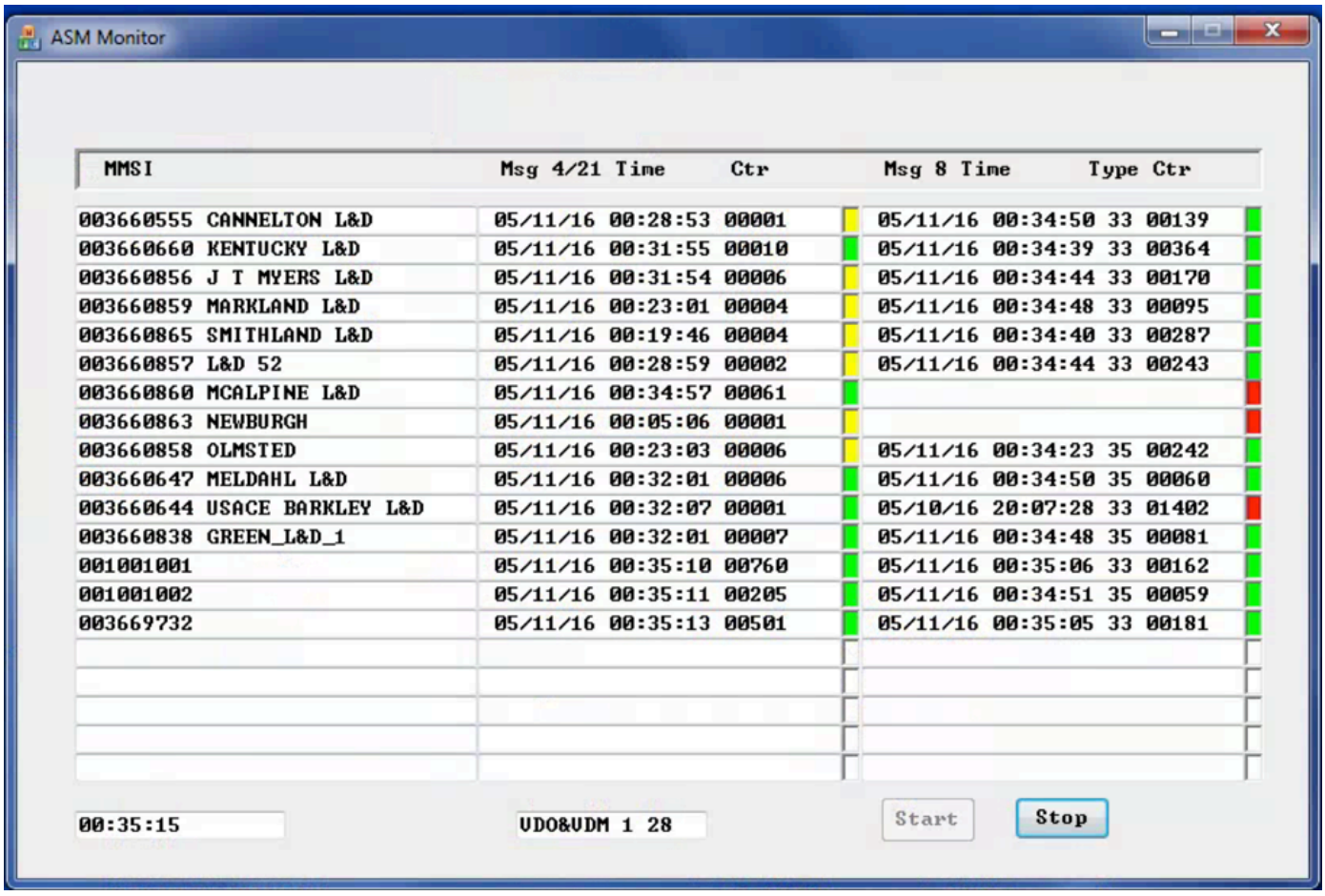

Figure 28. ASM Monitor tool.

Monitoring is completed two ways: (1) monitoring transmitter connectivity and last transmission; and (2) through logging all data in log files for each transmitter.

3.10 Inter-Agency Connectivity

During the demonstration an Inter-Agency Agreement (IAA) was established between RDC and USACE. The IAA allowed a connection between both agency's DataSwitch applications and the sharing of data for message routing and transmission. The DataSwitch-to-DataSwitch connectivity was discussed in Section 3.3.3. This prototype serves as a model for future inter-agency connectivity.

3.11 Cybersecurity

During the demonstration an IATT was authorized by CG-642. Internet connectivity to USACE and four field AIS base stations located along the Ohio and Mississippi River was established to transmit eMSI. All hardware within the RDC P-LAN environment maintained current security patches. An authorized user list was maintained to control access. Strict firewall configurations were established and maintained to control and minimize in-bound and out-bound data traffic. All IT equipment was kept within a physically secured location – in accordance with COMDTINST M5500.13D, Security and Information Assurance Manual.

4 TRANSMIT EXAMPLES FROM DEMONSTRATION

During the demonstration, eMSI was broadcast continuously for 15 months throughout the test bed. Approximately 93,000 ASM messages per day (equating to 4.5 messages per minute or 0.5 percent of VDL loading) were sent throughout the test bed. In May 2017, RDC expanded installation of Fetcher/Formatter application to include forty additional USACE AtoN units and transitioned the application operations to USACE ERDC. USACE created and transmitted AtoN in the Olmsted Lock and Dam Construction area. Additionally, RDC supported several events to include the Republican National Convention (RNC) and Democratic National Convention (DNC) broadcasting security zones via AIS. Self-contained AIS AtoN transmitters were configured, tested and installed in the test bed. Also, just prior to completing this effort, a security zone was transmitted around the riverboat, The River Queen, as a precaution during a reported bomb threat clearly demonstrating the usefulness of the need for this capability.

Provided below in this section are a series of screen shots showing examples of the transmissions of ASMs in the test bed. Although there are some standards for portrayal of these messages, not all ASMs are covered.

4.1 eMSI Transmitted Throughout Test Bed

TV32 display showing eMSI transmissions throughout the test bed.

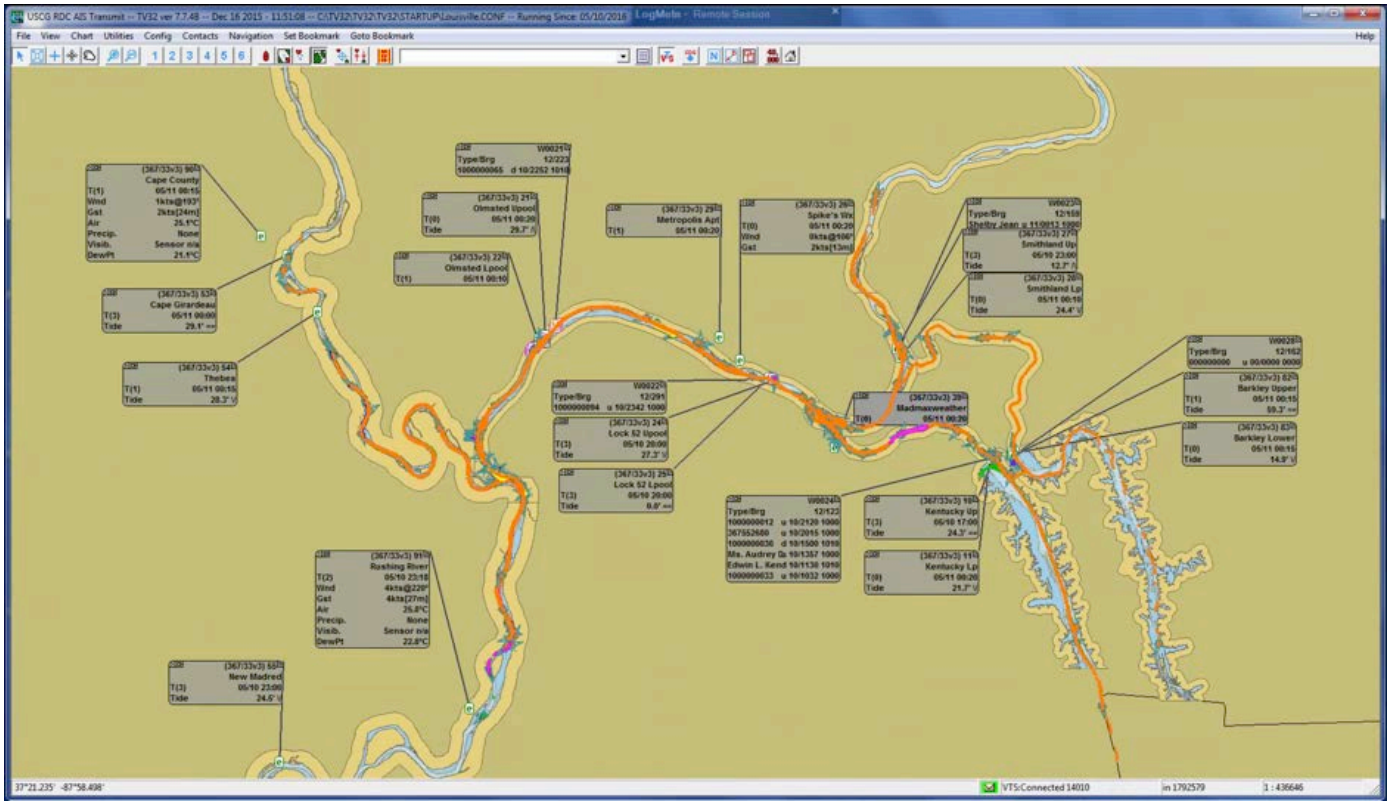

Figure 29. TV32 Display – Weather and other eMSI information.

TV32 display showing eMSI transmissions in the Olmsted Lock & Dam area. Specifically, weather, upper and lower poll heights, and AtoN unit location information is being displayed.

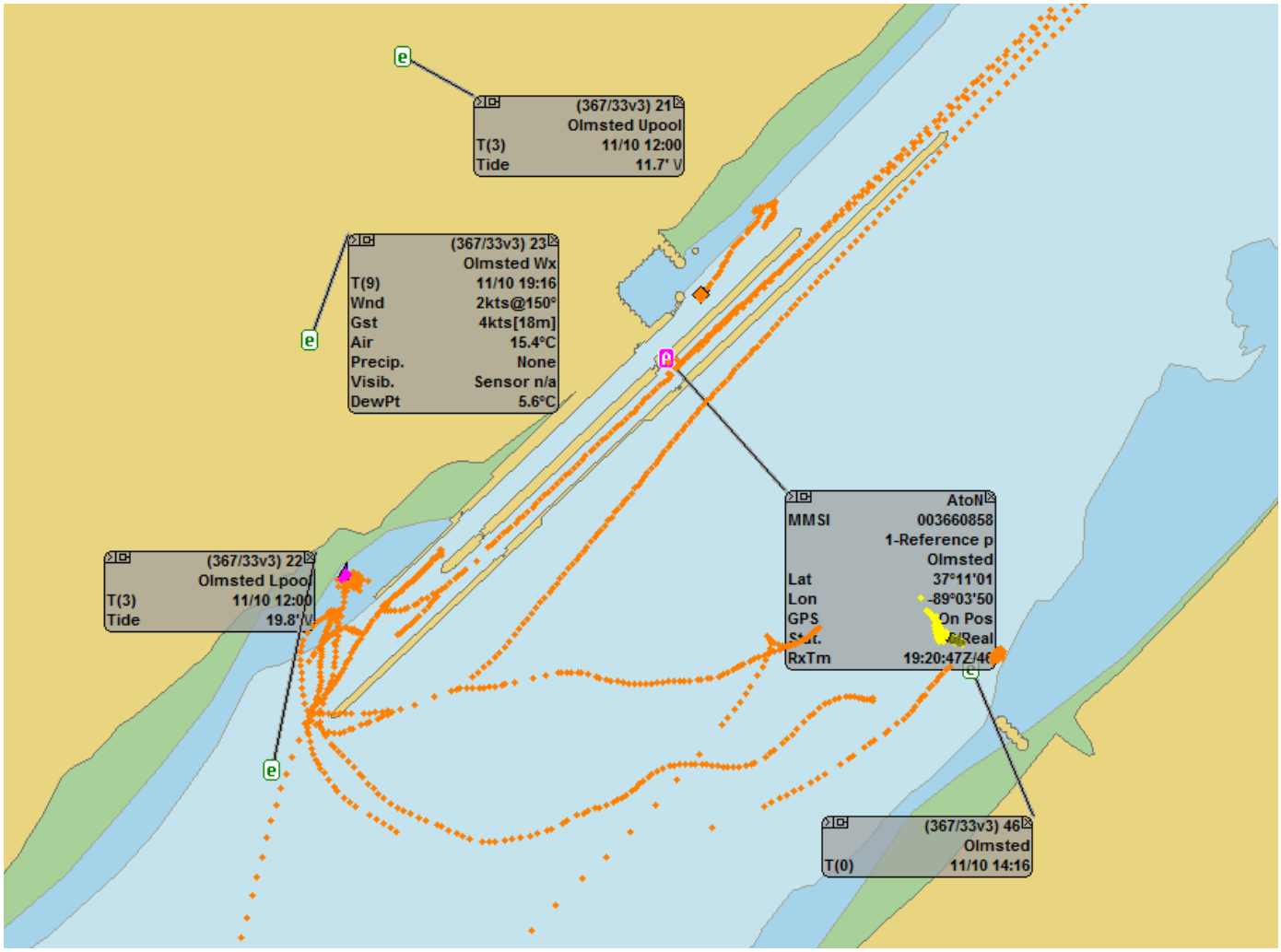

Figure 30. TV32 Display – Transmissions in the Olmsted Lock & Dam area.

Rose Point display showing eMSI (yellow dots) and Olmsted construction area AtoN (blue diamonds).

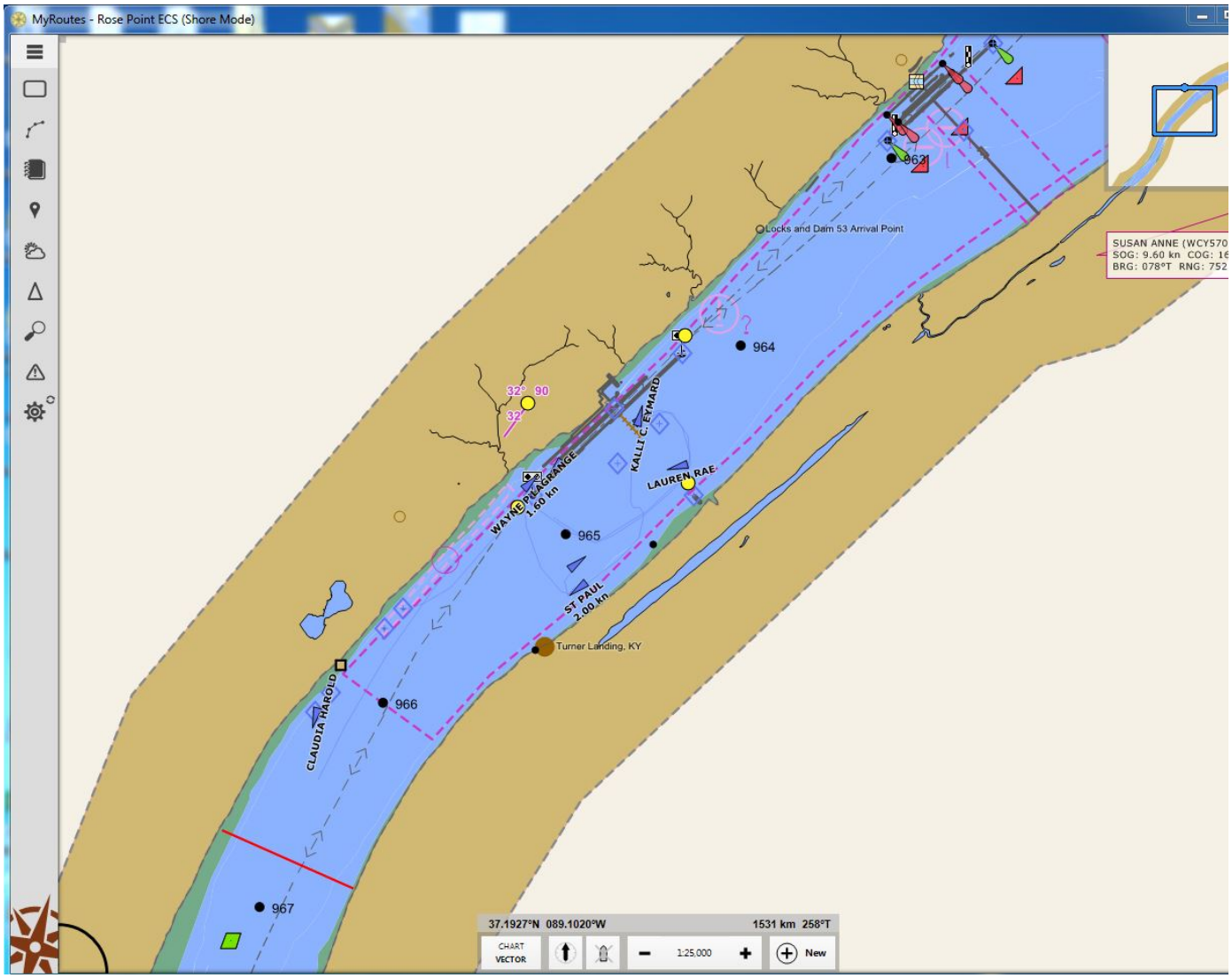

Figure 31. Rose Point Display – eMSI transmission in Olmsted construction area.

Rose Point display showing weather and lock queue information being transmitted in Olmsted.

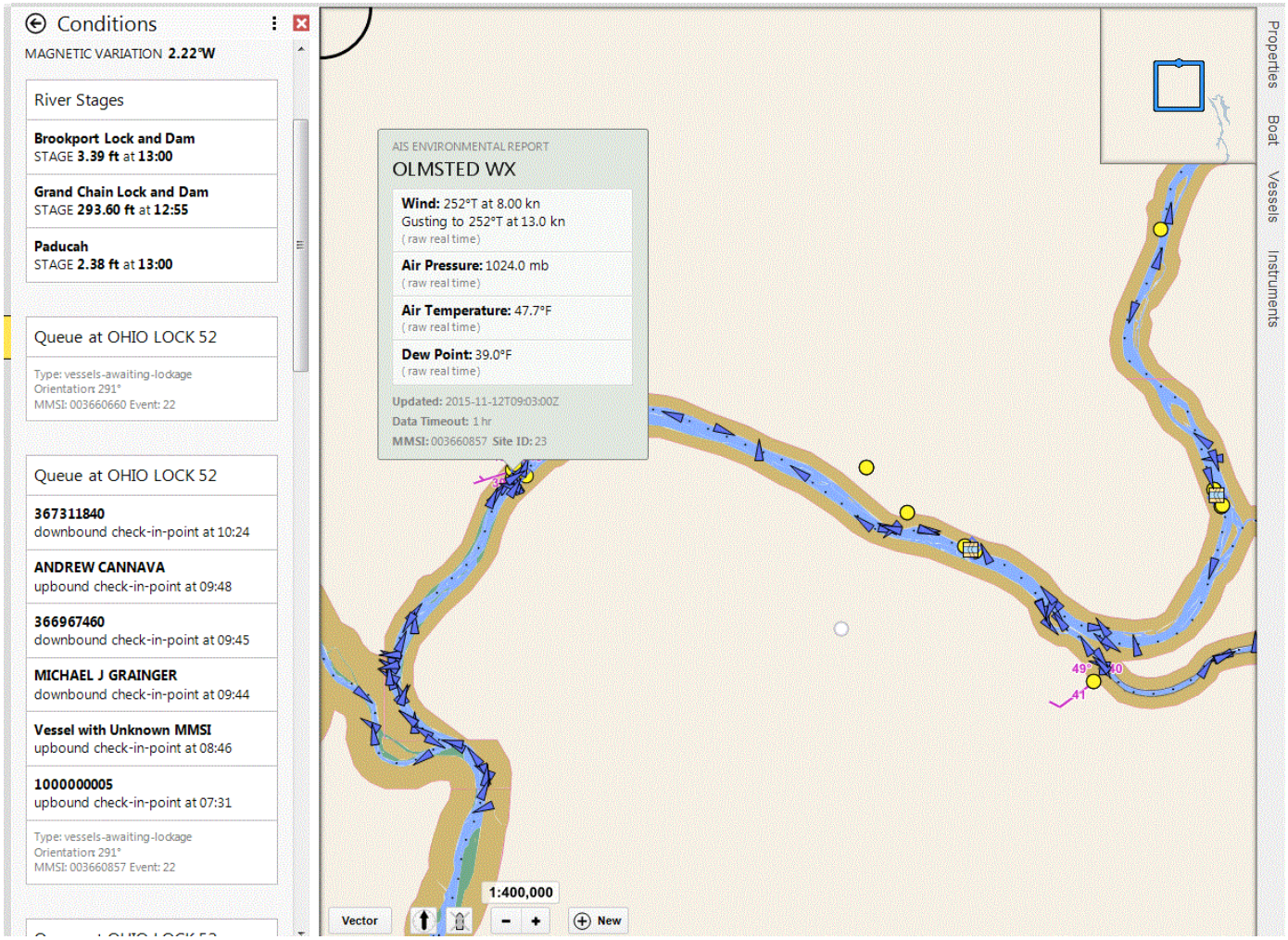

Figure 32. Rose Point Display – Weather and lock queue information in Olmsted.

TV32 display showing upper and lower pool height at Kentucky Lock & Dam.

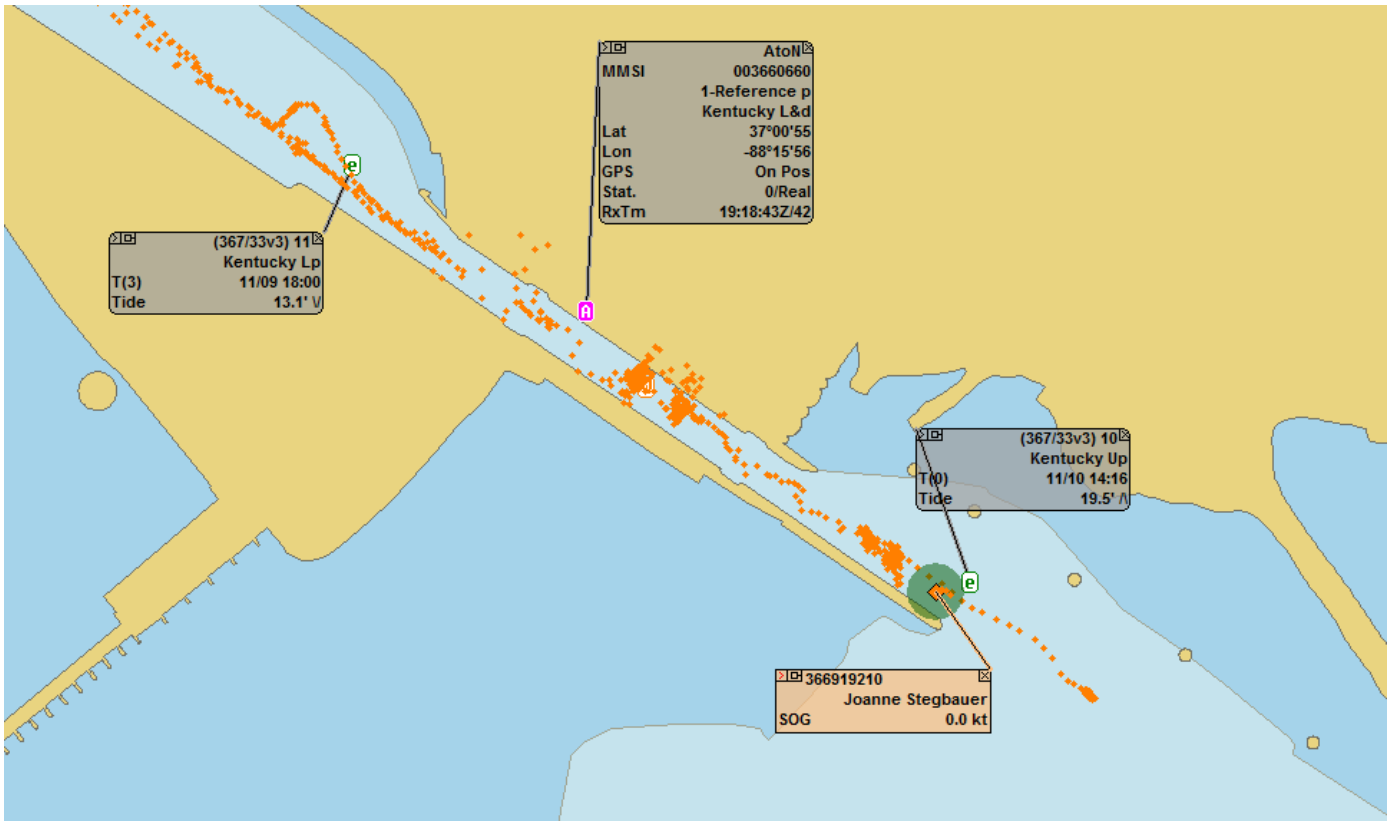

Figure 33. TV32 Display – Upper and lower pool height at Kentucky Lock & Dam.

