



Craig County, Virginia

Radio System Assessment Report



April 2021



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Executive Summary

Introduction

Craig County contracted CTA Consultants LLC (CTA) to provide an evaluation/assessment and recommendations for a Public Safety Grade Radio/Paging Communications System to serve Sheriff, Fire and Rescue, EMS, and Craig County Public Schools. Craig County has a land area of 331 square miles and is bordered by Alleghany, Botetourt, Giles, Montgomery and Roanoke Counties in Virginia and Monroe County in West Virginia.

Craig County's agencies operate different radio systems, which include hybrid low-band VHF and UHF analog radio systems. The goal of this project is to design an upgraded radio system which will allow for seamless interoperability for the County's Sheriff, Fire and Rescue, and EMS Departments, Public Safety Dispatch Center and Craig County Schools, with considerations to improve interoperability with agencies in the surrounding counties.

CTA's assessment of the radio system addresses existing coverage and communication problems and provides options and considerations for system alternatives, details the benefits of each, with cost estimates and other considerations for the County's public safety radio communications systems.

CTA interviewed Craig's Emergency Management Services (EMS), Volunteer Rescue Squad, Sheriff's Office, Dispatch Center, County Fire, five Volunteer Fire Departments and the County School Board. CTA surveyed the radio system sites at Potts Mountain, Craig County Emergency Operations Center, Craig County Sheriff's Office and Dispatch Center, and Simmonsville Volunteer Fire Department. CTA also reviewed information on the Sinking Creek site. We use all information gathered to evaluate the existing systems, determine future operational and technical requirements, and develop viable approaches to upgrade or replace the existing radio system.

Assessment

Craig County agencies provide public safety services throughout the County. Craig County agencies primarily use the radio system to communicate with Dispatch, however they also communicate with:

- | | |
|-------------------------|---|
| ■ County Animal Control | ■ Roanoke County and Botetourt County VFD |
| ■ Giles County | ■ Newport Volunteer Fire and Rescue |
| ■ Alleghany County | ■ National Forest Service |
| ■ Montgomery County | ■ Virginia State Police (VSP) |
| ■ Monroe County, WV | ■ Department of Wildlife Resources (DWR) |

There are three different radio systems operating in Craig County:

- Craig County Sheriff's System - hybrid talk-out Low-Band VHF and talk-in UHF system
- Craig County Fire and Rescue System - two channel UHF radio system
- Simmonsville Volunteer Fire and Rescue System - one channel UHF repeater system

All of the Craig County agencies (Rescue, EMS, Sheriff, Dispatch, and Volunteer Fire Departments) share many of the same concerns about the current radio system including:

- Equipment is aging and at the end of their useful life to safely provide communications for the County.
- Interference
- Channel Crowding with Dispatch
- Coverage is lacking or weak in geographic areas. Coverage problems with talk-in from users in the field. Dispatch is unable to hear users. Talk-in coverage is problematic inside buildings and schools. Coverage for pagers is limited throughout the County.
- Many users, especially on the Fire and Rescue system, must often rely on their cell phones for communication.

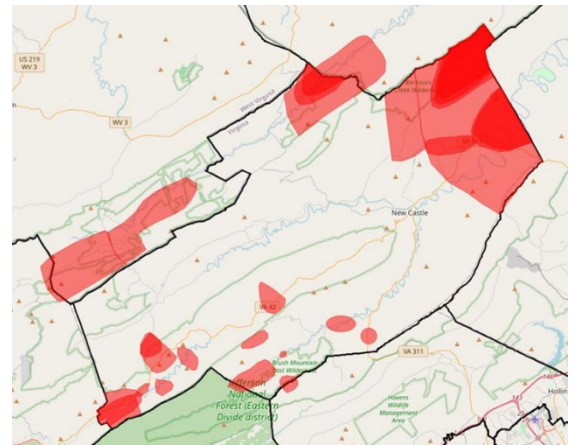


Figure ES-1: Coverage Problem Areas

CTA asked radio system users to identify coverage problem areas on a large map of the County. CTA digitally recreated the map showing the coverage problem areas as shown in Figure ES-1.