Following are series of Rose Point displays showing eMSI transmitted throughout the test bed.

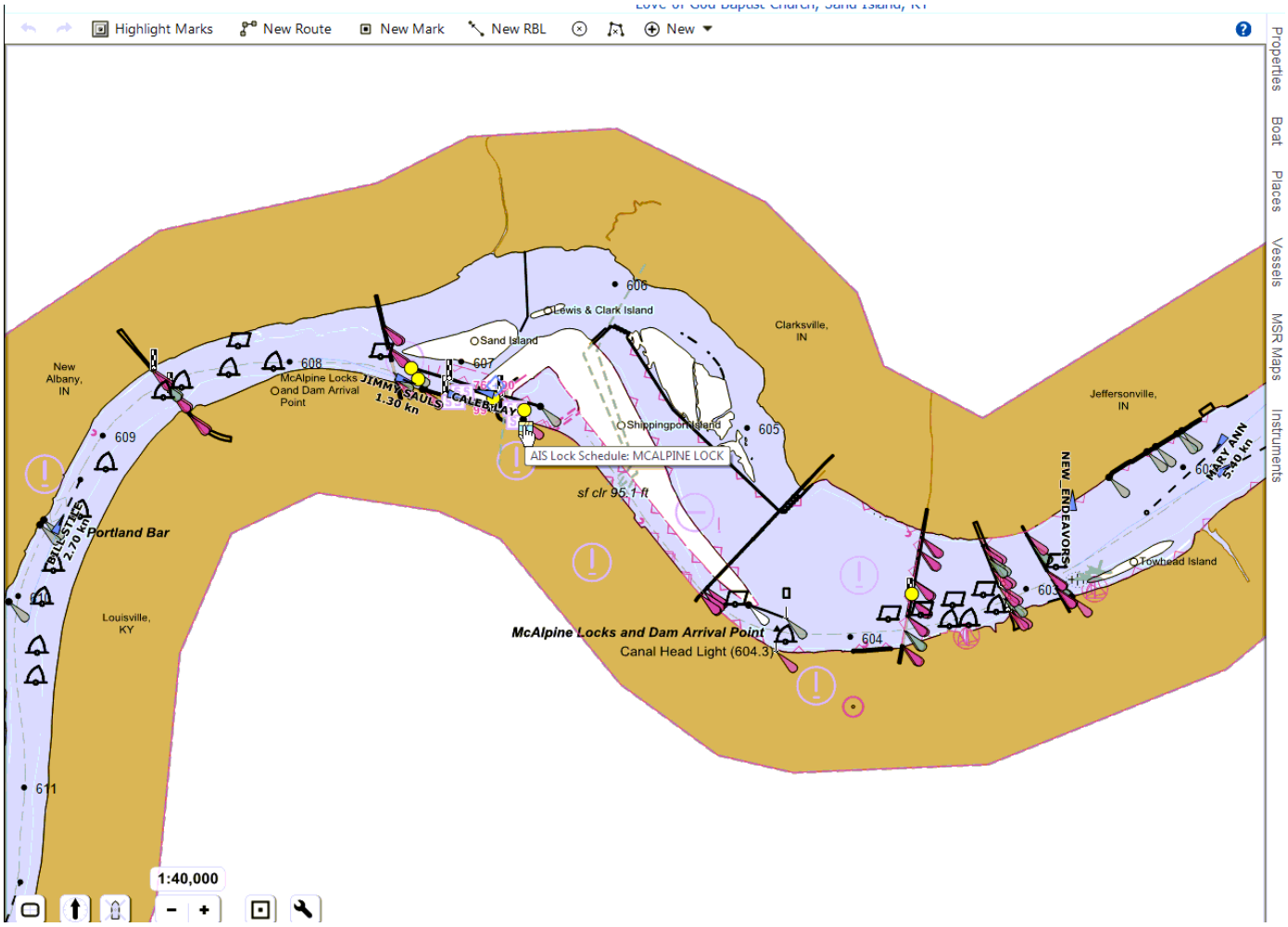

Figure 34. Rose Point display showing eMSI transmission (Lock Schedule).

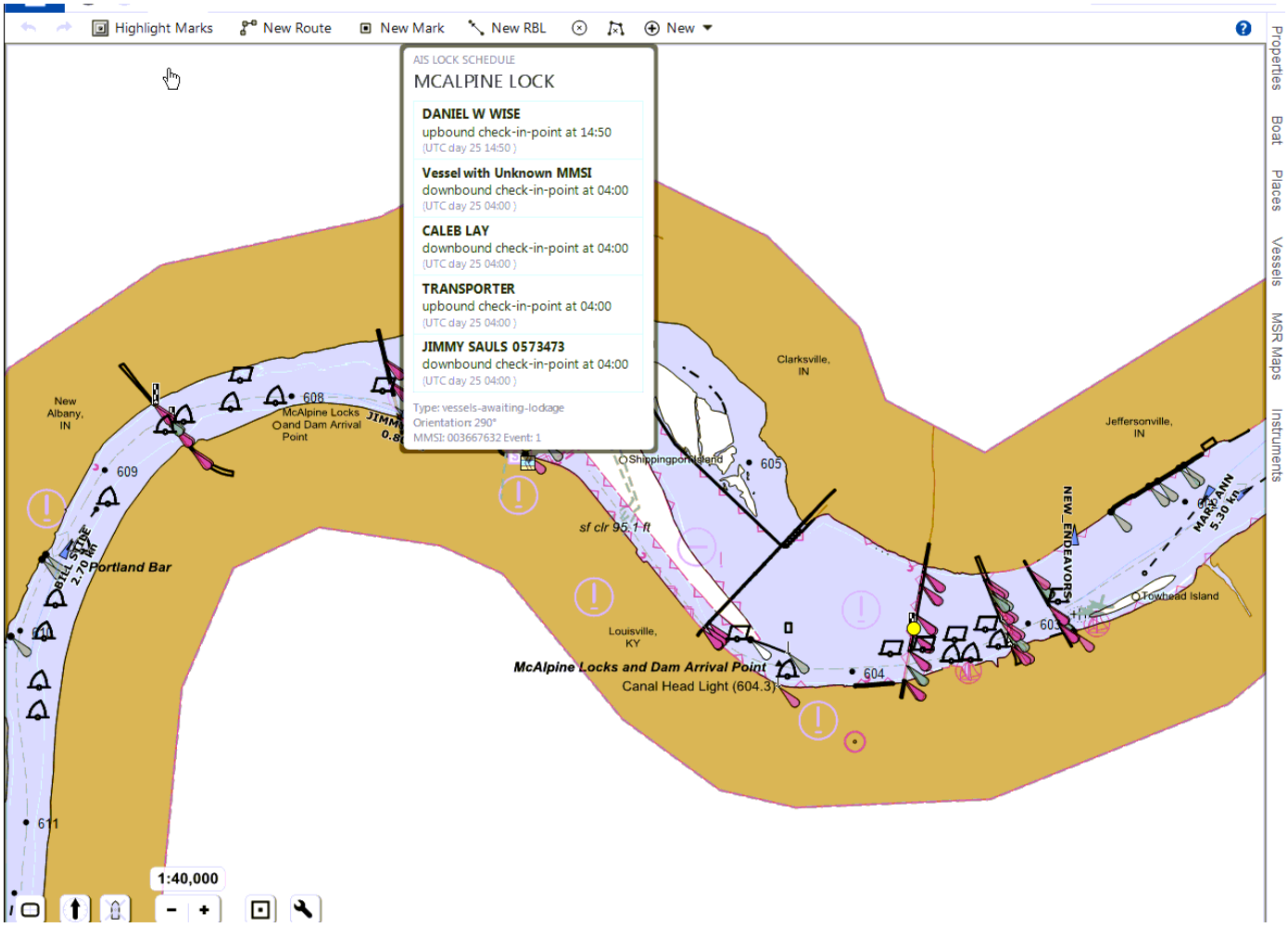

Figure 35. Rose Point display showing eMSI transmission (Lock View 2).

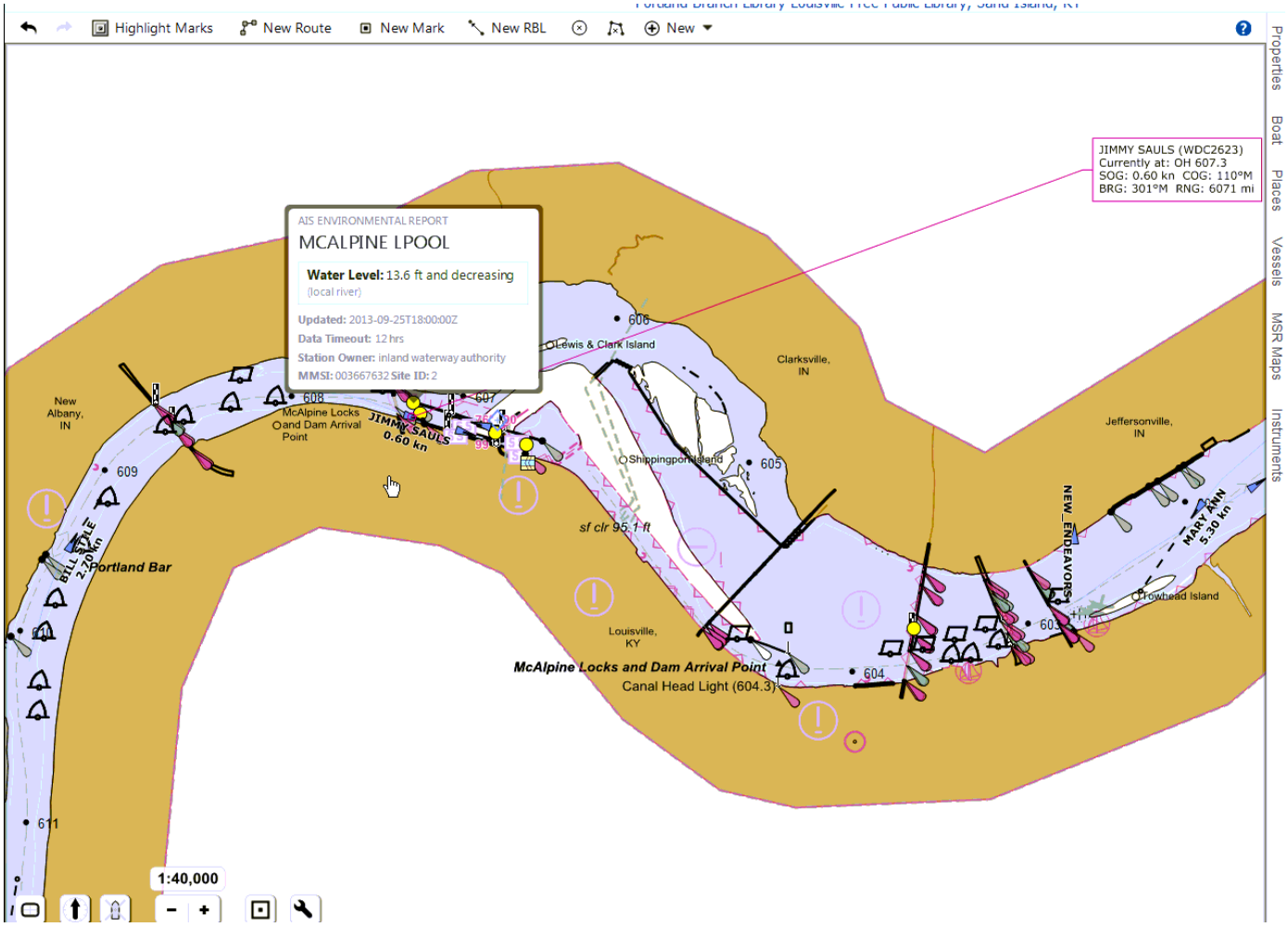

Figure 36. Rose Point display showing eMSI transmission (Lower Pool Height).

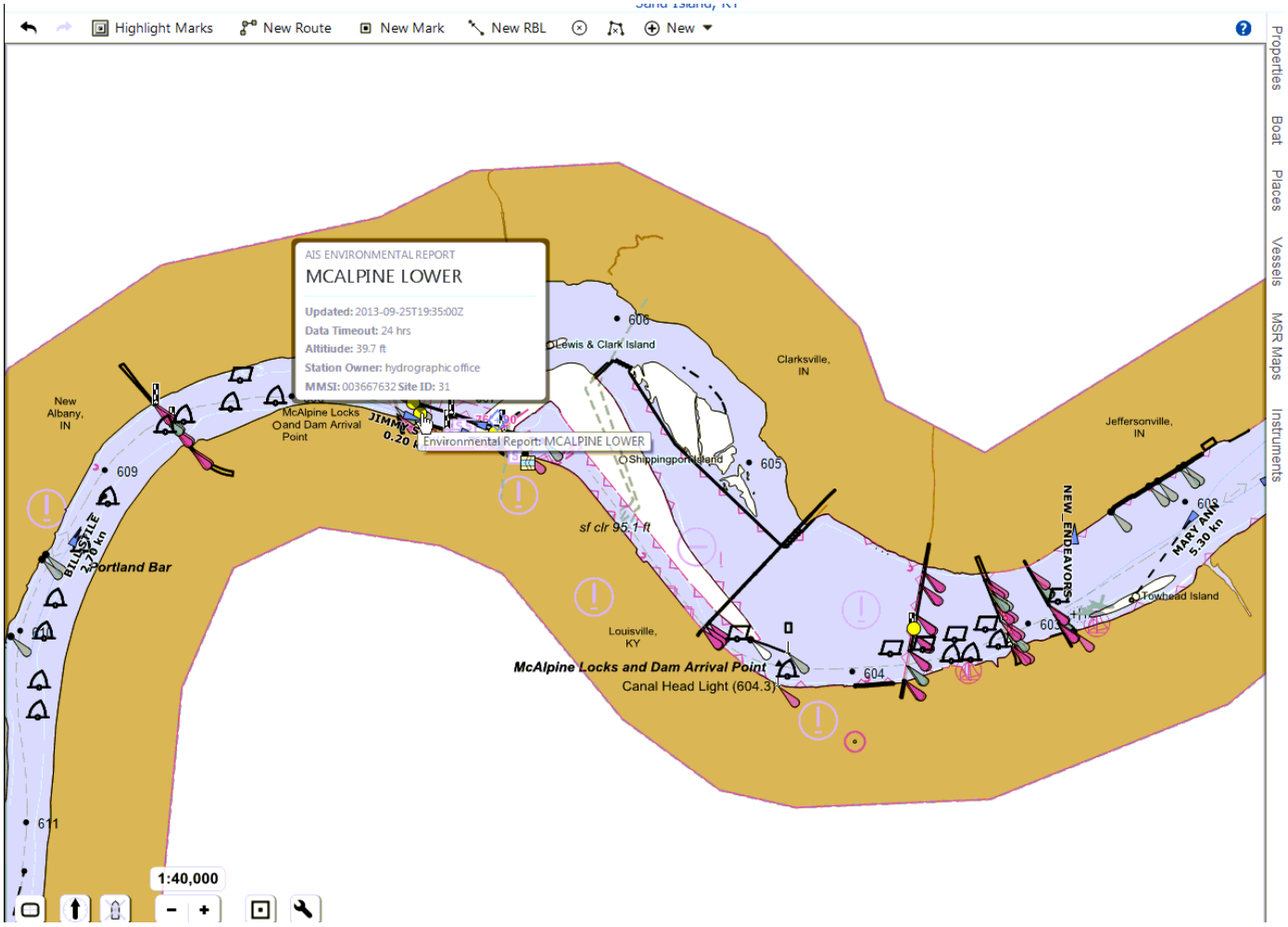

Figure 37. Rose Point display showing eMSI transmission (Environmental Report).

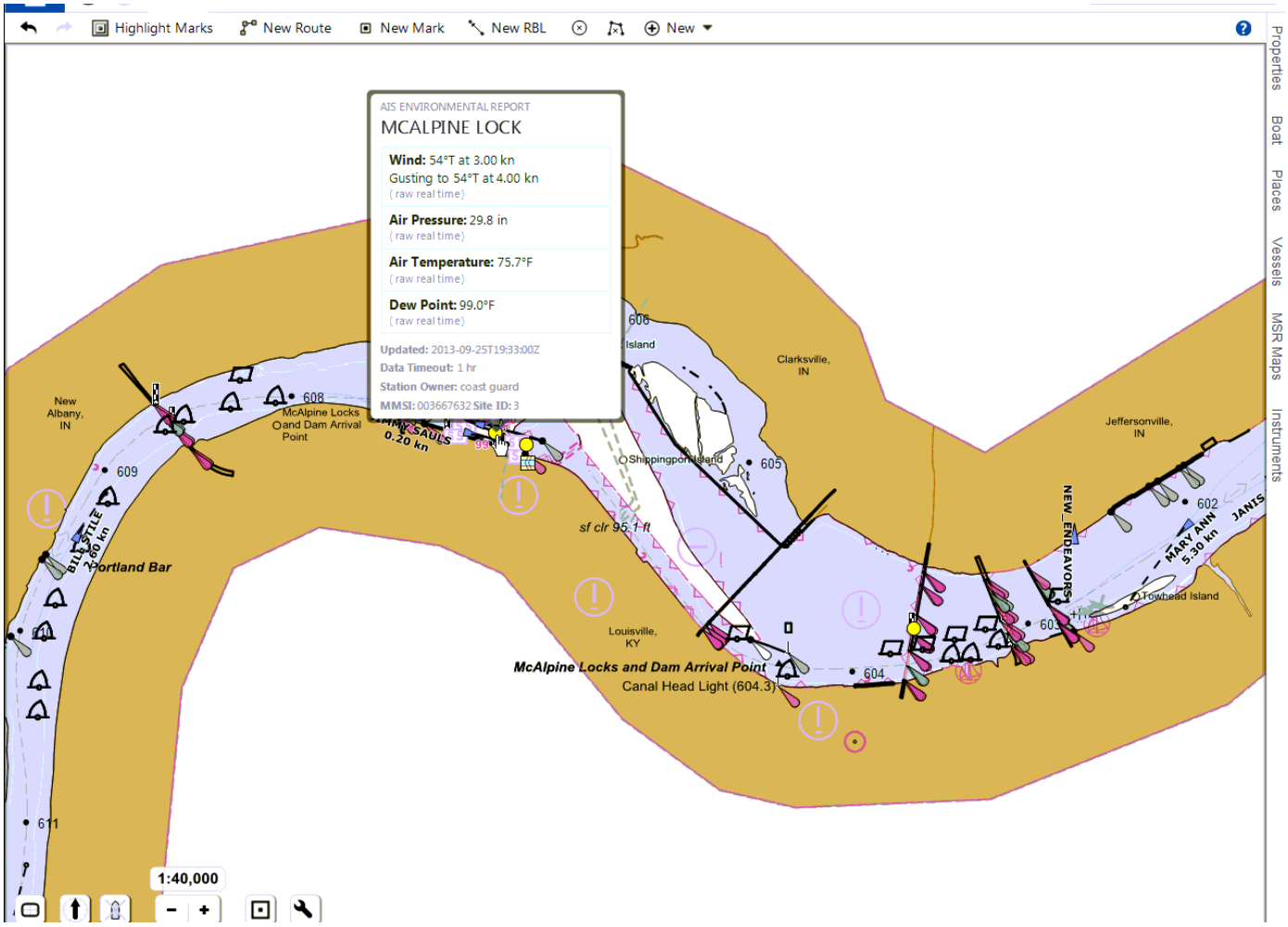

Figure 38. Rose Point display showing eMSI transmission (Weather).

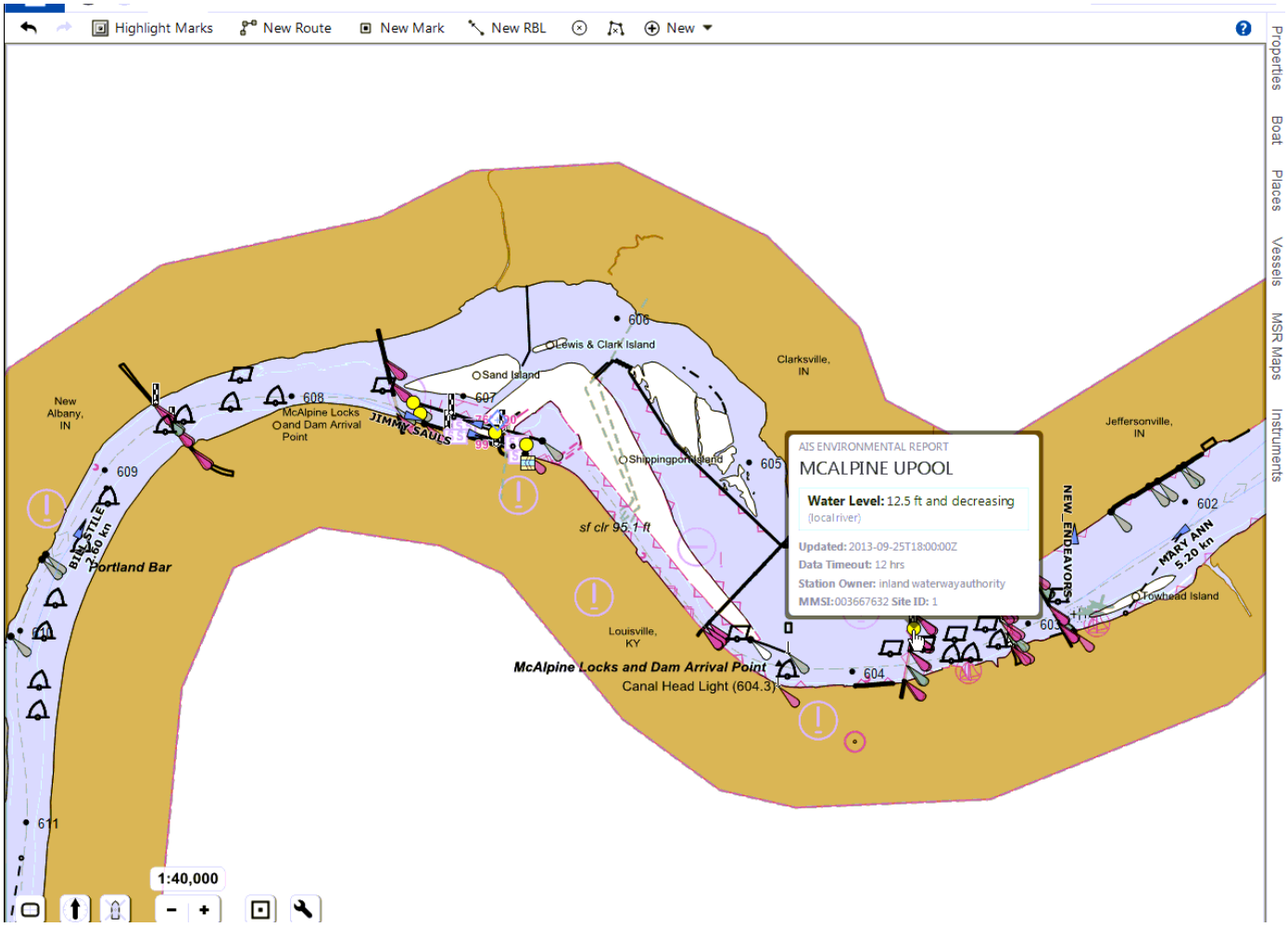

Figure 39. Rose Point display showing eMSI transmission (Upper Pool).

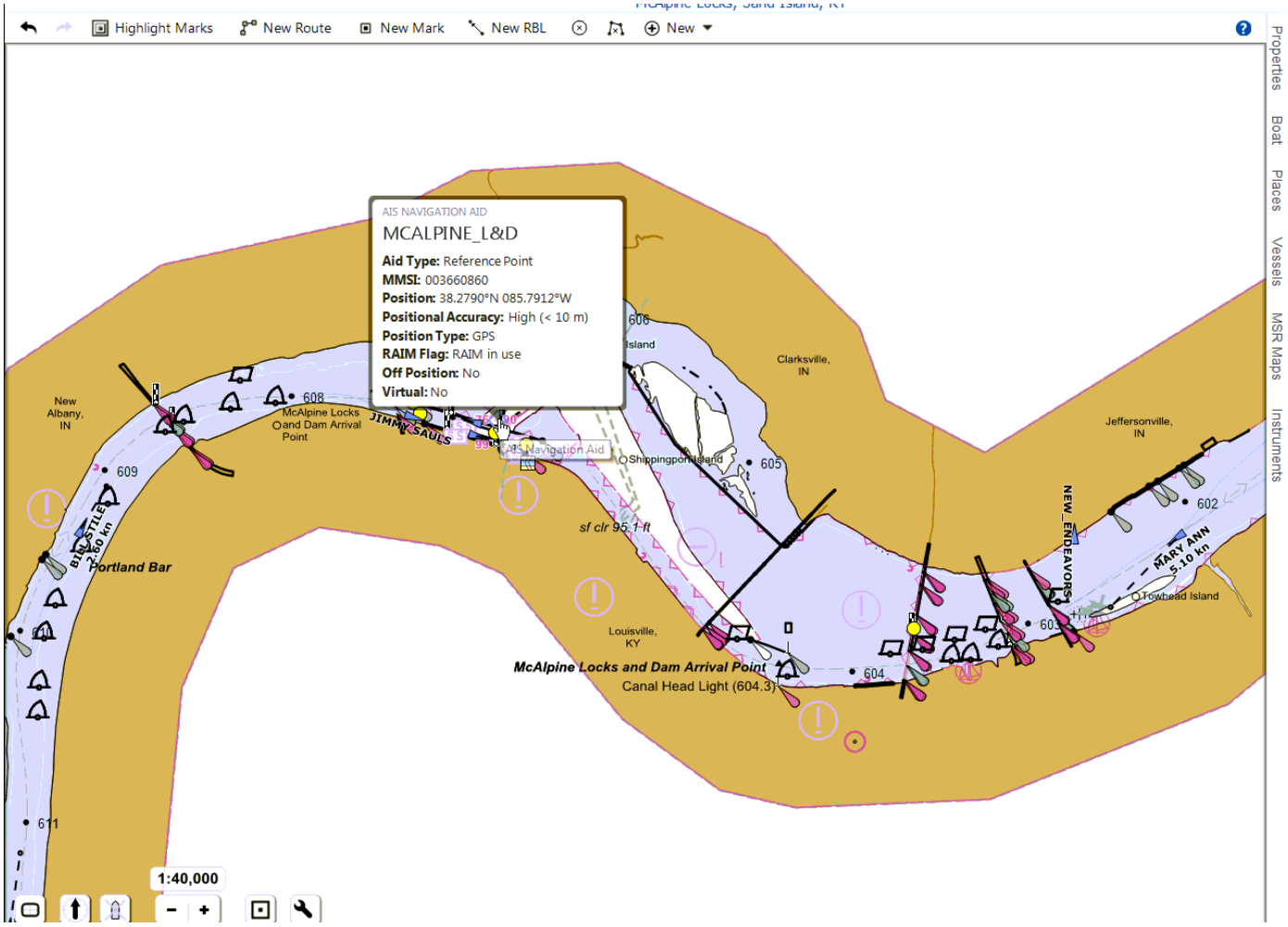

Figure 40. Rose Point display showing eMSI transmission (AtoN Unit Location).

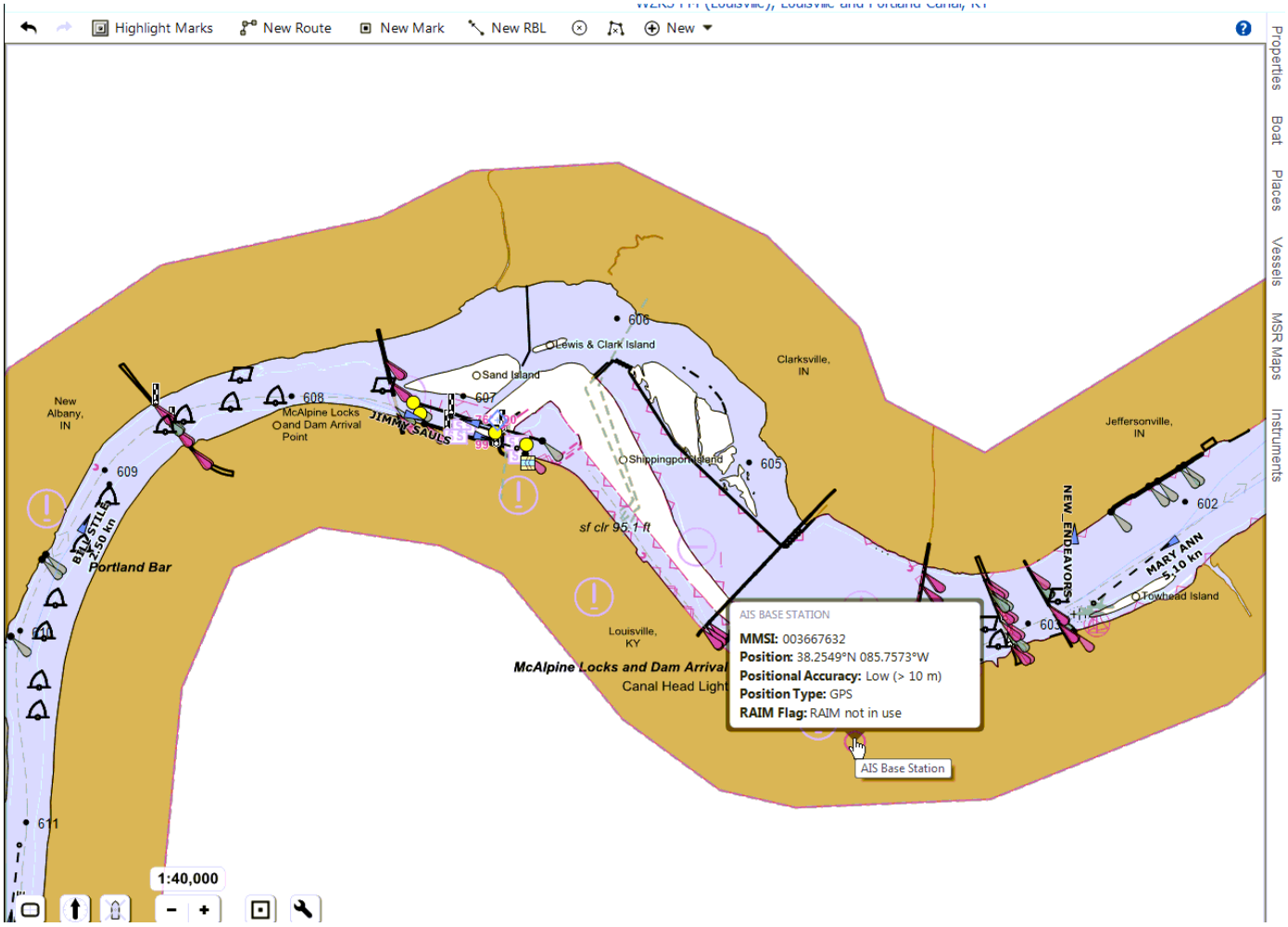

Figure 41. Rose Point display showing eMSI transmission (Base Station Location).

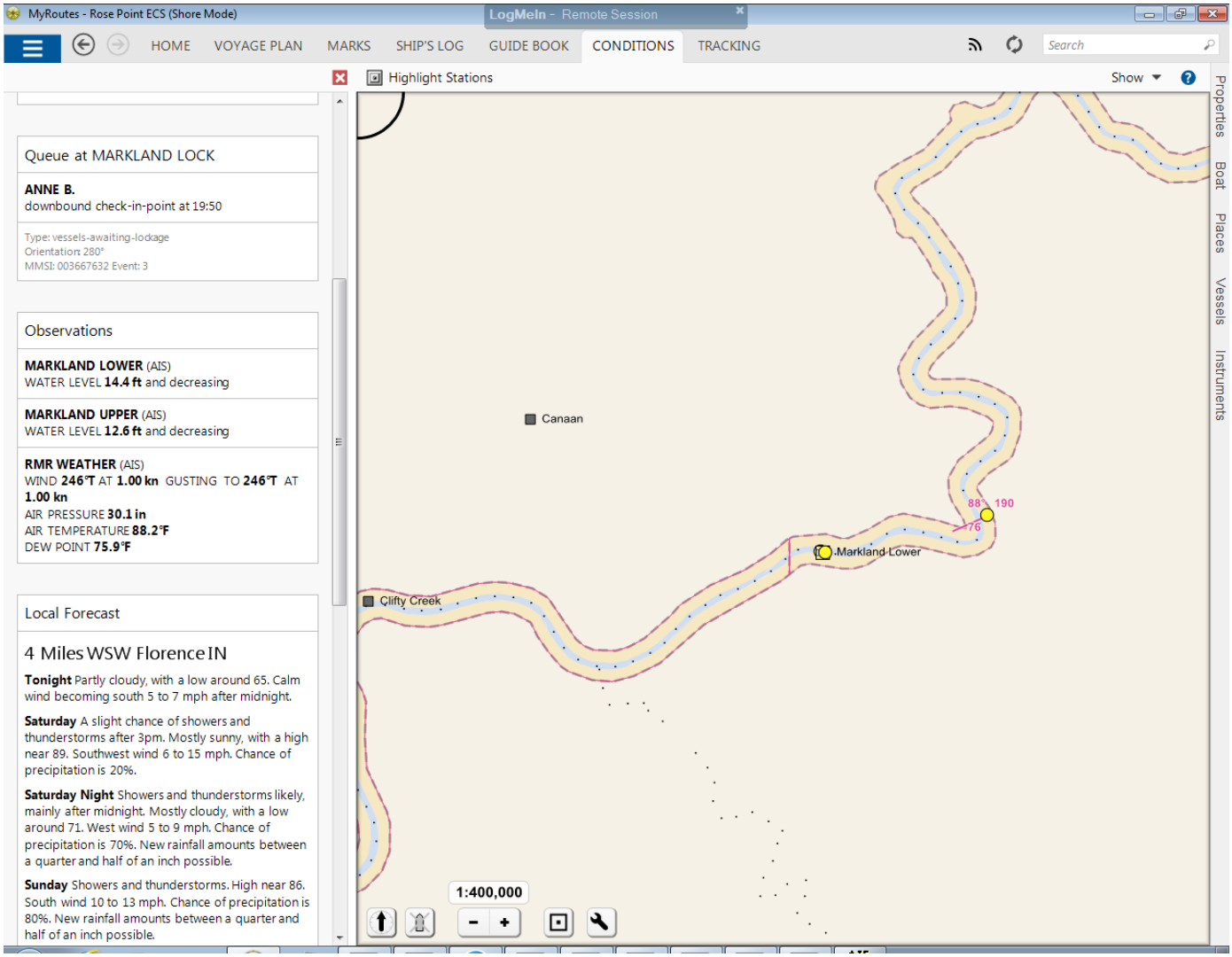

Figure 42. Rose Point display showing eMSI transmission (Side Text Display).

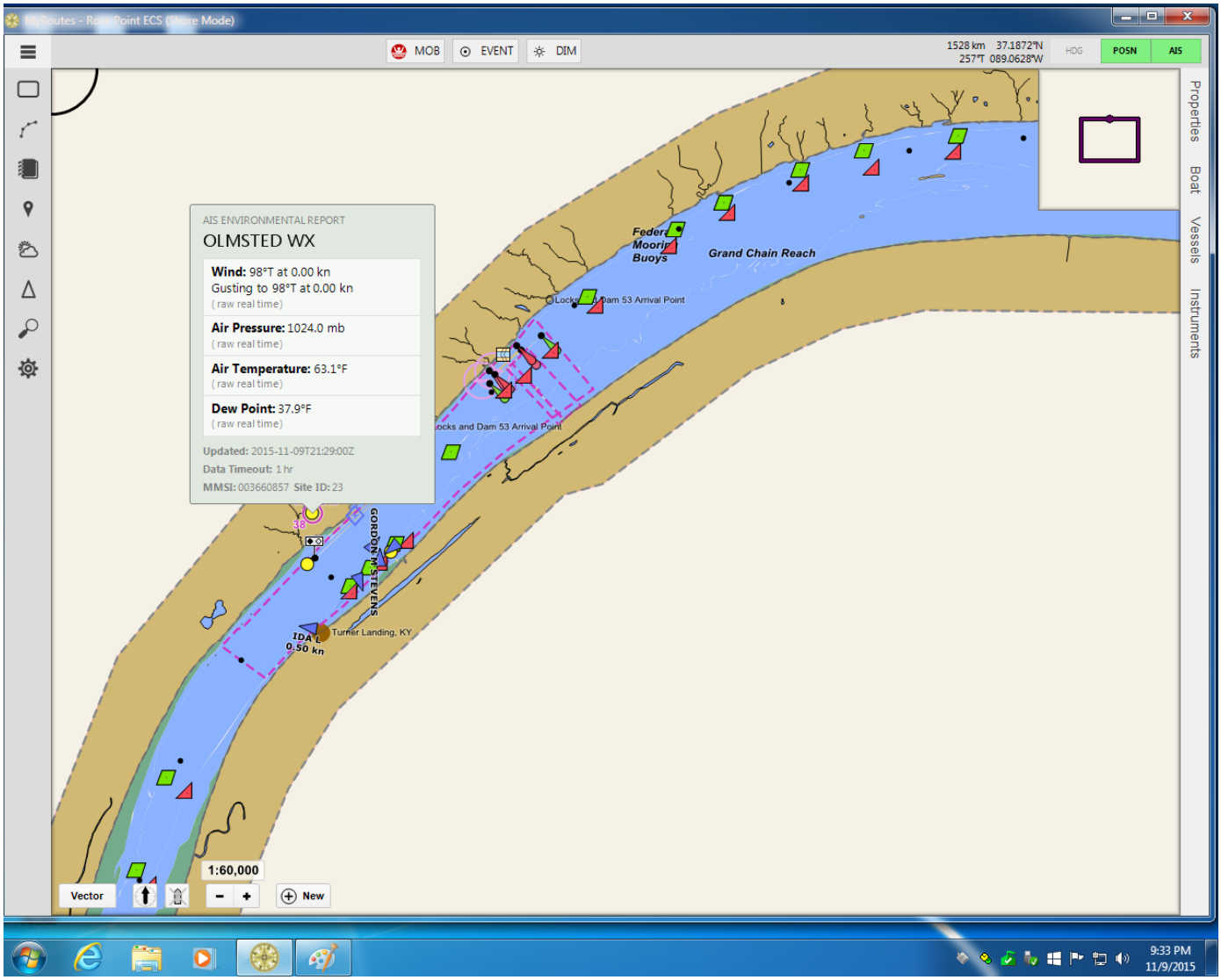

Figure 43. Rose Point display showing eMSI transmission (Olmsted Weather).

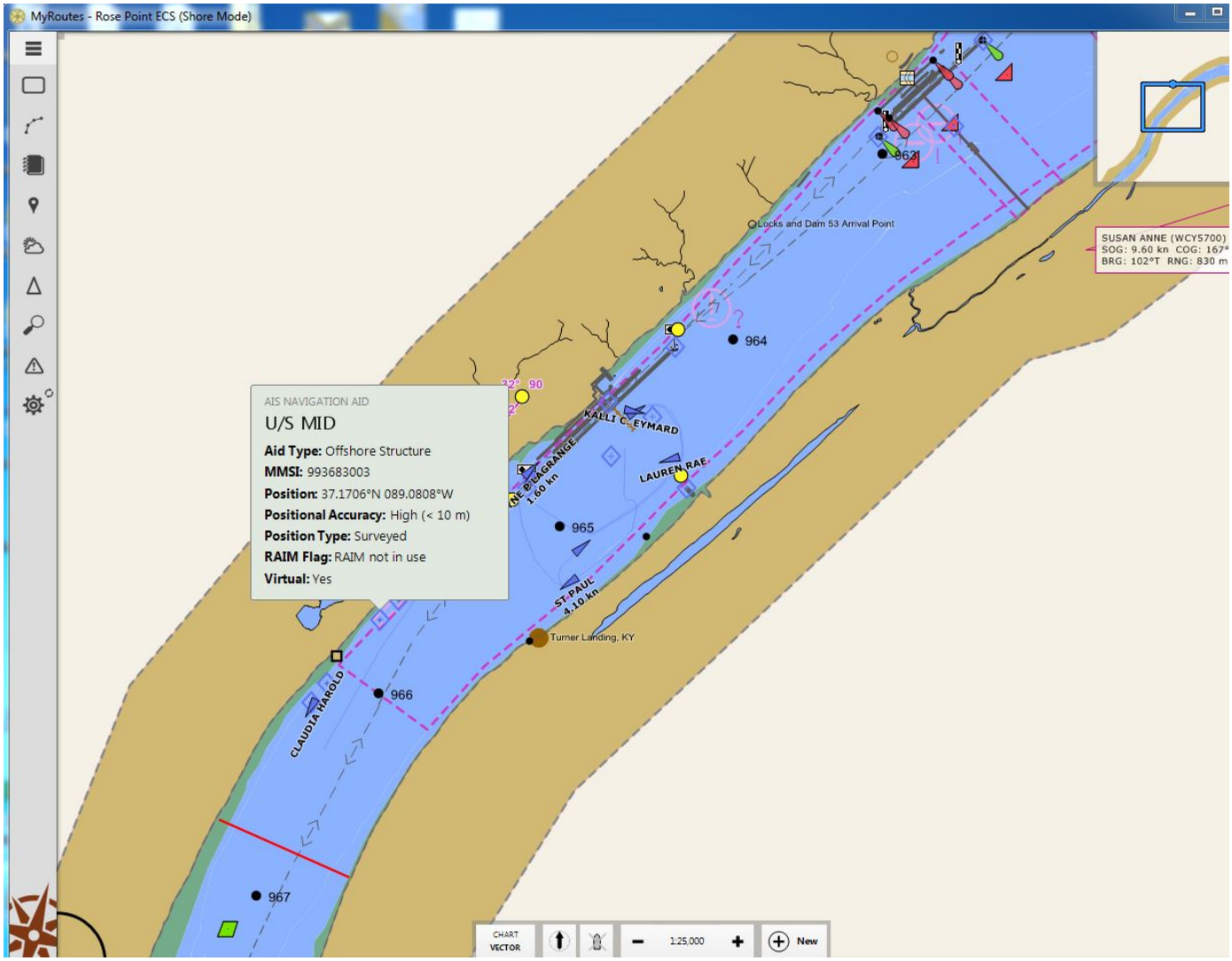

Figure 44. Rose Point display showing eMSI transmission (Virtual AtoN).

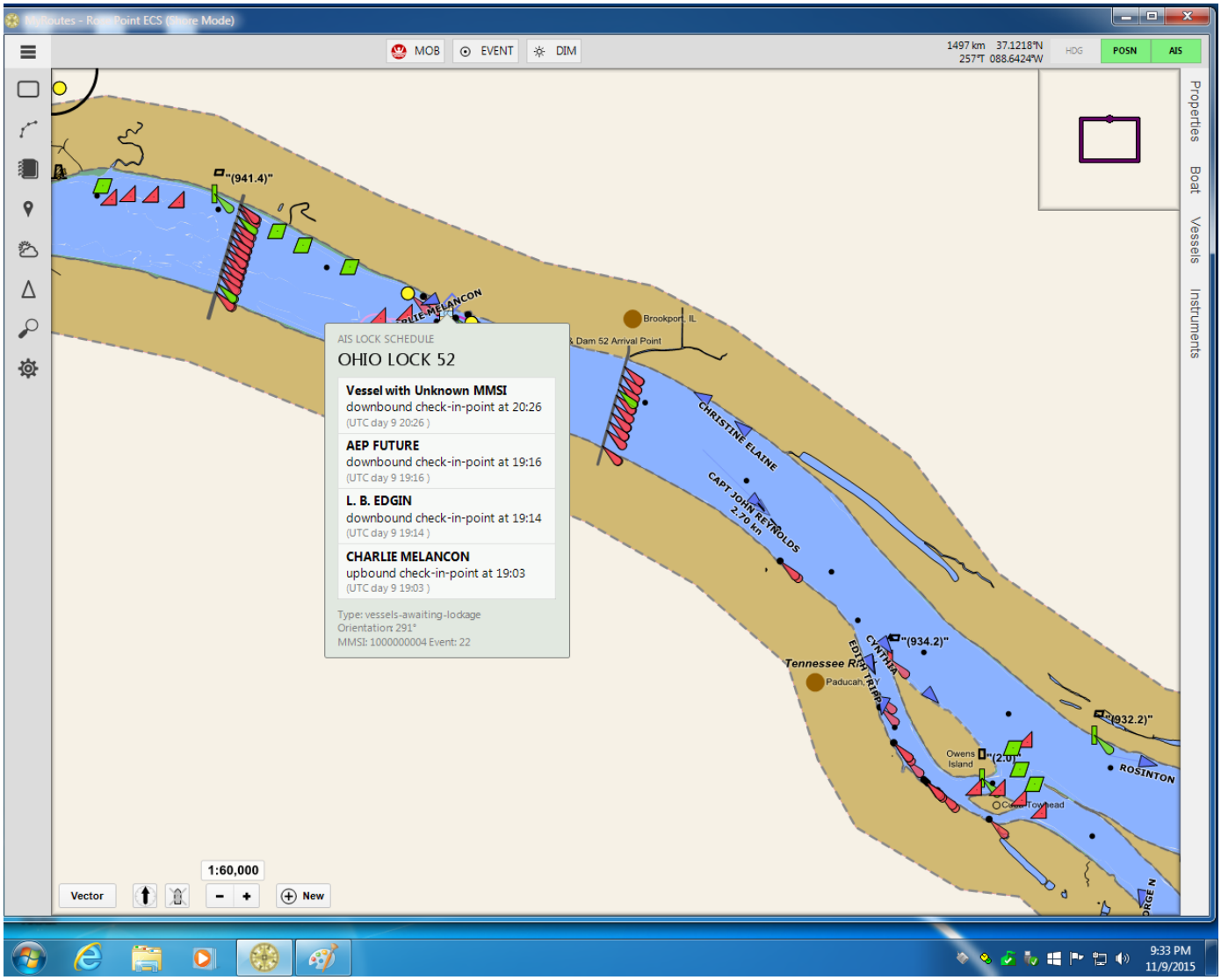

Figure 45. Rose Point display showing eMSI transmission (Vessel Lock Schedule).

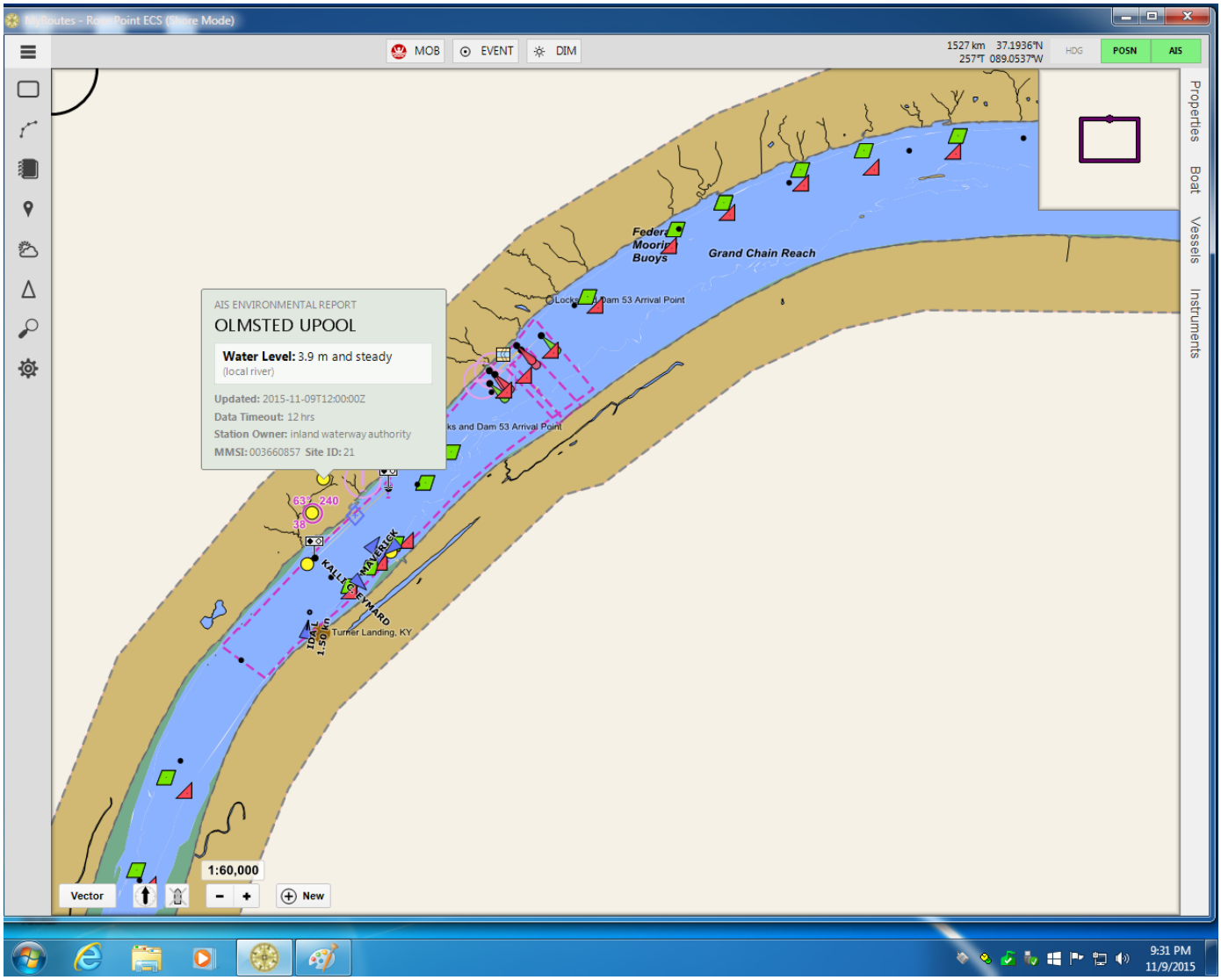

Figure 46. Rose Point display showing eMSI transmission (Pool Height).