The north end of the County has been designated as having poor coverage, while the southeast part of the County has spotty coverage, with the differing terrain being a major factor. The map above was recreated to show where users reported coverage issues on the County's current radio system. Areas of darker red shading indicate that multiple user agencies described coverage issues in those areas.

System Alternatives

CTA identified potential alternatives that will allow the County to implement a unified radio system. Below are the alternatives evaluated for a County-wide public safety grade radio system that will provide reliable communications for Craig County:

- Do Nothing
- Upgrade Existing Radio Systems
- UHF DMR Radio System
- UHF Conventional Analog Radio System
- UHF Hybrid Analog/P25 Conventional Radio System
- UHF P25 Conventional Radio System
- 700/800 MHz P25 Phase 2 Trunked Simulcast Radio System
- Join a Neighboring P25 Trunked Radio System
- Join Virginia State Police VHF STARS System

CTA used the following overarching system considerations when developing our System Alternatives: **coverage, capacity, and interoperability**. The ability of a public safety communications system to meet the requirements of the users will rely heavily upon meeting these system considerations.

Coverage:

Based upon preliminary coverage estimations: 3 sites may provide public safety grade (95%) mobile coverage for the Craig County service area in the VHF band, 4-5 sites may provide public safety grade (95%) portable outdoor coverage for the Craig County service area in the UHF band; and 6 sites may provide public safety grade (95%) portable outdoor coverage for the Craig County service area in the 700/800 MHz band.

Capacity – the number of channels necessary to meet your needs:

Based upon preliminary capacity estimations, a conventional analog simulcast system may require 4 channels, with several added channels for tactical operations; a trunked DMR system will need 3 channels for each of the 4-5 sites, requiring a total of 12-15 channels; and a P25 Phase 1 Conventional or P25 Phase 2 Trunked Simulcast system will require 4 channels.

Interoperability:

Interoperability for the local jurisdictions operating around Craig County is critically important and must be considered as we look at potential system alternatives. CTA developed an interoperability chart as part of the interview process, which clearly shows the need for law enforcement, fire, and EMS to be able to communicate directly with each other in emergency situations. It also reflects the need for users to communicate with other agencies outside of the local jurisdictions, and the ability to use dedicated channels to communicate directly with each other without overloading the primary dispatch channels. The interoperability chart is included in Section 4 of the report.

Based upon our analyses and these considerations, we evaluated the viability of each potential alternative:

■ ***Do Nothing Alternative***

Craig County may consider staying the course and continue to communicate using the existing radio systems when they are operational. Under this course of action, significant costs will be incurred just to maintain today's communications with no improvements. Coverage will continue to be severely inadequate. Capacity will continue to be limited. Interoperability will remain fragmented both within and outside of Craig County. Overall communications will not improve, and Craig County will be no closer to its goal of safe and reliable communications for its public safety users.

■ ***Upgrade Existing Radio Systems***

Craig County can upgrade their existing radio systems, keeping the same general technical system configuration used today. This alternative keeps the County's public safety agencies on different frequency bands, as they are configured today. Upgrading the existing radio systems will require replacement of equipment which will not be supported by the vendor past 2021. Additional coverage is needed to provide reliable communications County-wide for mobile and portable radios. If Craig County decides to upgrade their existing radio systems, there will be very few operational changes, and the overall functionality of the radio systems will not be improved.

■ ***UHF DMR Radio System***

A new UHF DMR Radio System can provide mobile and portable outdoor coverage for reliable public safety communications in Craig County. Implementing a DMR radio system will have many obstacles to overcome, not the least of which is the difficulty in achieving the desired level of interoperability with neighboring jurisdictions. This alternative also does not provide Craig County a **sustainable** public safety grade system that will provide reliable mission critical communications for the next 15-20 years.