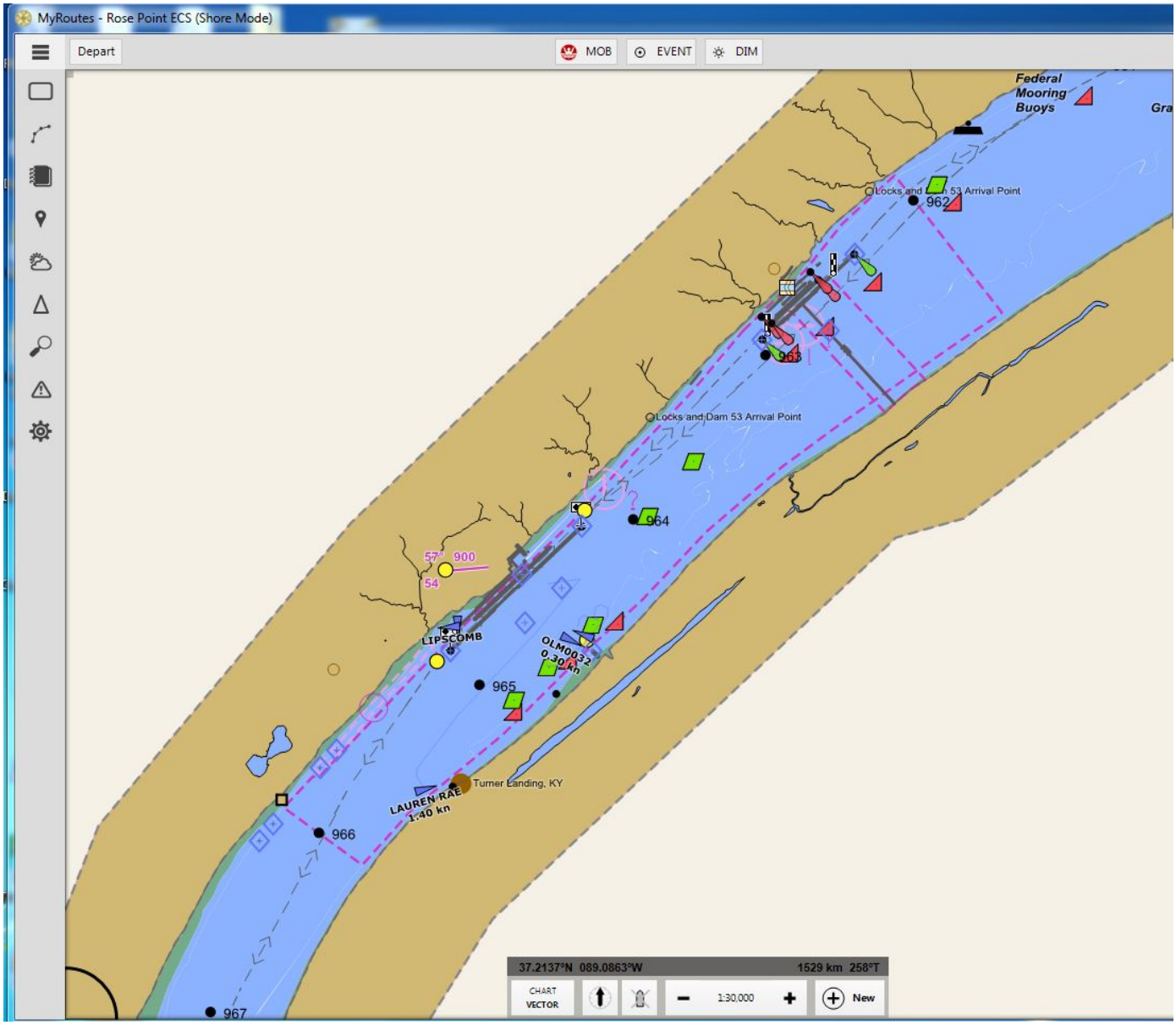

Figure 47. Rose Point display showing eMSI transmission (Virtual Aids).

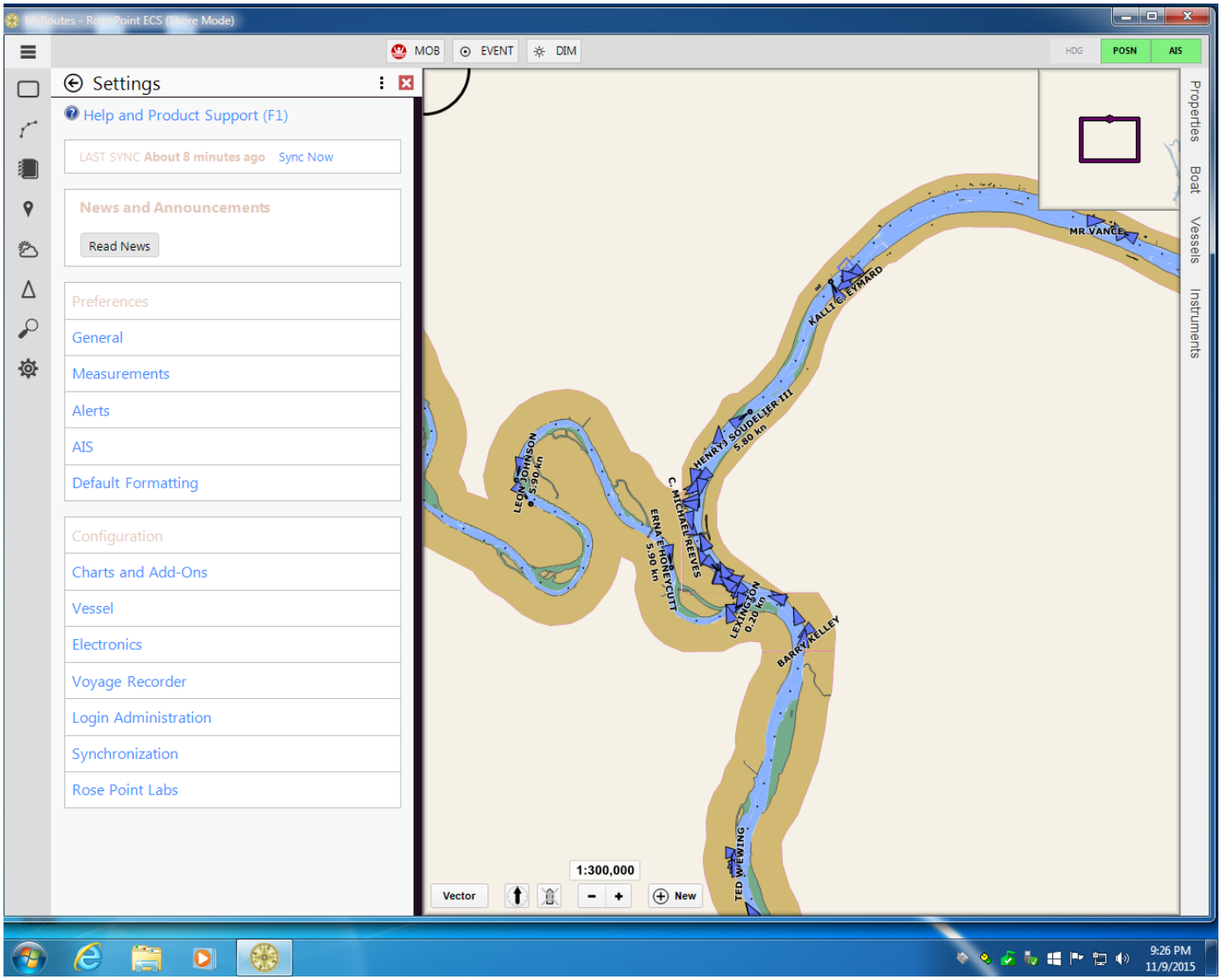

Figure 48. Rose Point display showing eMSI transmission (Vessel traffic).

4.2 AtoN Message Broadcast

USACE used the virtual AtoN tool to create and transmit AtoN messages within the construction area.

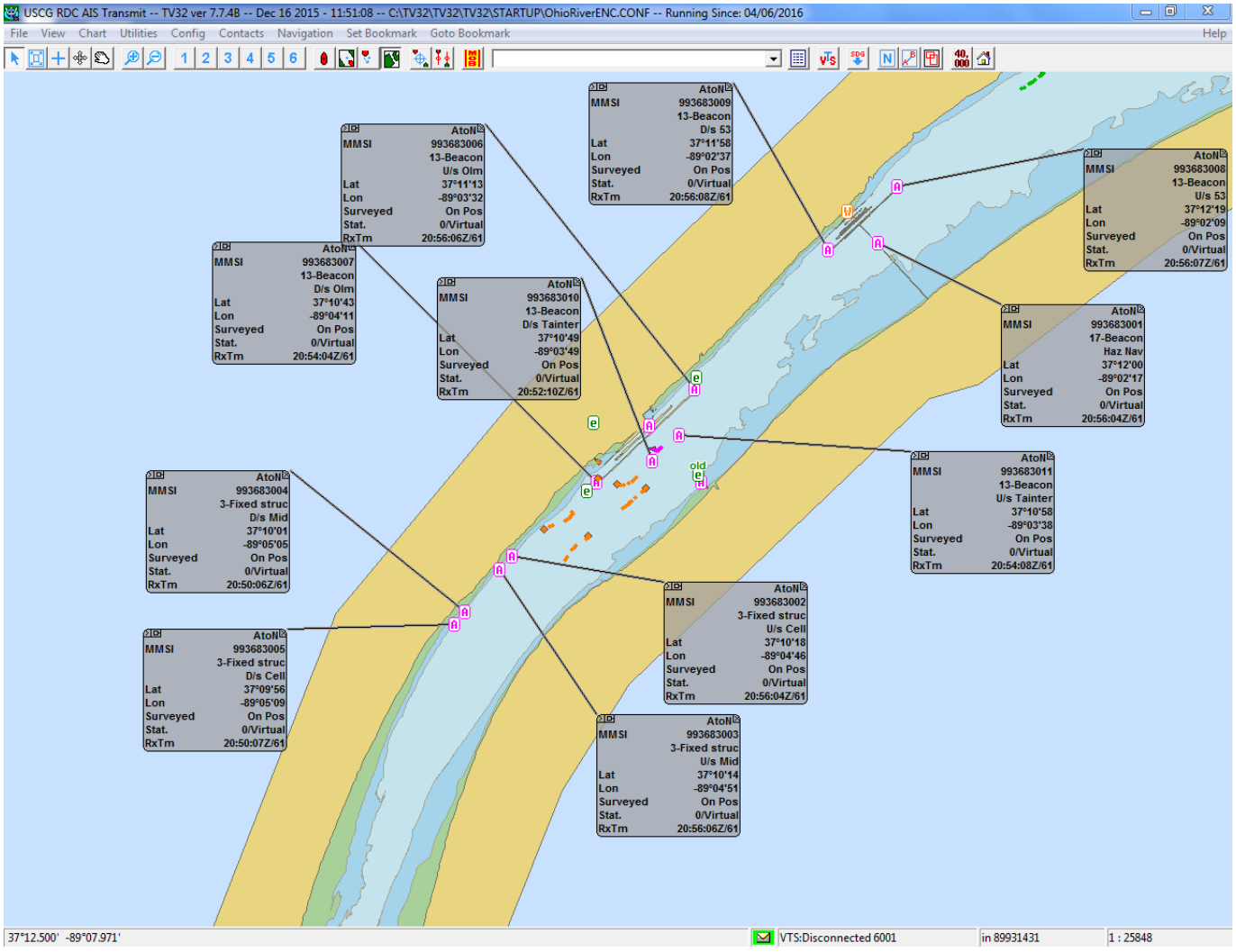

Figure 49. TV32 Display – Olmsted L&D construction area.

4.3 Geographic Notice Message Broadcast

Throughout the test duration, geographic notice messages were broadcast for several events. These ASMs were created from information contained in the BNM's.

Table 10. List of Geographic Notices transmitted from VTS Louisville.

Date	Event	Refrence
22-23 Apr 2016	Thunder Over Louisville	BNM 0127-16 OV
27 Aug 2016	Red Bull Flugtag	BNM 0364-16 OV
31 Aug 2016 – 15 May 2017	Olmsted Construction Area	
09-10 Sept 2016	Dragon Boat Festival	BNM 0398-16OV
09Sep – 01 Nov 2016	Anchorage Prohibited	Ohio River MM 936
30Sep-02Oct 2016	Owensboro Air Show	BNM 045-16OV
29 May 2017	Mayor Hike	BNM
23May2017	Bomb threat to River Queen	BNM

TV32 display showing transmission of Geographic Notice, upper and lower pool height, weather, and water ways information in Louisville.

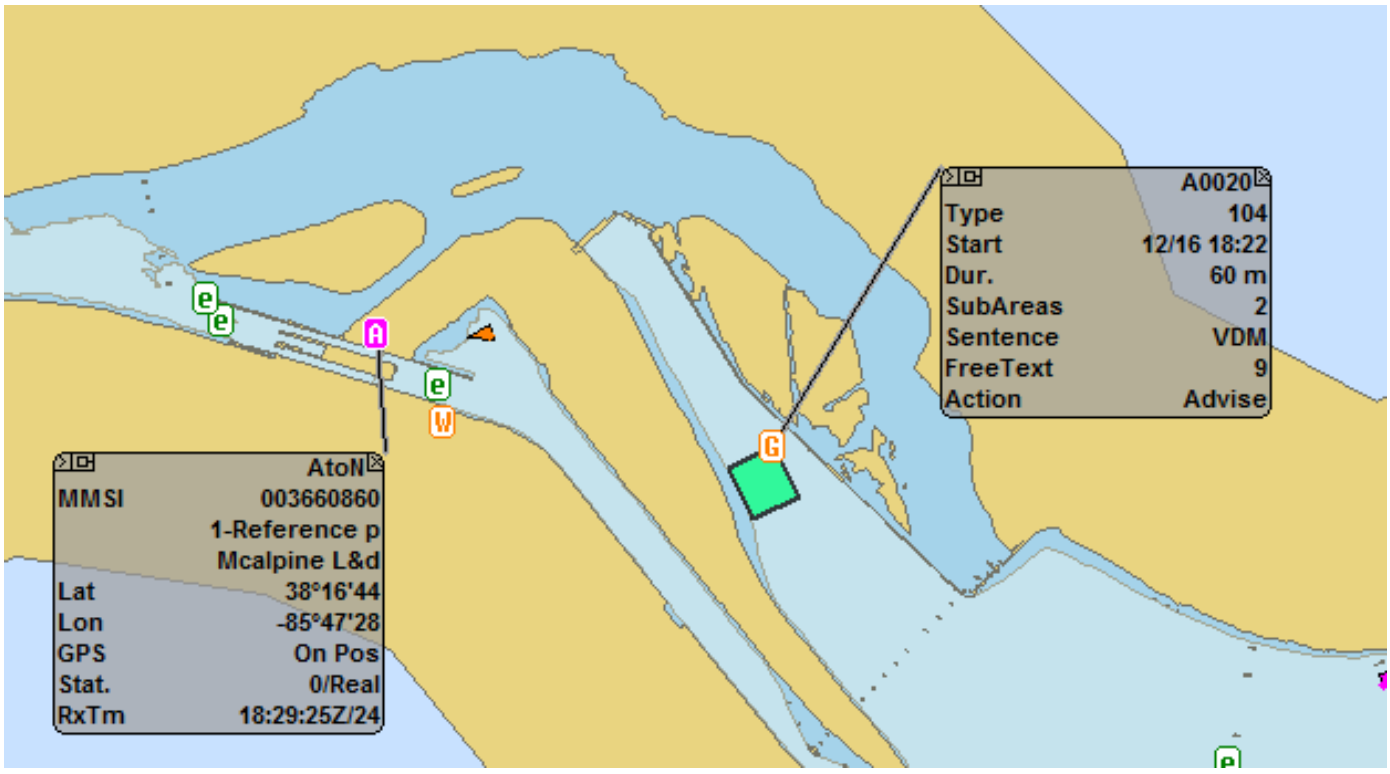

Figure 50. TV32 Display – Geographic Notice message broadcast in Louisville.

Rose Point display showing transmission of caution zone.

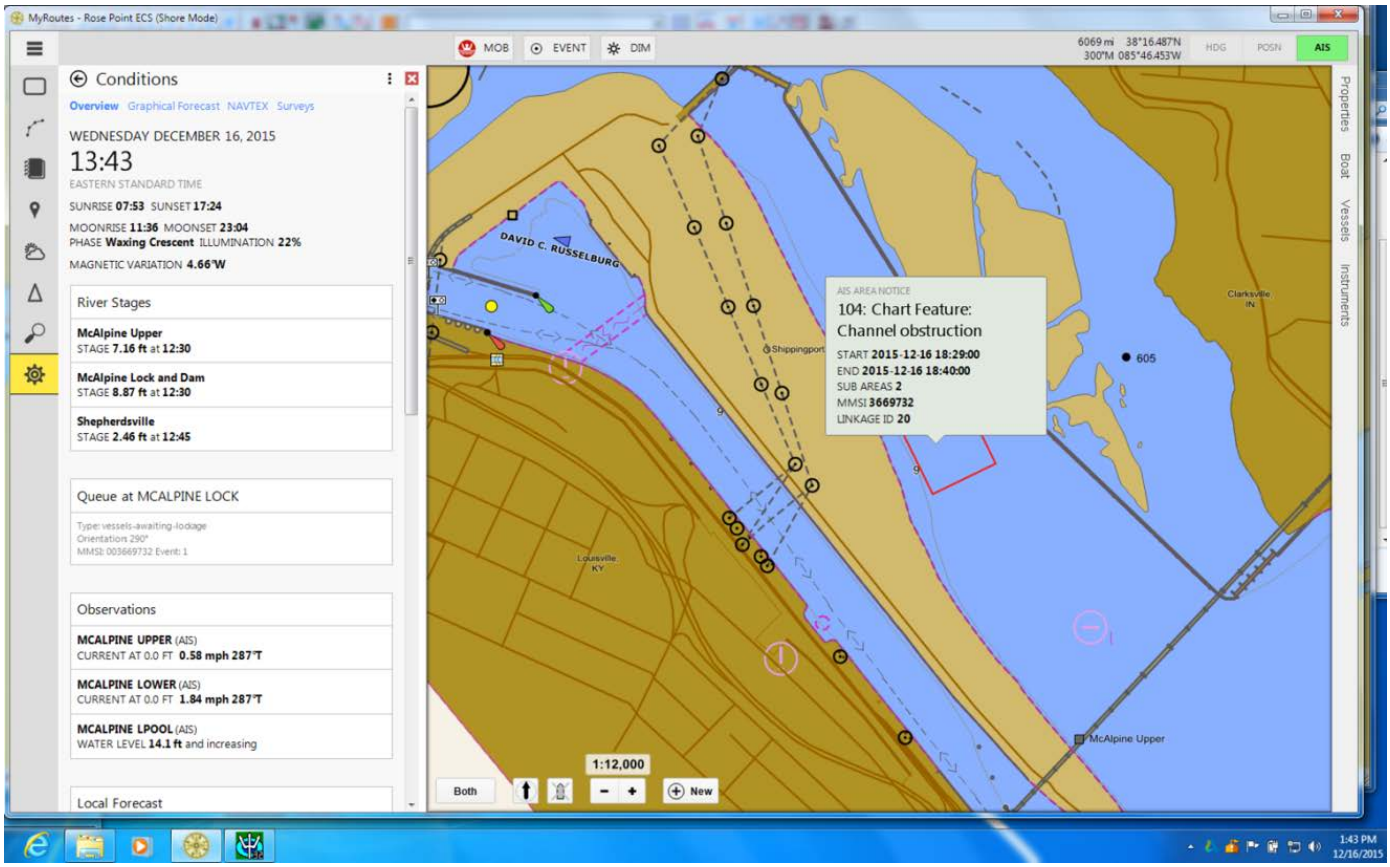

Figure 51. Rose Point display of caution zone.

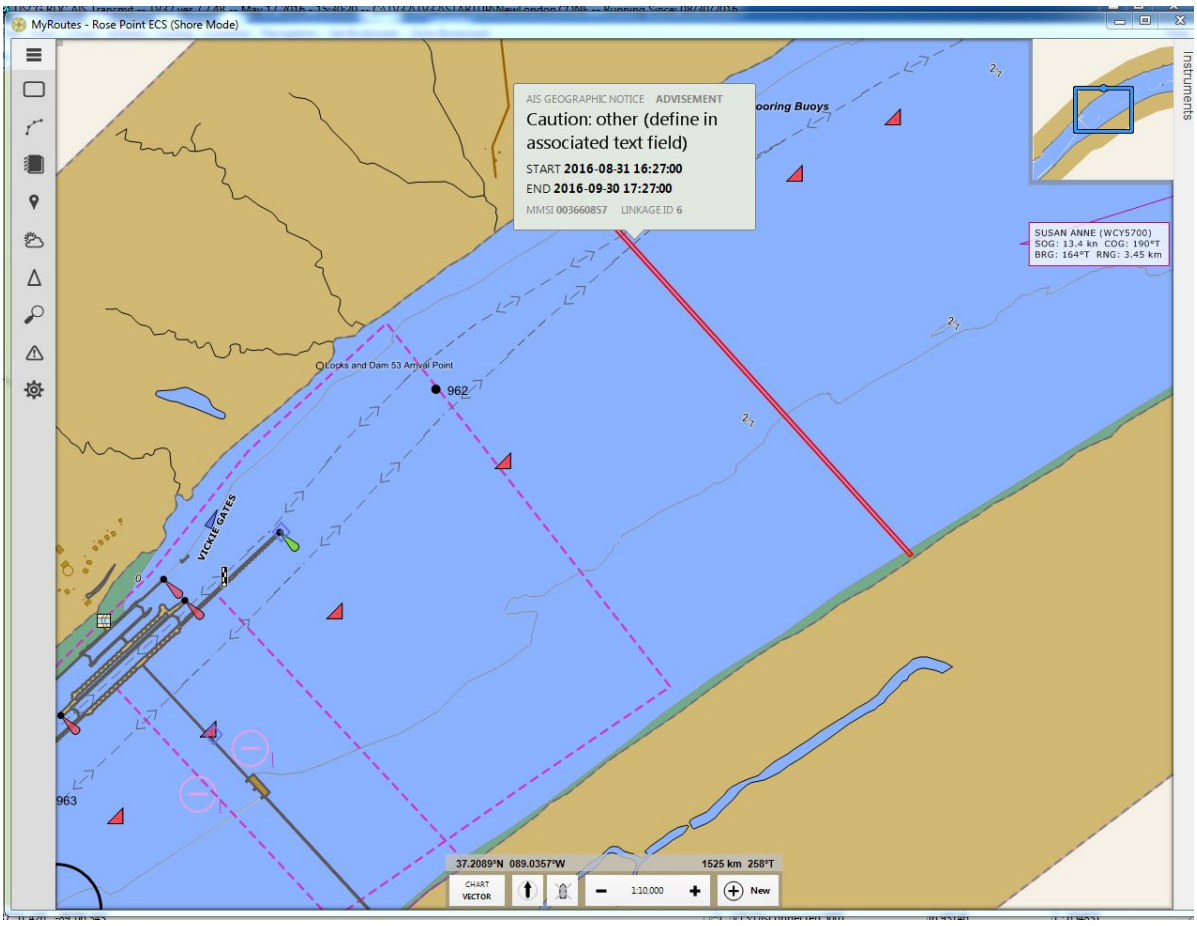

Figure 52. Rose Point Display – Transmission of caution zone.

4.4 FLUTAG Event

The USCG Captain of the Port Sector Ohio Valley established a no wake zone and a river closure on the Ohio River Sunday, September 4th, 2016. The no wake zone was on the Ohio River from mile 476 (beyond Riverside Park Boat Ramp) to mile 464 (Four Seasons Marina and Aquaramp Marinas) and on the Licking River from mile 0.0 to mile 3.0 and was enforced from Noon on Sunday to 3:00 a.m. on Monday, September 5th, 2016.

The zone and river closures were created and transmitted as Geographic Notice messages by CG-NAV-DETACHED personnel located at VTS Louisville.

TV32 displays showing creation of Geographic Notice message.

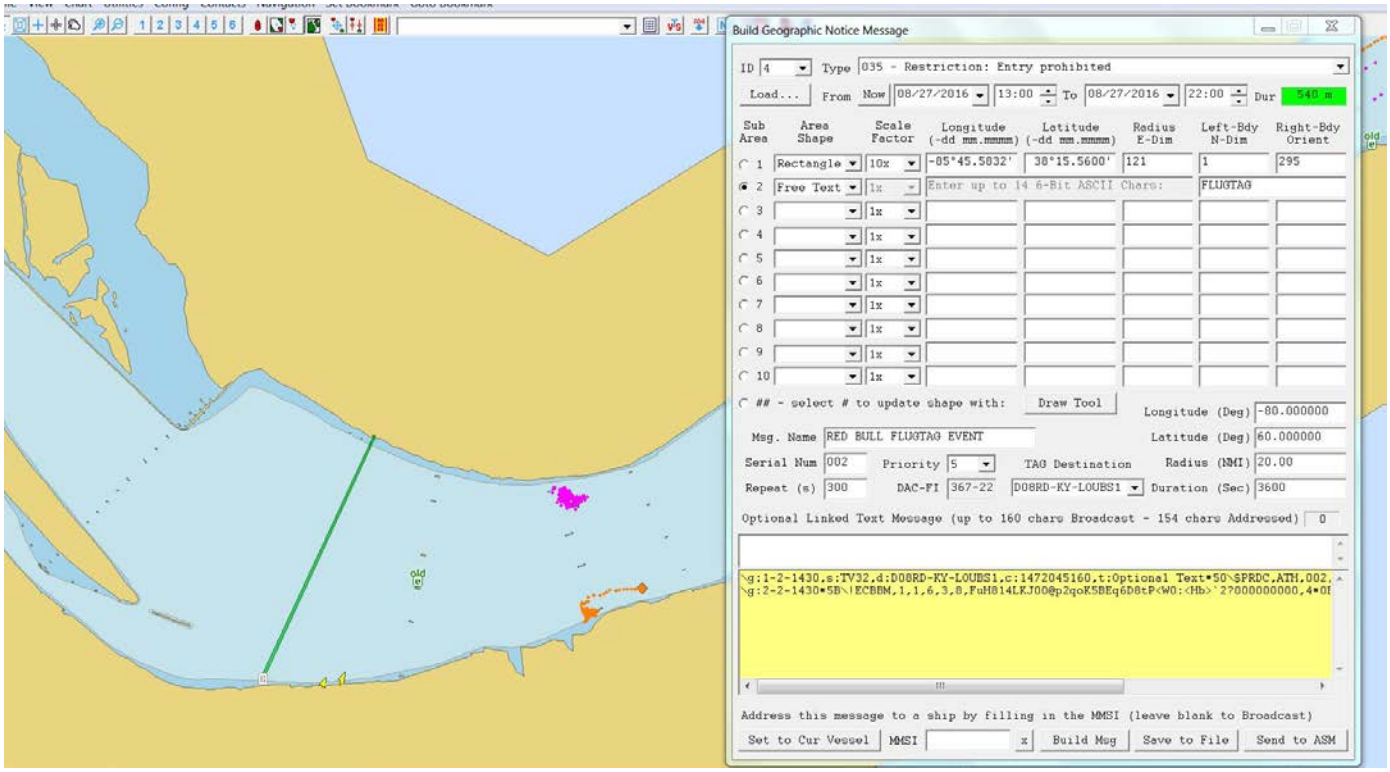

Figure 53. TV32 Display – Geographic Notice message creation.

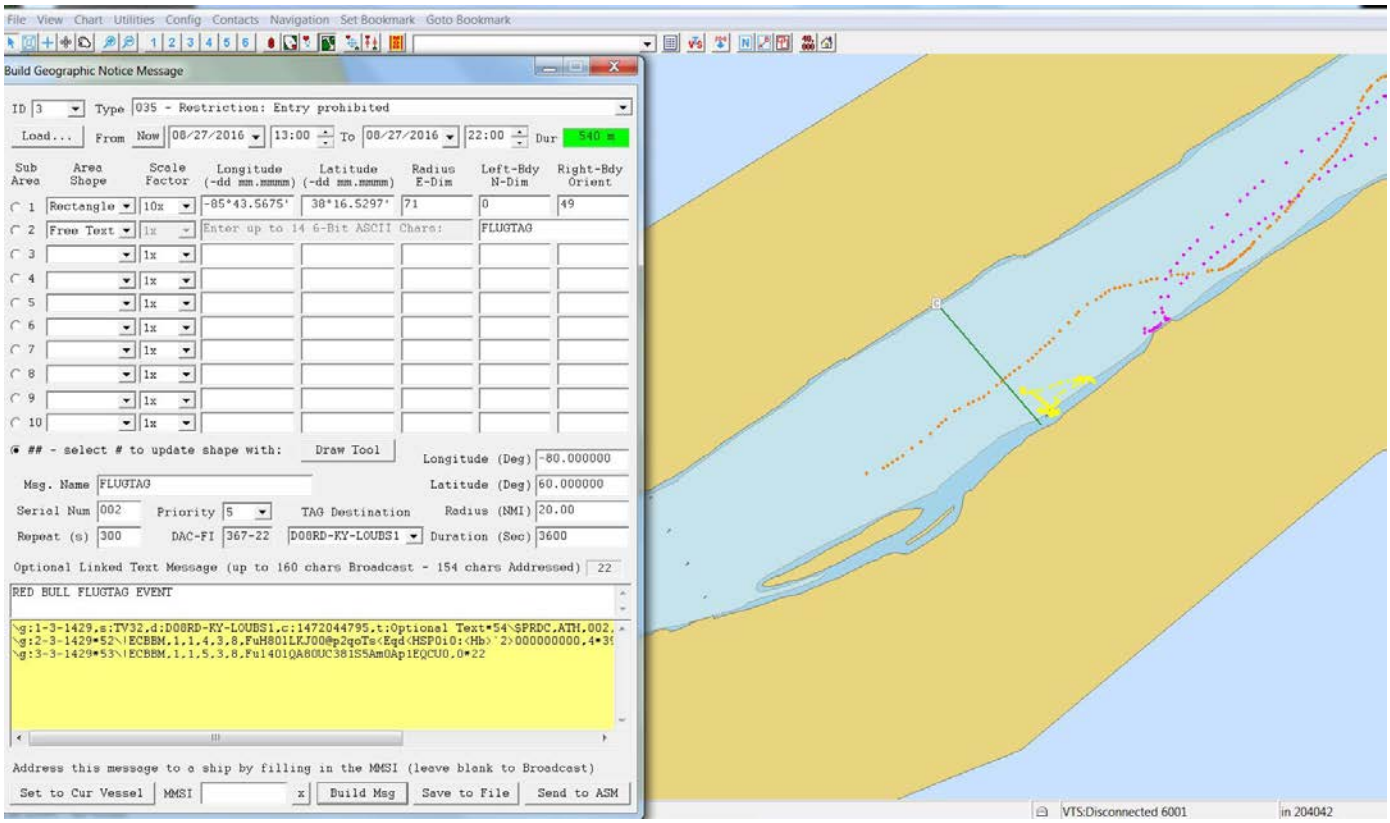

Figure 54. TV32 Display – Geographic Notice message creation.

TV32 display showing actual zone and closure boundaries.

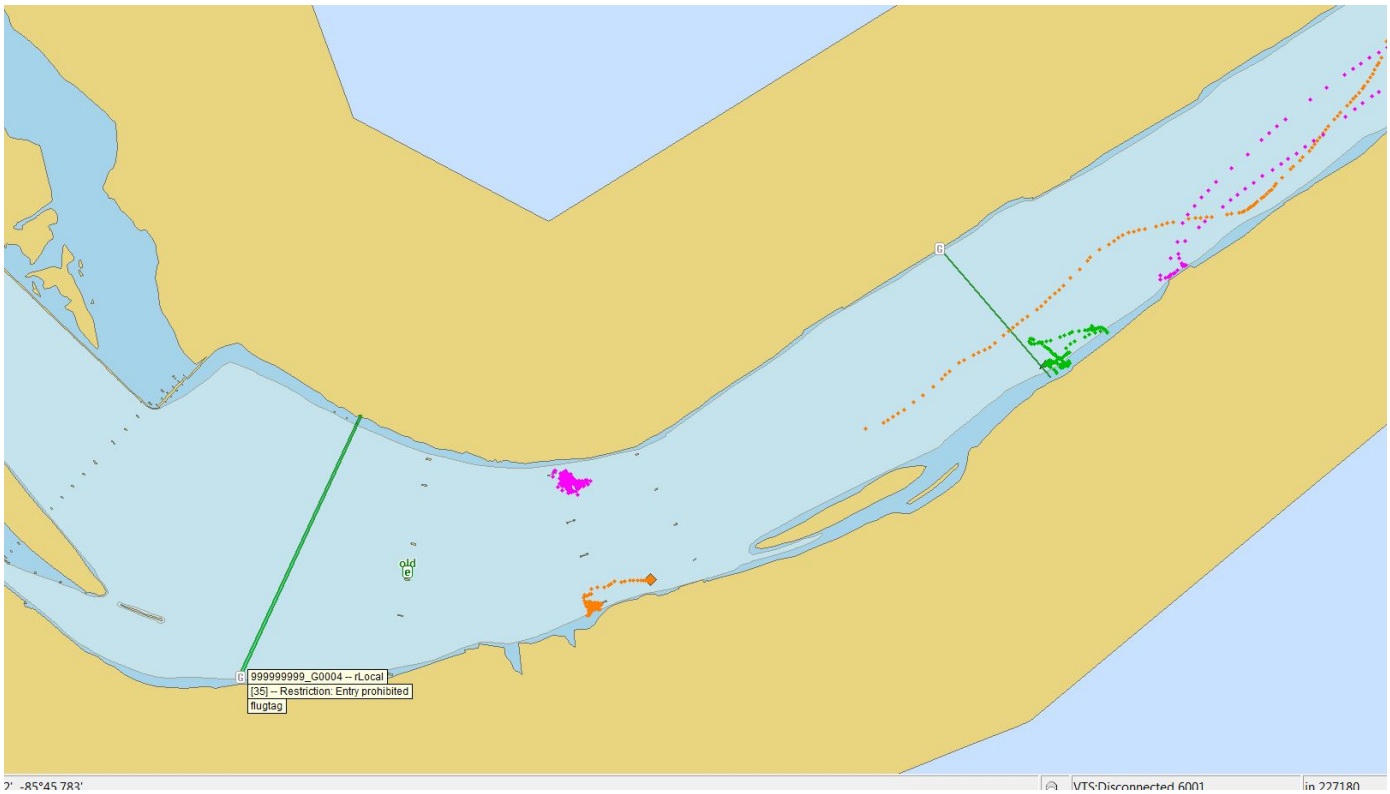

Figure 55. TV32 Display – Geographic Notice zone closure.

4.5 Testing of Self-Contained AtoN Transmitter

RDC configured, tested and installed a self-contained AtoN transmitter to broadcast two virtual aid lights, Craig Bar Lower LT (MM542.3) and Vevay Bar LT (MM538.4). Due to monitoring limitations it was relocated and tested. The unit, however, was eventually uninstalled due to poor transmission coverage.

TV32 display showing transmission of two virtual aids.

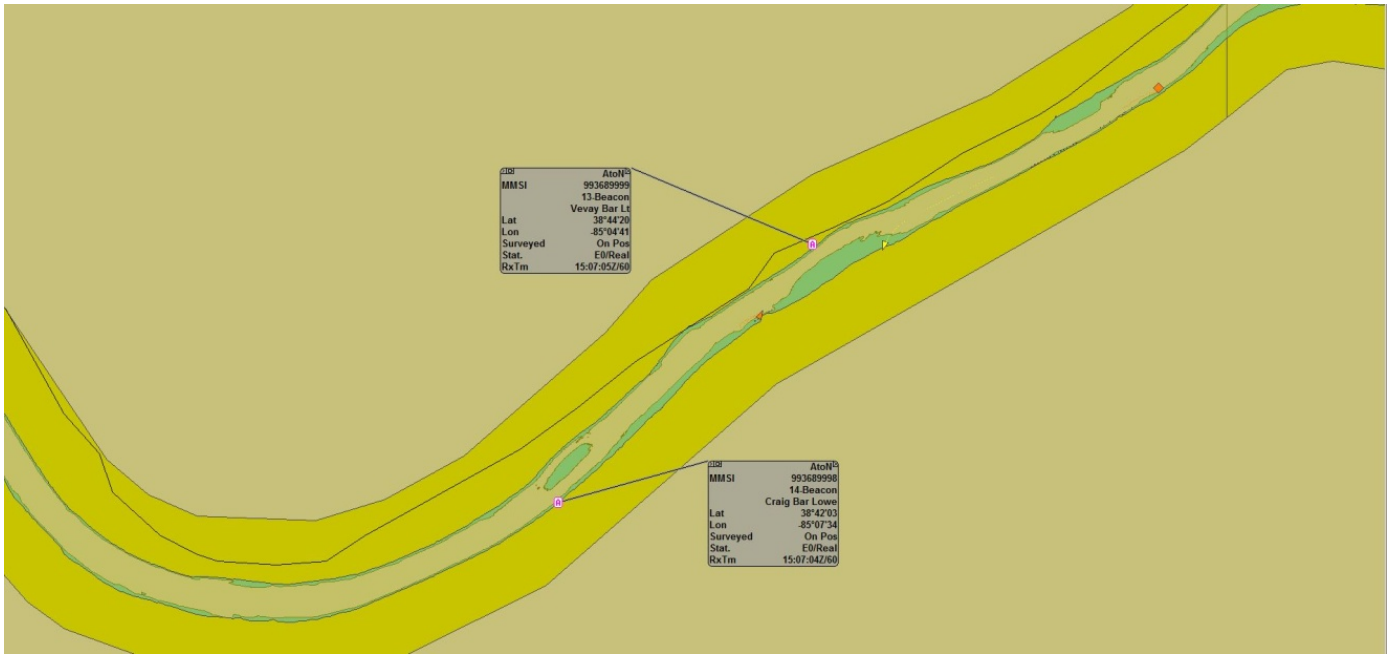

Figure 56. TV32 Display – Transmission of Craig Bar Lower LT and Vevay Bar LT.

4.6 Security Zone for Bomb threat on The River Queen

On May 23, 2017 a security zone was created around The River Queen riverboat based on information of an onboard bomb threat. The message was created and displayed within 5 minutes of hearing about the threat, prior to the BNM going out. The message was broadcasted for approximately 20 minutes before the vessel was cleared by local Law Enforcement. Geographic Notice extended from mile marker 469.5 to 470.5 and was located near the I-74 Bridge in Cincinnati.

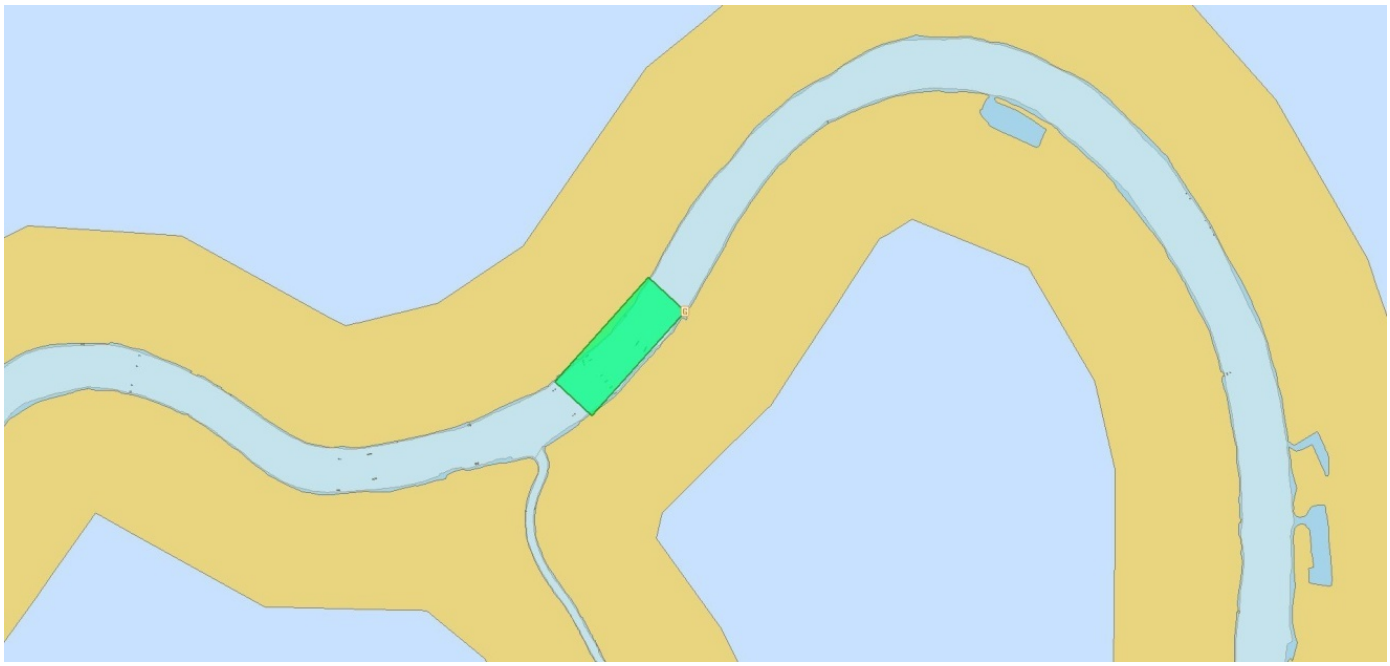

Figure 57. Security zone on The River Queen.

4.7 RNC / DNC Event

Supporting the Office of Navigation Safety's (CG-NAV) desire to broadcast notice to mariner security zones during the conventions virtually, the RDC created a portable deployable "digital lightship" go-kit enabling transmission of security zones via VHF-AIS frequencies. The go-kit consisted of AIS transmitter, computer with software to generate the AIS application specific messages and manage message delivery. The transmissions were created to mirror the geographic descriptions provided in the Coast Guard Notice to Mariners. Sector Buffalo and Sector Delaware Bay Captains' of the Port placed various restrictions on port access in specific zones during the week long events. Transmission of the active zones via AIS enabled mariners to see a depiction of the active zone on their navigational display systems. The transmissions also included text that referenced the appropriate Notice to Mariners. During the RNC, CG-NAV deployed the go-kit on board Coast Guard Cutter (CGC) MURRO BAY and broadcast several messages throughout the convention week including both restricted zones and first amendment protest zones. At the DNC, the go-kit was installed on a Coast Guard Auxiliary boat with a cell modem allowing for remote access to the kit. Ability to remotely access and operate the go-kit during the week was successfully demonstrated.

TV32 display showing DNC security zone transmissions.

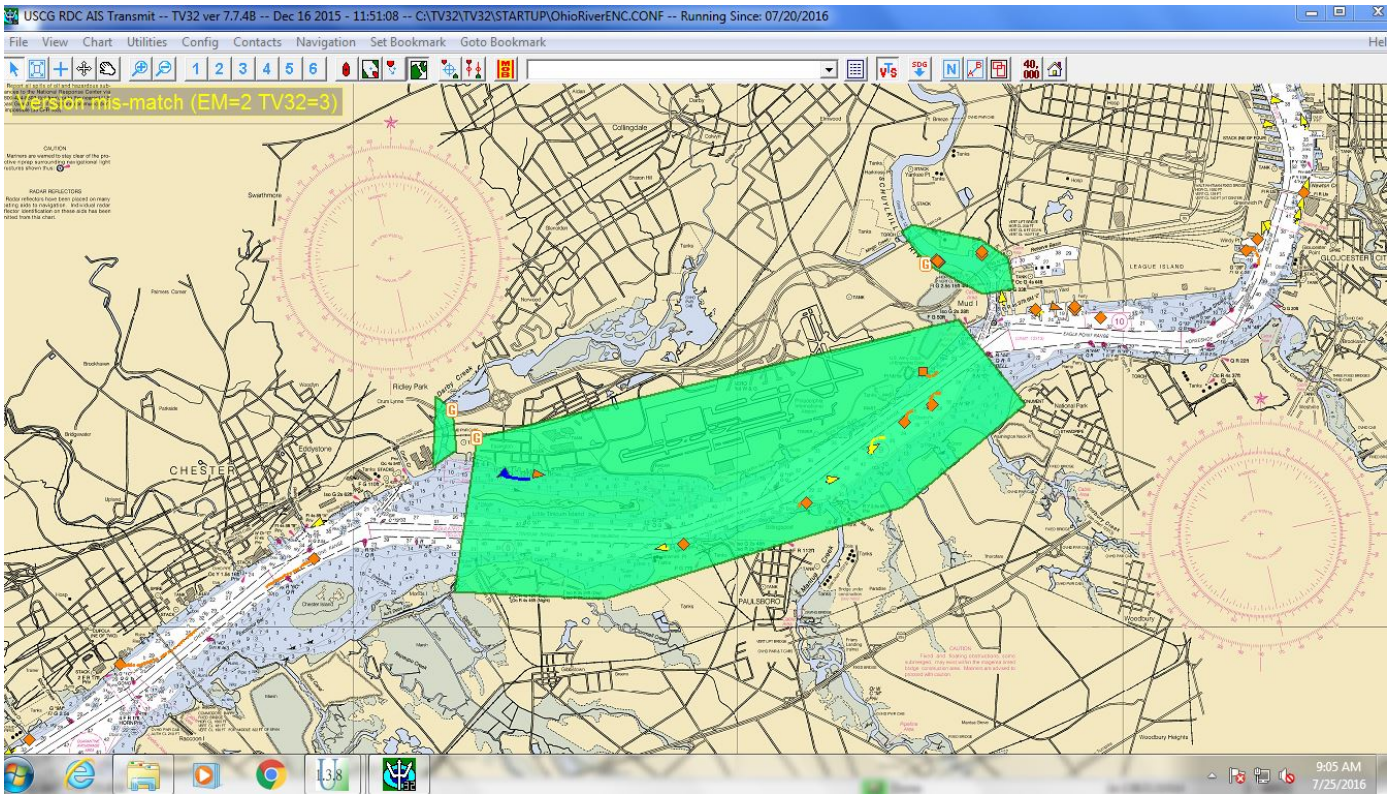

Figure 58. TV32 Display – DNC security zone transmissions.

The USCG established temporary security zones for navigable waters in Lake Erie, and the Cuyahoga River during the July 2016 RNC. Four different security zones were created and broadcast at different periods in accordance with the broadcast notice to mariners. Two other safety zones located northwest of the Rock and Roll Hall of Fame and Museum and on the Western side of the entrance to the Cuyahoga River were established to allow individuals expressing their views the means to do so in a safe manner to their intended audience.

Figure 59. Google Map Display – RNC security zone.

TV32 display showing zones broadcast on Monday morning.

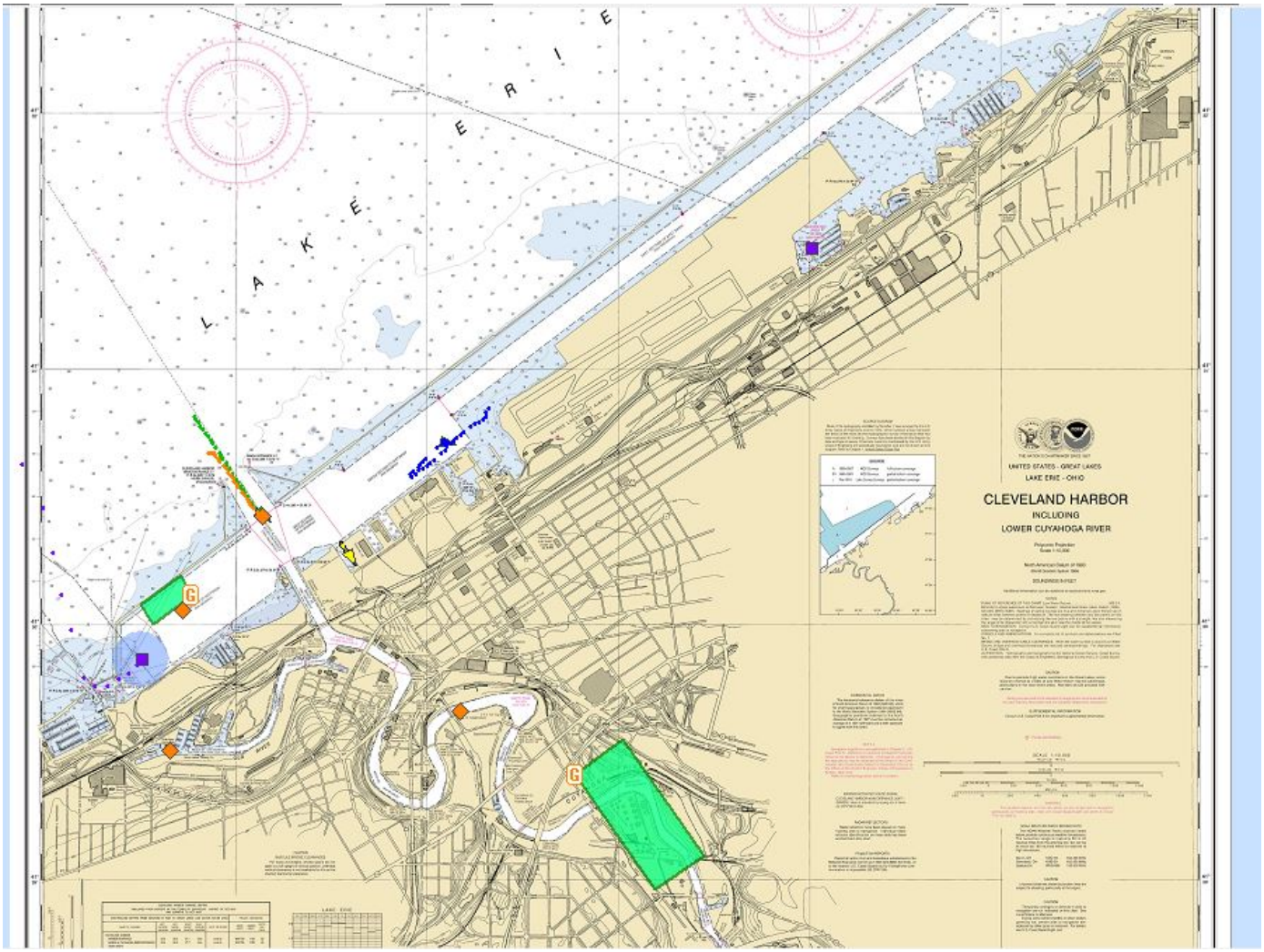

Figure 60. TV32 Display – Monday RNC security zone broadcast.

TV32 display showing zones broadcast on Tuesday morning.

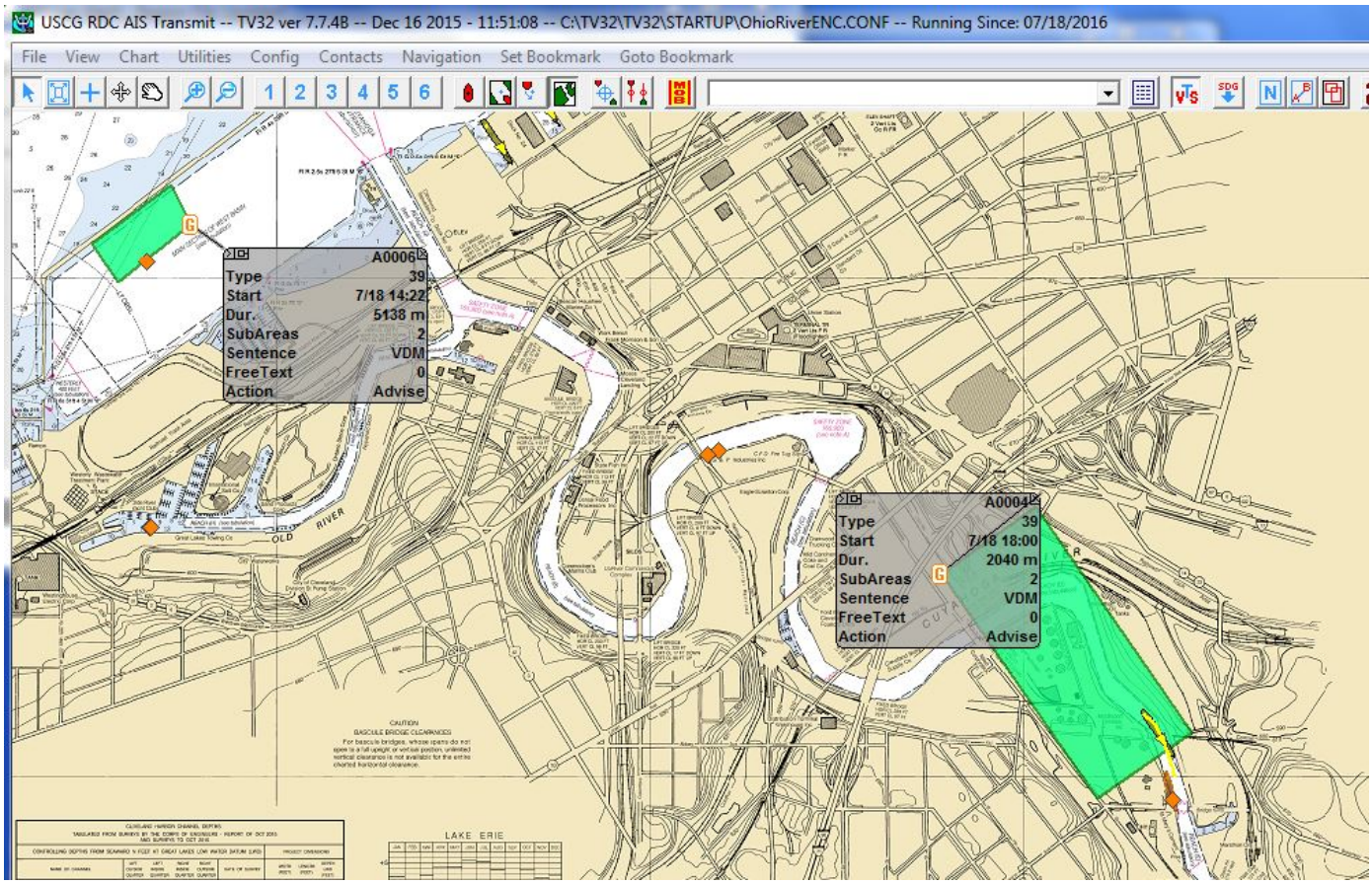

Figure 61. TV32 Display – Tuesday RNC security zone broadcast.

TV32 display showing zones broadcast on Wednesday morning.

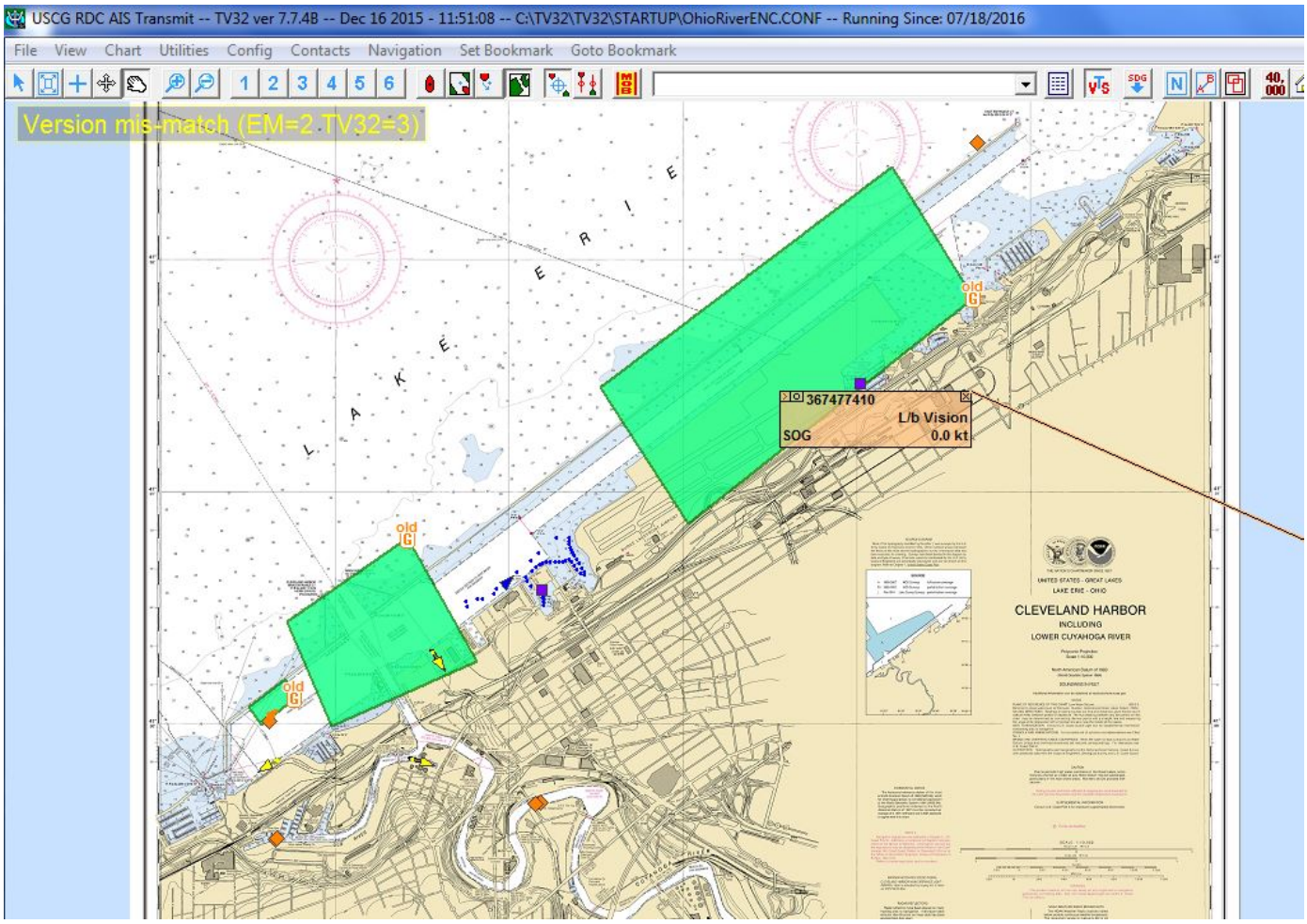

Figure 62. TV32 Display – Wednesday RNC security zone broadcast.

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APPENDIX A. OHIO RIVER COVERAGE PLOTS

Process used to create coverage plots.

- Predicted Coverage:
  - Received Signal Strength (RSS) Calculated using STK.
    - DTED 1 terrain.
    - Transmit antenna: omni-directional, 12.5W minus 1 dB for cables/connectors, typically 10m antenna height.
    - Receiver antenna: omni-directional, 10m above surface.
    - Calculated for inside river boundaries only.
  - Plotted onto Google map in MatLab.

- Tracks:
  - Collected from data loggers on various tugs.
  - For each message 21 and 8 that is received the vessel position is saved, stored by transmitter.
  - Vessel positions are plotted as overlay onto predicted coverage.
    - Blue dots are positions of message 21s received.
    - Black dots are positions of message 8s received.
    - Difficult to see blue dots on most plots as there are more message 8s than 21s.

Meldahl

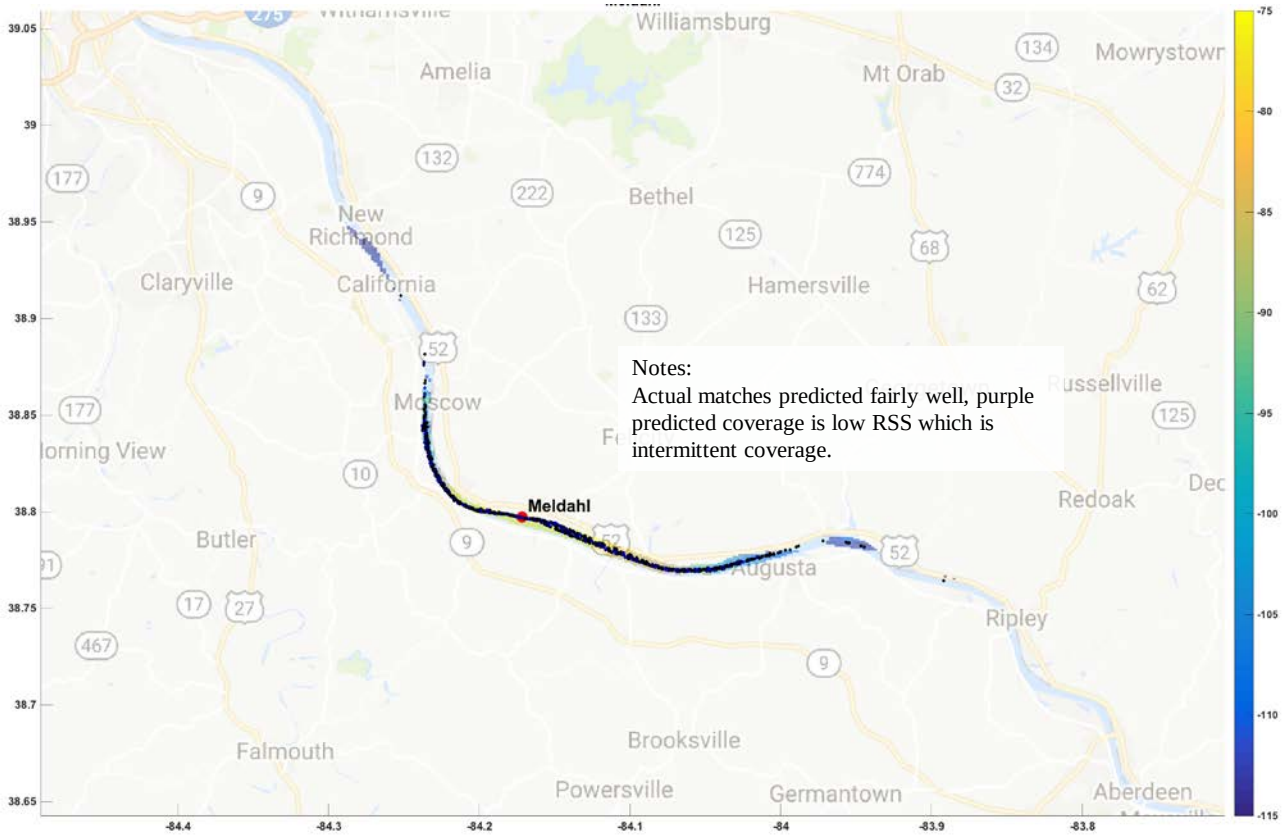

Figure A-1. Meldahl coverage plot.

Markland

Figure A-2. Markland coverage plot.

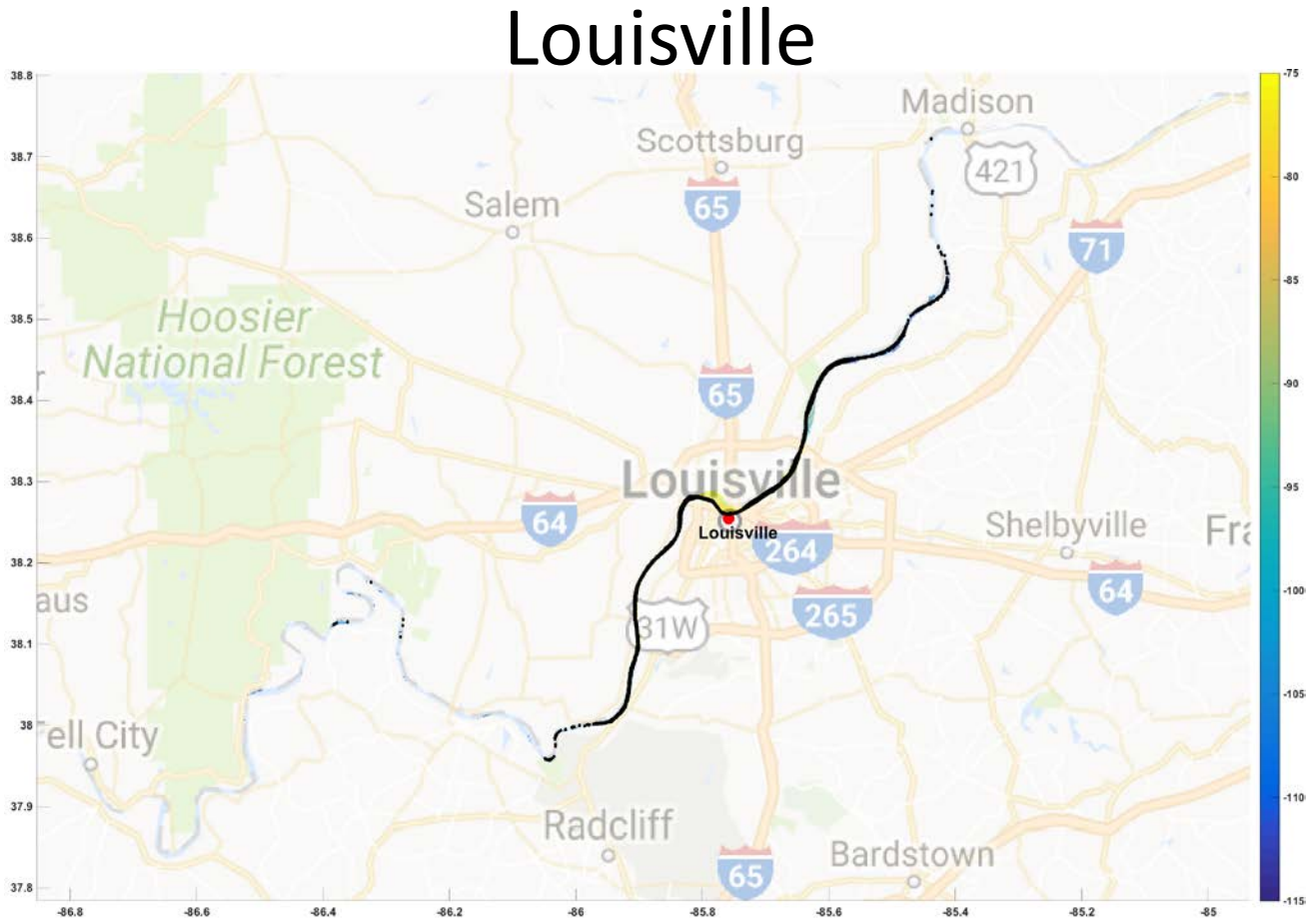

Figure A-3. Louisville coverage plot.

Louisville – upriver end of coverage

Figure A-4. Louisville upriver coverage plot.

Louisville – downriver end of coverage

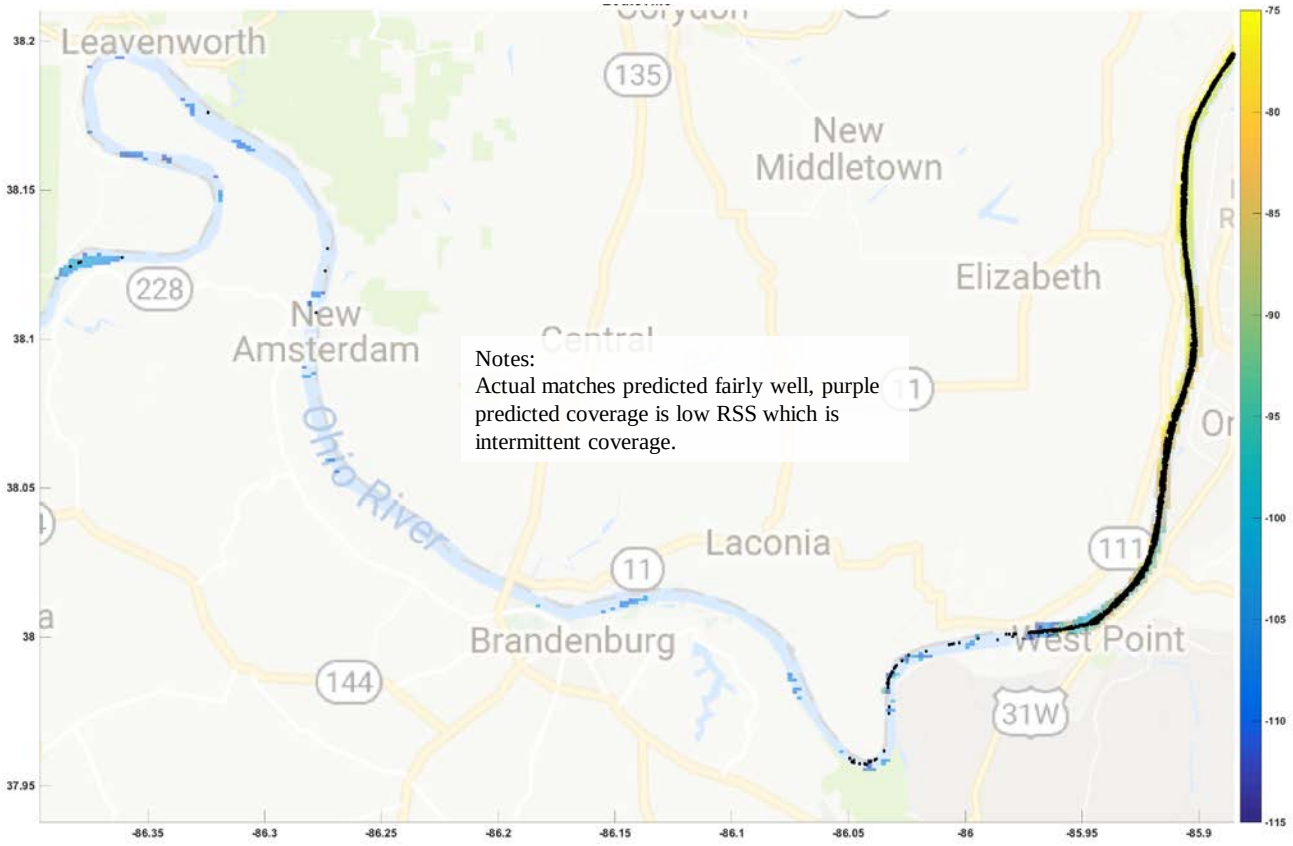

Figure A-5. Louisville downriver coverage plot.

McAlpine

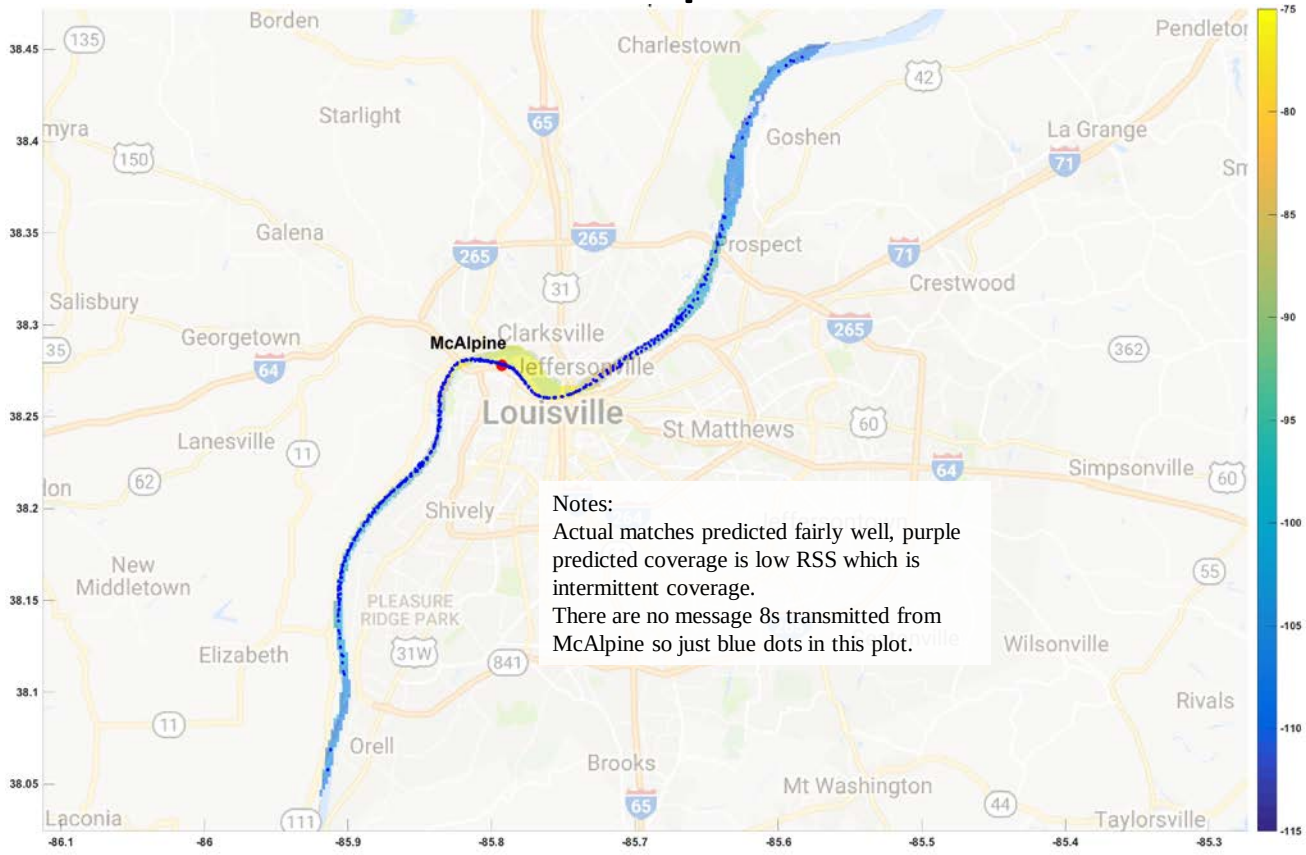

Figure A-6. McAlpine coverage plot.

Battletown

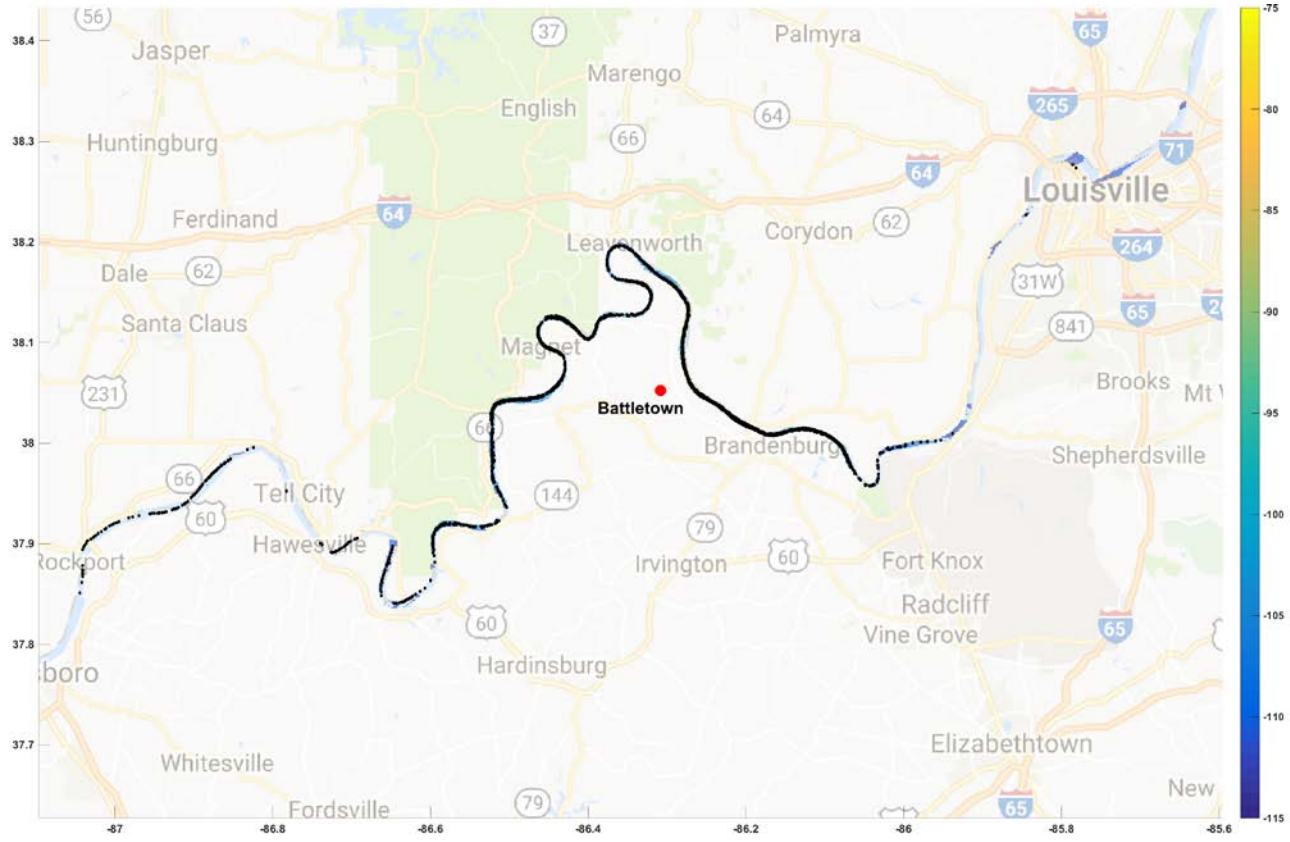

Figure A-7. Battletown coverage plot.

Battletown – upriver end of coverage

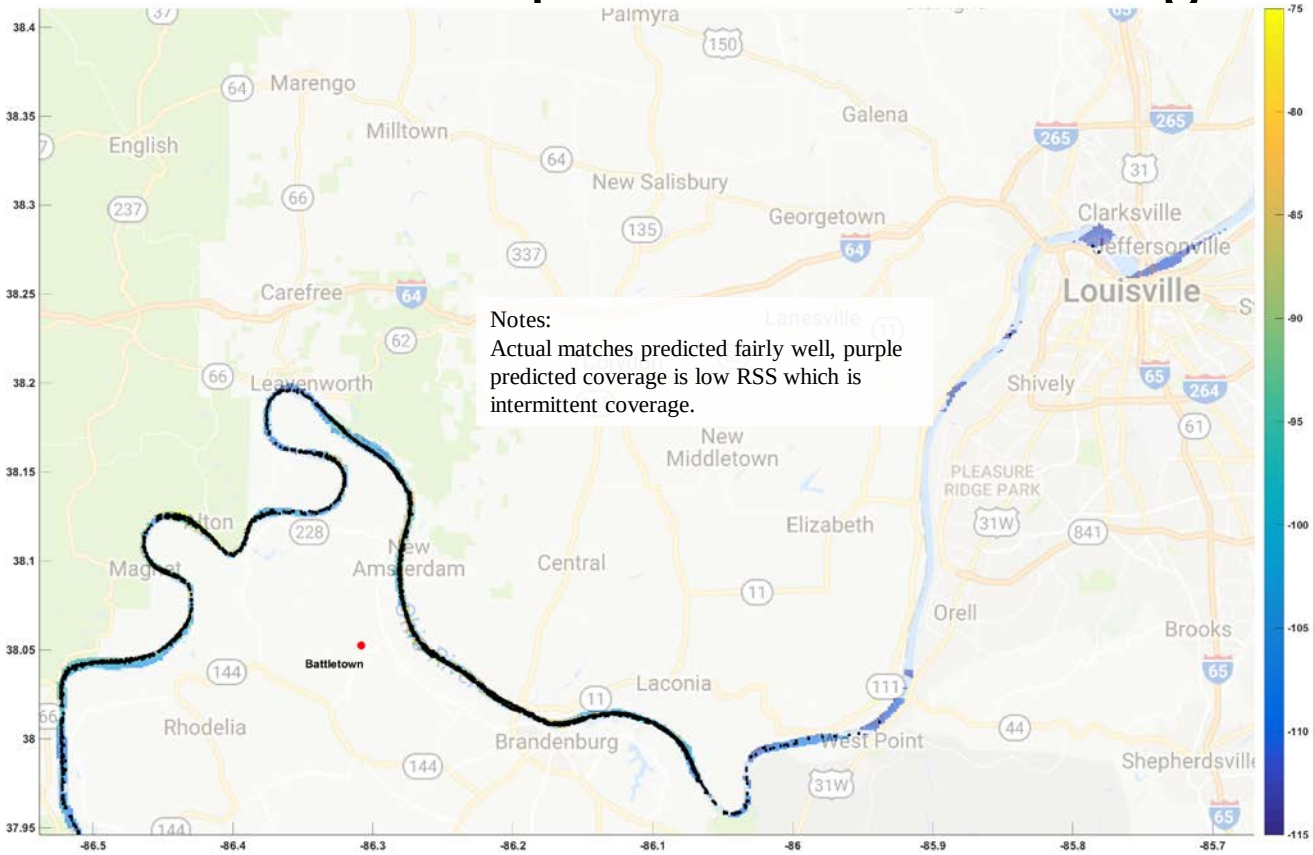

Figure A-8. Battletown upriver coverage plot.

Battletown – downriver end of

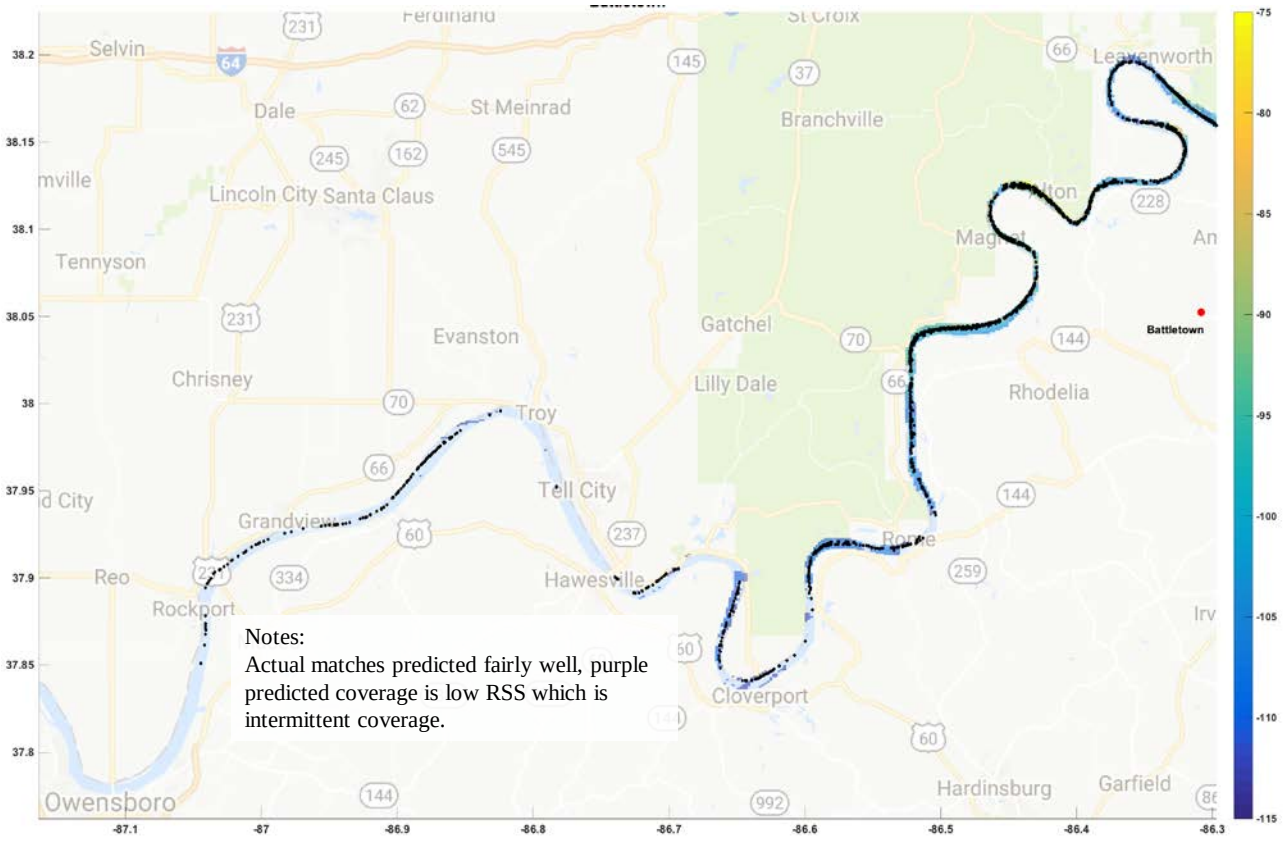

Figure A-9. Battletown downriver coverage plot.

Cannelton

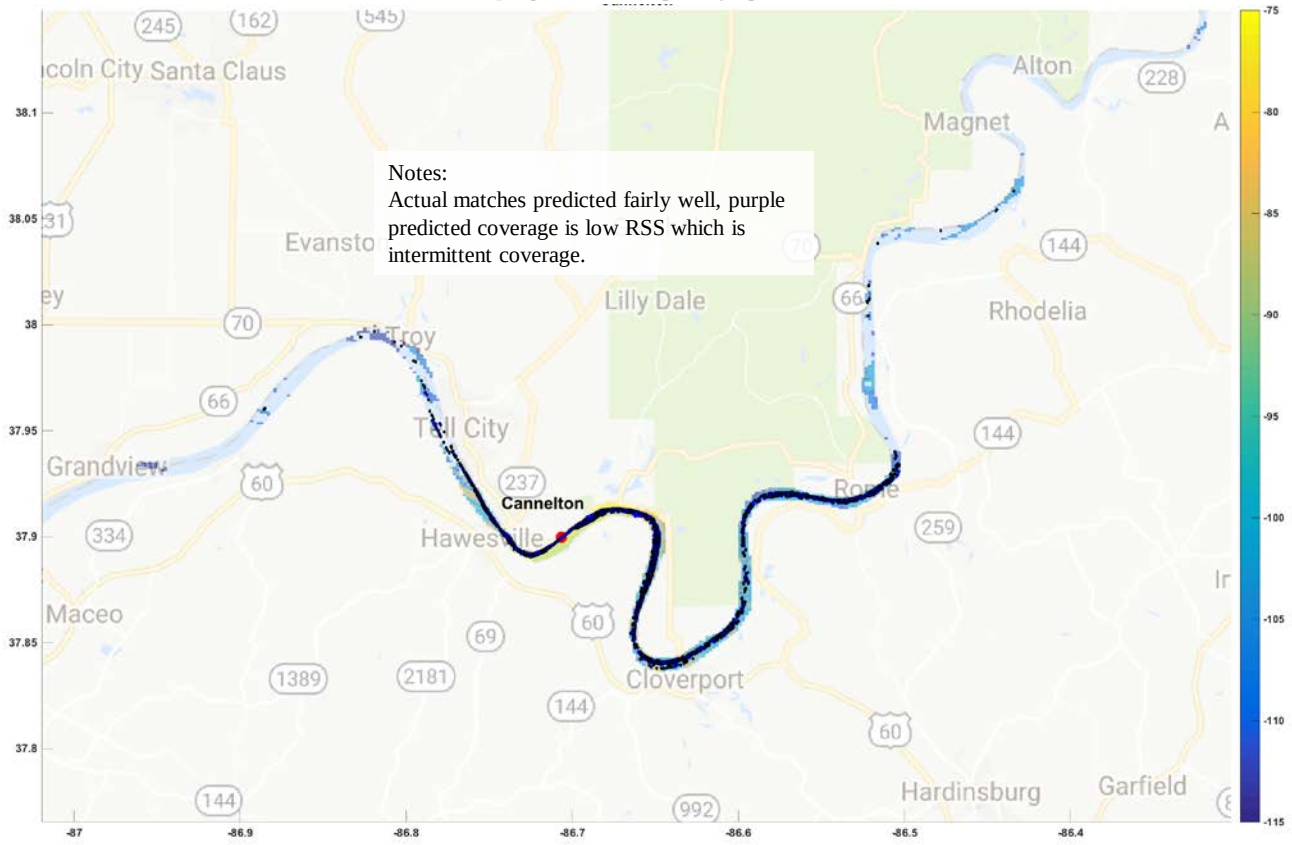

Figure A-10. Cannelton coverage plot.

Obion Pier

Figure A-11. Obion Pier coverage plot.

Newburgh

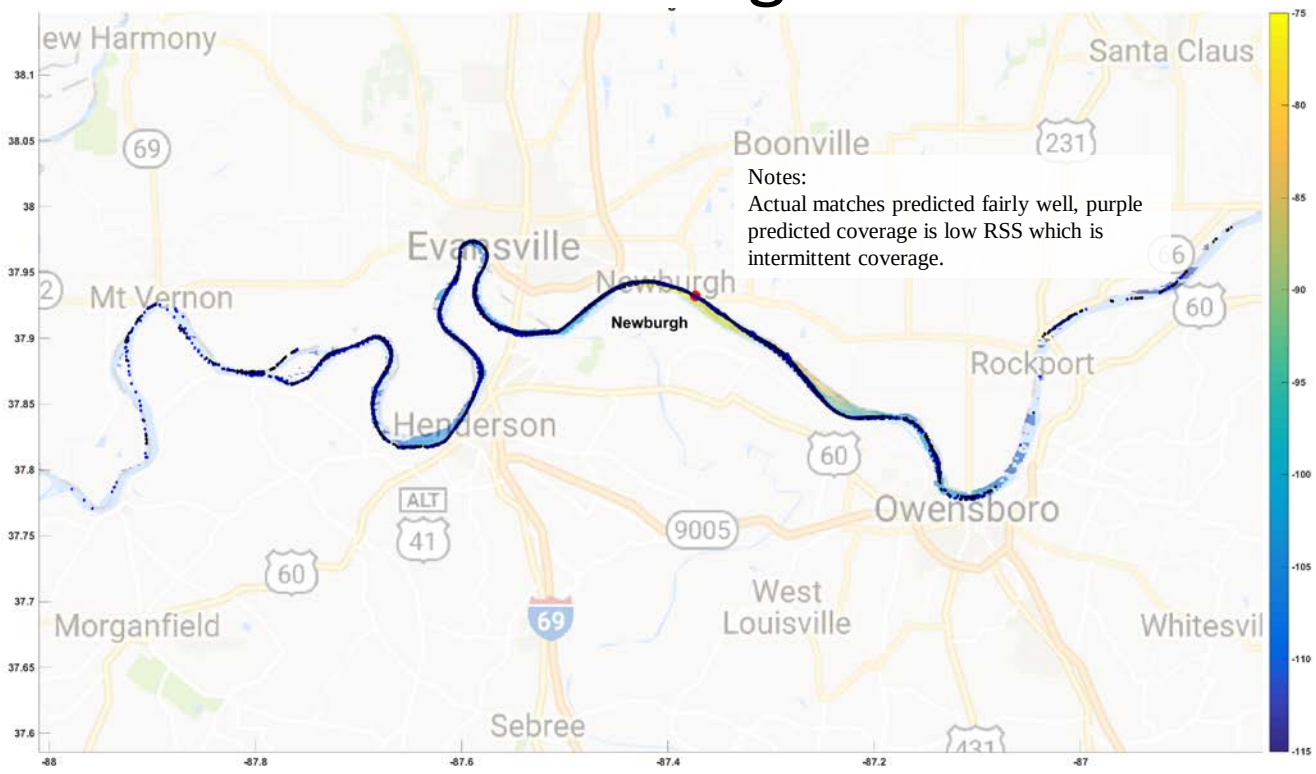

Figure A-12. Newburgh coverage plot.

JT Myers

Figure A-13. JT Myers coverage plot.

Smithland

Figure A-14. Smithland coverage plot.

Kentucky Lock

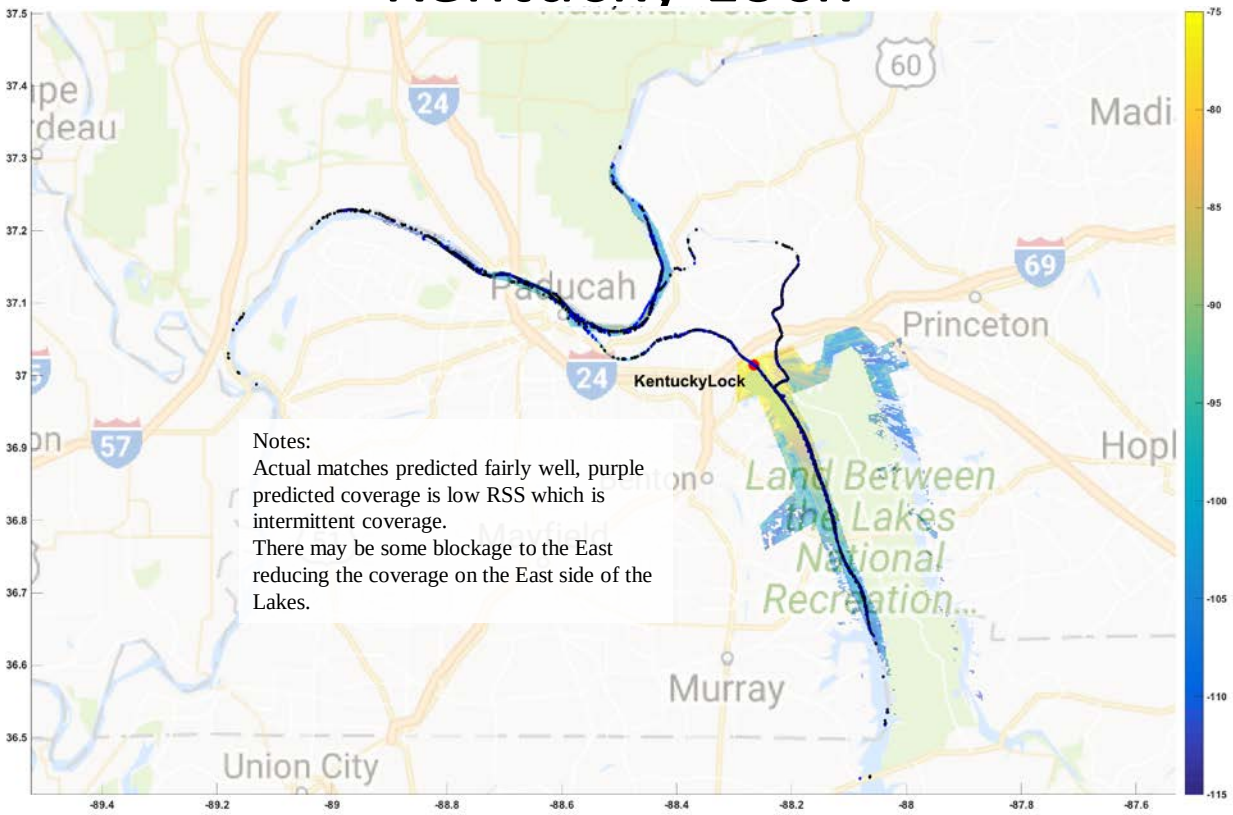

Figure A-15. Kentucky Lock coverage plot.

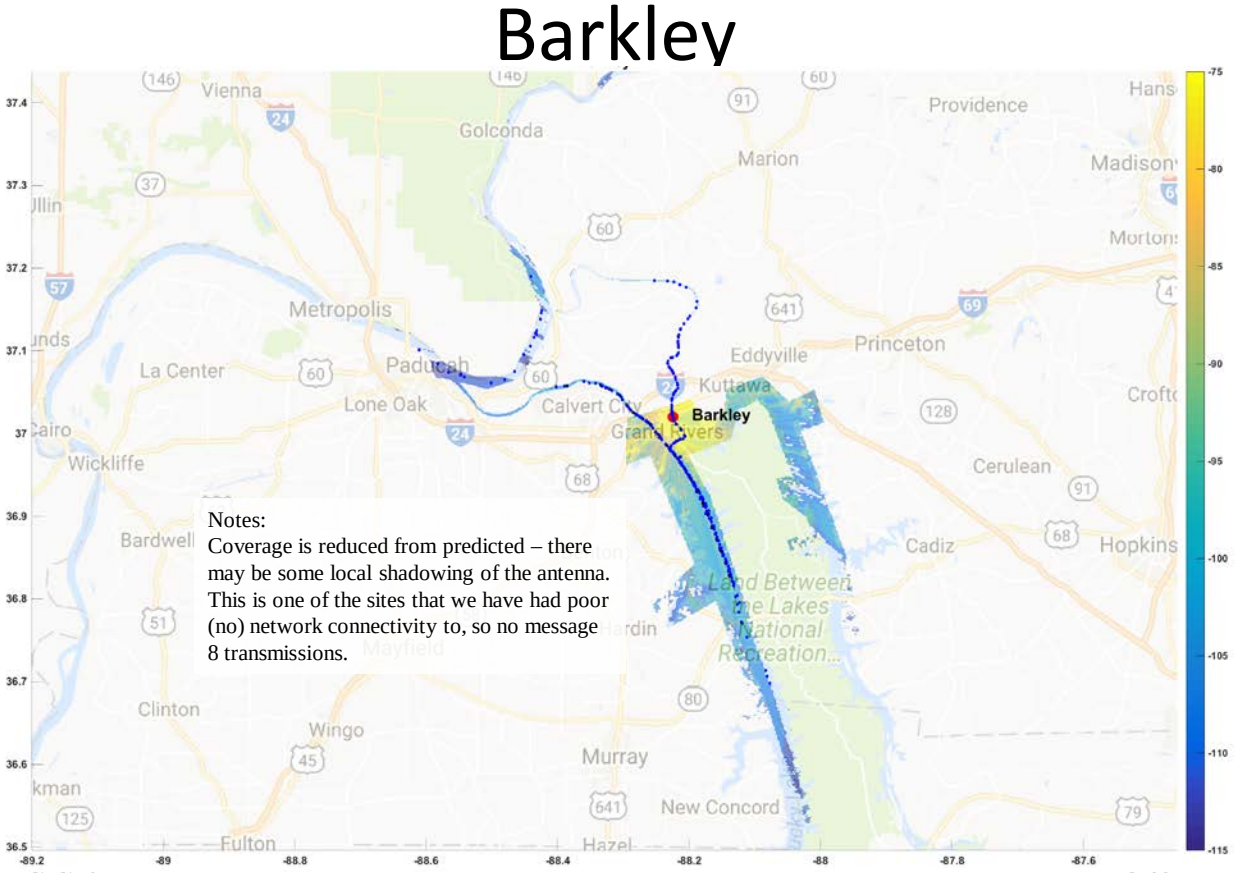

Figure A-16. Barkley coverage plot.

Lock 52

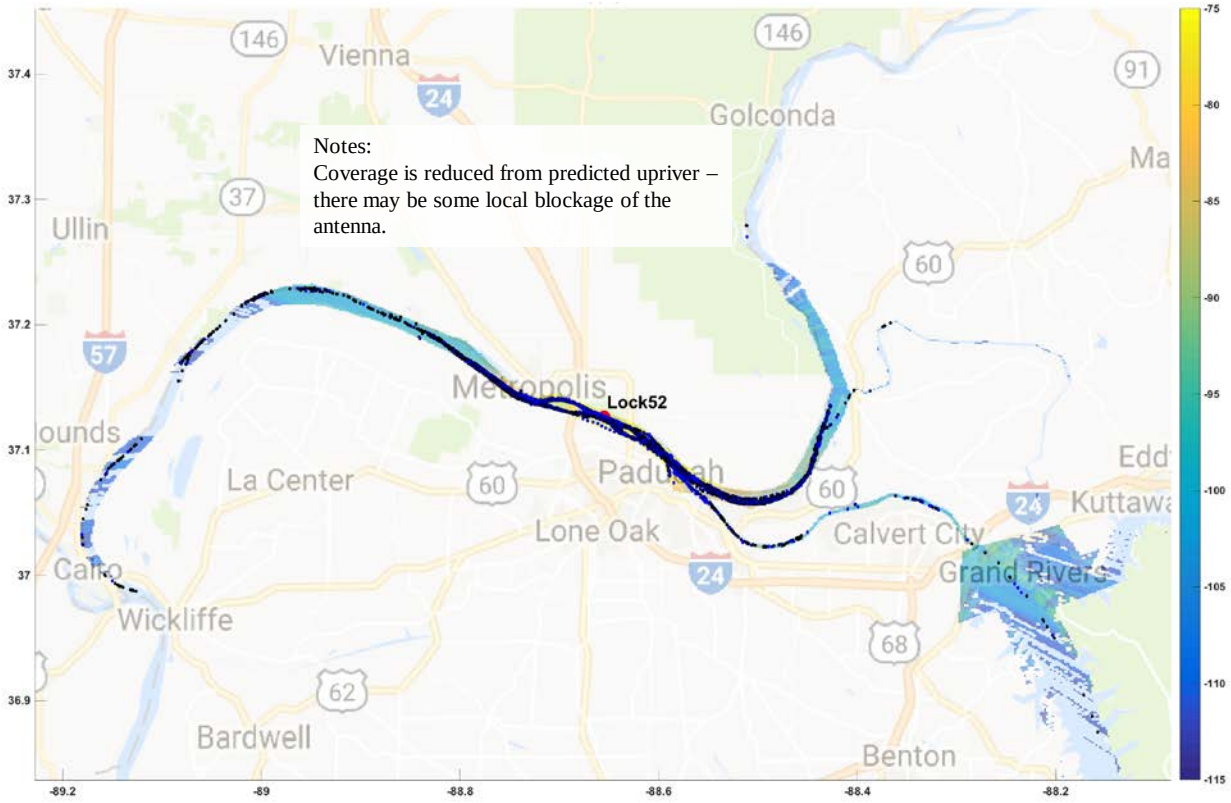

Figure A-17. Lock 52 coverage plot.

Olmsted

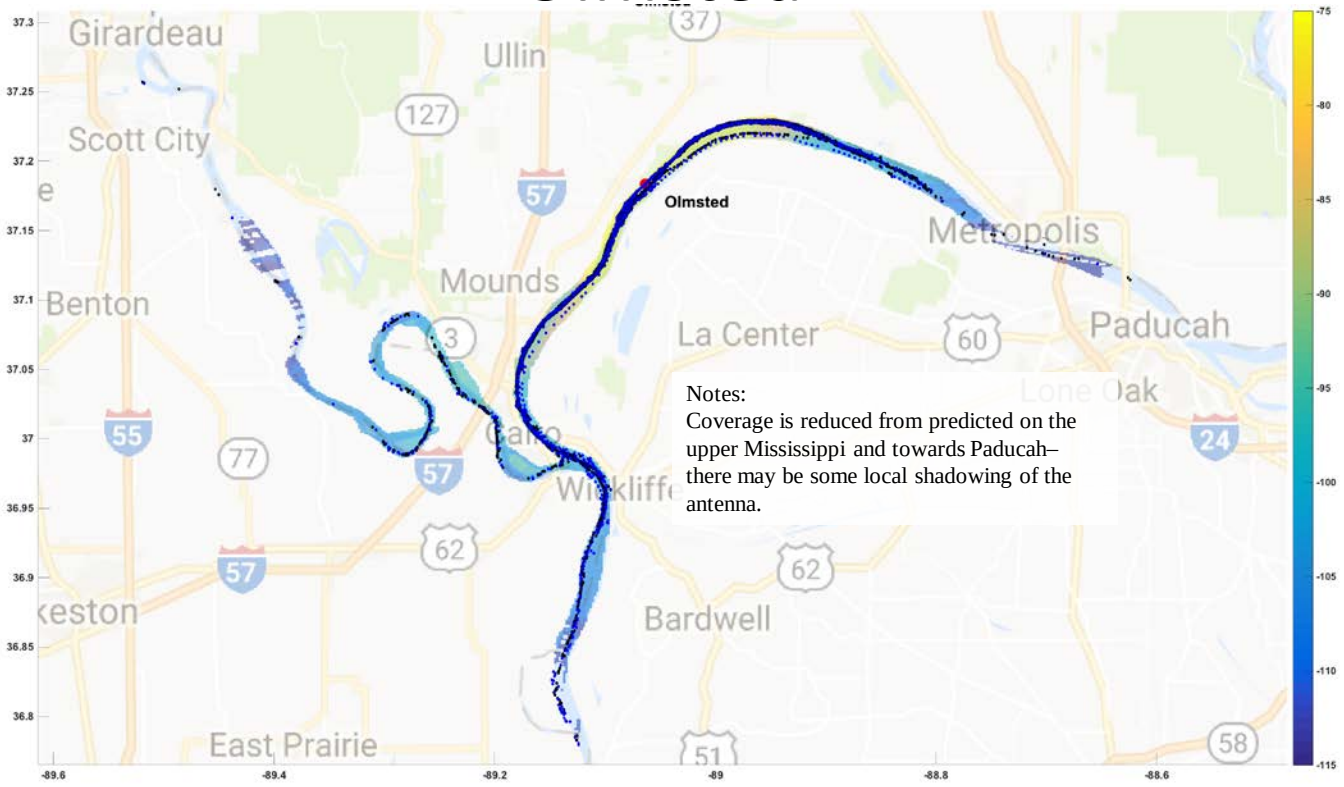

Figure A-18. Olmsted coverage plot.

All Sites, RSS at -112 dB (3dB margin)

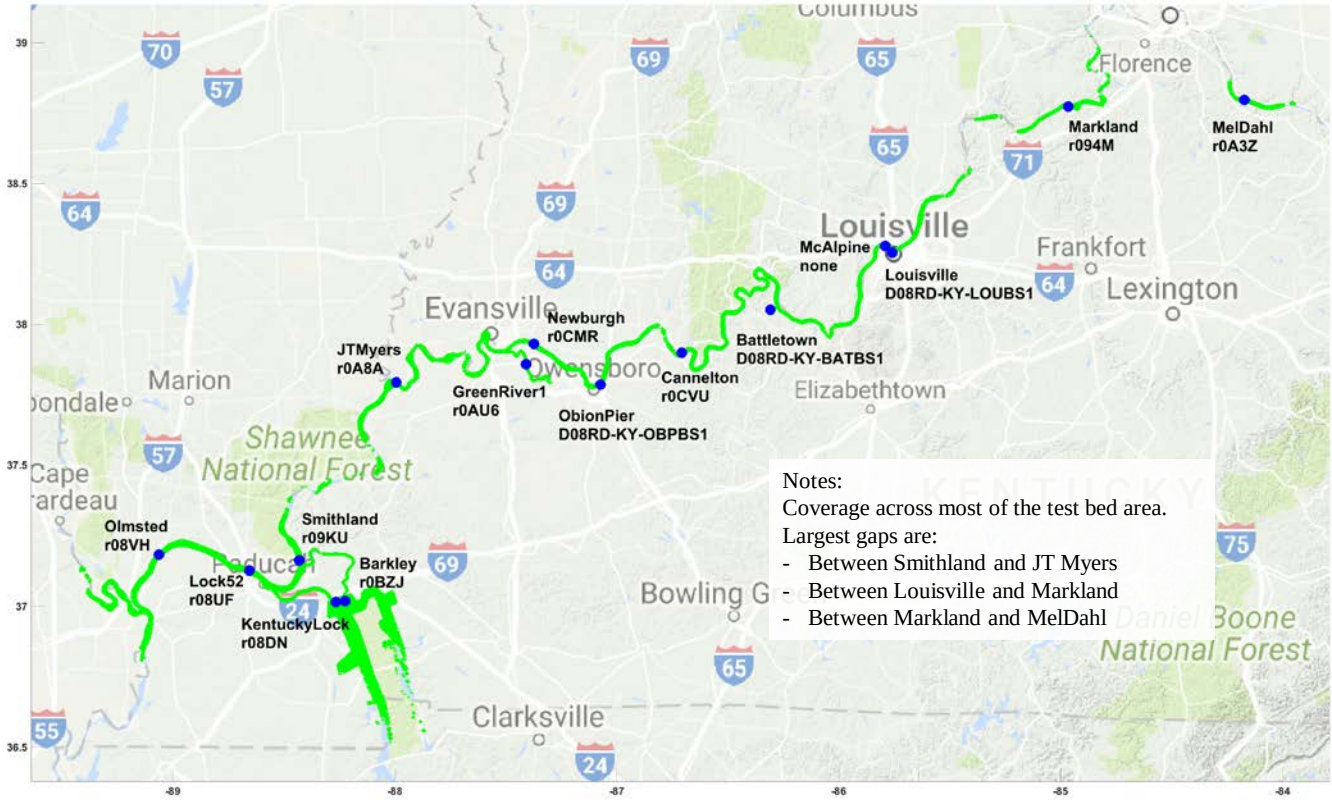

Figure A-19. All Sites coverage plot.

APPENDIX B. TRANSMIT MESSAGE MASTER LIST

Table B-1. Transmit message master list.

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
4	n/a	n/a	Position, UTC, date and current slot number of base station	n/a			• RDC • Sector/VTS	Automated	• Base Station
6	367	16	Binary data for addressed communication.	Passenger and Crew Count	Total crew and passenger count				
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	0 Caution: Marine mammal habitat		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	1 Caution: Marine mammals in area - reduce speed		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	2 Caution: Marine mammals in area - stay clear		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	3 Caution: Marine mammals in area - report sightings		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	4 Caution: Protected Habitat - reduce speed		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	5 Caution: Protected habitat - stay clear		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	6 Caution: Protected habitat - no fishing or anchoring		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	7 Caution: Derelicts (drifting objects)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	8 Caution: Traffic congestion		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	9 Caution: Marine event or regatta		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	10 Caution: Divers down		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	11 Caution: Swim area		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	12 Caution: Dredge operations		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	13 Caution: Survey operations		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	14 Caution: Underwater operation		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	15 Caution: Seaplane operations		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	16 Caution: Fishery - nets in water		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	17 Caution: Cluster of fishing vessels		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	18 Caution: Fairway closed		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	19 Caution: Harbor closed		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	20 Caution: Submerged pipeline or cable		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	21 Caution: Unmanned vehicle operation		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	22 Caution: other (define in associated text field)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	23 Environmental Caution: Storm front (line squall)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	24 Environmental Caution: Hazardous sea ice i.e., icebergs and growlers		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	25 Environmental Caution: Storm warning (storm cell or line of storms)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	26 Environmental Caution: High wind		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	27 Environmental Caution: High waves		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	28 Environmental Caution: Restricted visibility (fog, rain, etc)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	29 Environmental Caution: Strong currents		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	30 Environmental Caution: Heavy icing		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	31 Environmental Caution: Oil or other hazardous substance in area		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	32 Environmental Caution: other (define in associated text field)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	33 Restriction: Fishing prohibited		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	34 Restriction: Entry approval required prior to transit		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	35 Restriction: Entry prohibited		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	36 Restriction: Active military OPAREA		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	37 Restriction: Firing - danger area		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	38 Restriction: Drifting mines		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	39 Restriction: other (define in associated text field)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	40 Anchorage: Anchorage open		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	41 Anchorage: Anchorage closed		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	42 Anchorage: Anchoring prohibited		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	43 Anchorage: Deep draft anchorage		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	44 Anchorage: Shallow draft anchorage		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	45 Anchorage: Vessel transfer operations		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	46 Anchorage: other (define in associated text field)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	47 Ice Report: Ice Edge		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	48 Ice Report: New Ice (<10cm ocean <5cm lake)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	49 Ice Report: Young Ice (10-30cm)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	50 Ice Report: Thin 1st year ice (30-70cm ocean, 5-15cm lake)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	51 Ice Report: Medium 1st year ice (70-120cm ocean, 15-30cm lake)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	52 Ice Report: Thick 1st year ice (120-200 cm ocean, 30-70cm lake)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	53 Ice Report: Old /very thick ice (>200cm ocean, >70cm lake)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	54 Ice Report: Undetermined or unknown thickness		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	55 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	56 Security Alert - Implement USA MARSEC Level 1		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	57 Security Alert - Implement USA MARSEC Level 2		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	58 Security Alert - Implement USA MARSEC Level 3		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	59 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	60 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	61 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	62 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	63 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	64 Distress: Vessel disabled and adrift		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	65 Distress: Vessel sinking		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	66 Distress: Vessel abandoning ship		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	67 Distress: Vessel requests medical assistance		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	68 Distress: Vessel flooding		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	69 Distress: Vessel fire/explosion		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	70 Distress: Vessel grounding		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	71 Distress: Vessel collision		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	72 Distress: Vessel listing/capsizing		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	73 Distress: Vessel under assault		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	74 Distress: Person overboard		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	75 Distress: SAR area		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	76 Distress: Pollution response area		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	77 Distress: other (define in associated text field)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	78 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	79 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	80 Instruction: Contact VTS at this point/juncture		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	81 Instruction: Contact Port Administration at this point/juncture		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	82 Instruction: Do not proceed beyond this point/juncture		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	83 Instruction: Await instructions prior to proceeding beyond this point/juncture		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	84 Instruction: Proceed to this location – await instructions		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	85 Instruction: Clearance granted – proceed to berth/lock		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	86 Instruction: other (define in associated text field)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	87 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	88 Information: Pilot boarding position		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	89 Information: Icebreaker waiting area		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	90 Information: Places of refuge		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	91 Information: Position of icebreakers		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	92 Information: Location of response units		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	93 Information: VTS active target		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	94 Information: Rogue or suspicious vessel		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	95 Information: Vessel requesting non-distress assistance		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	96 Information: other (define in associated text field)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	97 Chart Feature: Submerged object / sunken vessel (describe in associated text field)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	98 Chart Feature: Semi-submerged object		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	99 Chart Feature: Shoal area		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	100 Chart Feature: Shoal area due north		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	101 Chart Feature: Shoal area due east		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	102 Chart Feature: Shoal area due south		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	103 Chart Feature: Shoal area due west		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	104 Chart Feature: Channel obstruction		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	105 Chart Feature: Reduced vertical clearance		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	106 Chart Feature: Bridge/Gate/Lock/other closed		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	107 Chart Feature: Bridge/Gate/Lock/other partially open (opening)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	108 Chart Feature: Bridge/Gate/Lock/other fully open		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	109 Chart Feature: Bridge/Gate/Lock/other partially closed (closing)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	110 Chart Feature: Bridge/Gate/Lock/AtoN/other inoperative or not working properly		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	111 Chart Feature: other (define in associated text field)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	112 Report from ship: Icing info		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	113 Report from ship: Intended route		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	114 Report from ship: other (define in associated text field)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	115 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	116 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	117 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	118 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	119 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	120 Route: Recommended Route		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	121 Route: Alternative Route		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	122 Route: Recommended Route through ice		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	123 Route: other (define in associated text field)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	124 Reserved for Future Use		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	125 Other – Define in associated text field		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	126 Cancellation – cancel area as identified by Message Linkage ID		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
6 or 8	367	22	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Geographic Notice	127 Undefined (default)		• Sector/VTS • USACE (HYPACK)	Manual	• TV32 • ATONIS Database (data entered via US AIMS)
6 or 8	367	29	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Linked Text	Free text 1 - 154 characters 6-bits ASCII as per Table 44 in ITU-R M.1371-4, Annex 8.		• Sector/VTS • USACE	Manual	• Used in conjunction with other ASMs
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	0 Lock		• RDC • USACE	Automated	• Fetcher/Formatter
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	1 Gate		• RDC • USACE	Automated	• Fetcher/Formatter
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	2 Narrows		• RDC • USACE	Automated	• Fetcher/Formatter
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	3 Bridge		• RDC • USACE	Automated	• Fetcher/Formatter
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	4 Restricted channel -- one vessel at a time – could be alternating directions – no passing or overtaking		• RDC • USACE	Automated	• Fetcher/Formatter
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	5 Estimated Arrival Time		• RDC • USACE	Automated	• Fetcher/Formatter
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	6 Assigned Arrival Time		• RDC • USACE	Automated	• Fetcher/Formatter
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	7 Traffic Advisory		• RDC • USACE	Automated	• Fetcher/Formatter
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	8 Cleared to Enter / Proceed		• RDC • USACE	Automated	• Fetcher/Formatter
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	9 Not Cleared to Enter / Do not Proceed		• RDC • USACE	Automated	• Fetcher/Formatter
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	10 Proceed to Berth		• RDC • USACE	Automated	• Fetcher/Formatter
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	11 Proceed to _____ (defined in linked Text Msg)		• RDC • USACE	Automated	• Fetcher/Formatter
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	12 Vessels Awaiting Lockage		• RDC • USACE	Automated	• Fetcher/Formatter
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	13 Ice Convoy (specify speed and spacing in Linked text Message)		• RDC • USACE	Automated	• Fetcher/Formatter
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	14 Undefined		• RDC • USACE	Automated	• Fetcher/Formatter

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
6 or 8	367	35	(6) Binary data for addressed communication. (8) Binary data for broadcast communication.	Waterways Management	15 Undefined		• RDC • USACE	Automated	• Fetcher/Formatter
8	366	3	Binary data for broadcast communication	SAR Trackline	Type of search pattern				
8 or 26	366	12	(8) Binary data for broadcast communication. (26) Scheduled binary data transmission Broadcast or addressed.	SAR Pattern	Type of search pattern				
8	366	18	Binary data for broadcast communication	AtoN Discrepancy	Type of ATON discrepancy report (0-7)		• Sector/VTS	Manual	• ATONIS Database (data entered via US AIMS)
8	366	19	Binary data for broadcast communication	Lock Status	Lock/Chamber Operational Status				
8	366	20	Binary data for broadcast communication	Dam Status	Total amount of dam opening (all gates), in tenths of a meter.				
8	367	33	Binary data for broadcast communication	Environmental	0 Site Location		• RDC • USACE		• Fetcher/Formatter
8	367	33	Binary data for broadcast communication	Environmental	1 Station ID		• RDC • USACE		• Fetcher/Formatter
8	367	33	Binary data for broadcast communication	Environmental	2 Wind		• RDC • USACE	Automated	• Fetcher/Formatter
8	367	33	Binary data for broadcast communication	Environmental	3 Tide/river stage (water level)		• RDC • USACE	Automated	• Fetcher/Formatter
8	367	33	Binary data for broadcast communication	Environmental	4 Vertical Current Profile (2D)		• RDC • USACE	Automated	• Fetcher/Formatter
8	367	33	Binary data for broadcast communication	Environmental	5 Vertical Current Profile (3D)		• RDC • USACE	Automated	• Fetcher/Formatter
8	367	33	Binary data for broadcast communication	Environmental	6 Horizontal Current Profile		• RDC • USACE	Automated	• Fetcher/Formatter
8	367	33	Binary data for broadcast communication	Environmental	7 Sea state		• RDC • USACE	Automated	• Fetcher/Formatter
8	367	33	Binary data for broadcast communication	Environmental	8 Salinity		• RDC • USACE	Automated	• Fetcher/Formatter
8	367	33	Binary data for broadcast communication	Environmental	9 Weather		• RDC • USACE	Automated	• Fetcher/Formatter
8	367	33	Binary data for broadcast communication	Environmental	10 Air gap / Air draft		• RDC • USACE	Automated	• Fetcher/Formatter
8	367	33	Binary data for broadcast communication	Environmental	11 Wind v2		• RDC • USACE	Automated	• Fetcher/Formatter
8	367	33	Binary data for broadcast communication	Environmental	12 (reserved for future use)		• RDC • USACE	Automated	• Fetcher/Formatter

Table B-1. Transmit message master list (Cont'd).

AIS Message ID	Designated Area Code (DAC)	Function Identifier (FI)	Message Description	Application Specific Report Type	Report Type Description	Message Data Source (Competent Authority)	Message Creator	Message Creation Process	Message Creation Interface/Application
8	367	33	Binary data for broadcast communication	Environmental	13 (reserved for future use)		• RDC • USACE	Automated	• Fetcher/Formatter
8	367	33	Binary data for broadcast communication	Environmental	14 (reserved for future use)		• RDC • USACE	Automated	• Fetcher/Formatter
8	367	33	Binary data for broadcast communication	Environmental	15 (reserved for future use)		• RDC • USACE	Automated	• Fetcher/Formatter
20	n/a	n/a	Reserve slots for Base station(s)	n/a			• RDC • Sector/VTS	Manual	• Base Station
21	n/a	n/a	Position and status report for aids-to-navigation	n/a			• Sector/VTS	Manual	• Base Station/AtoN • ATONIS Database (data entered via US AIMS)