- ***UHF Hybrid Analog/P25 Conventional Radio System***

Craig County can replace their existing systems with a new UHF Hybrid Analog/P25 Phase 1 Trunked Simulcast Radio System, which may improve radio communications for all users in Craig County. This alternative allows the Sheriff's Office to add newer features such as encryption and mobile data. This will also allow the Fire and Rescue agencies to purchase cheaper subscriber units, because they will only operate in analog mode. Implementing a UHF Hybrid Analog/ P25 Conventional Radio System will provide some improvement for users in Craig County. However, interoperability and operability will be challenging due to Craig County Fire and Rescue, and Sheriff's Office operating on a different radio mode (analog vs digital).

- ***UHF Simulcast P25 Conventional Radio System***

The P25 standards facilitate interoperability by allowing any P25 certified radio subscriber to operate on any P25 Conventional system infrastructure regardless of the system vendor. This system alternative will allow Craig County to have dedicated channels for specific groups and users, and the user manually selects the channels they will use. If Craig County procures a UHF P25 Phase 1 Conventional Simulcast Radio System, interoperability will be seamless with Alleghany County. Interoperability will improve with Montgomery and Botetourt Counties, if they decide to implement UHF P25 Conventional systems. Implementing a UHF Simulcast P25 Conventional Radio System will provide the needed public safety grade coverage and provide capacity for all users in Craig County that desire to participate in the system.

- ***700/800 MHz P25 Phase 2 Trunked Radio System***

The P25 standards facilitate interoperability by allowing any P25 certified radio subscriber to operate on any P25 system infrastructure regardless of the system vendor. This system alternative will allow Craig County to significantly increase capacity using the same number of frequency pairs as a P25 Conventional or Phase 1 Trunked system. Implementing a 700/800 MHz P25 Phase 2 Trunked Simulcast Radio System will provide the needed public safety grade coverage and capacity for users in Craig County that desire to participate in the system. However, interoperability will be challenging due to Craig County operating on a different frequency band than the surrounding agencies they interoperate with.

- ***Join a Neighboring County's P25 Trunked Radio System***

Craig County could potentially use one of the neighboring jurisdiction's tower sites if the location is close to the border of both Counties. This could provide useful coverage for Craig County without requiring new tower sites to be constructed, and it could also extend Craig County's coverage into a neighboring jurisdiction for use during mutual aid events. Craig County will be required to sign a Memorandum of understanding (MOU) with the neighboring jurisdiction they are connecting to and pay a percentage of the maintenance costs for any shared equipment. This alternative will require a good working relationship with the neighboring jurisdiction(s) Craig County will join. However, the governance and level of control Craig County has over the radio system could be a challenging factor for joining a neighboring radio system.

- ***Join Virginia State Police STARS VHF P25 Trunked Radio System***

The Commonwealth of Virginia's Statewide Agencies Radio System (STARS) is a P25 Phase 1, multi-site VHF radio system designed for mobile only radio coverage for the entire state of Virginia. If using the STARS network, a DVR is required on all law enforcement vehicles, ambulances, and fire apparatus. The DVR will add significant costs; however, it will provide the needed coverage and interoperability with surrounding 700/800 MHz systems. This alternative will have many obstacles to overcome, not the least of which could be the difficulty in obtaining the necessary VHF frequencies and the requirement to purchase only the prescribed subscriber units/ DVRs currently operating on STARS, which can be cost prohibitive for a locality.

CTA uses an impact analysis process to help evaluate the system alternatives in combination with all the information gathered during this needs assessment. The results help narrow down the alternative(s) that best fit your needs by reflecting how well each alternative meets the needs and requirements of Craig County's users. Part of this process is evaluating the rough order of magnitude (ROM) costs for each alternative.

Table ES-1 provides the results of the alternatives analysis, summarized below:

ALTERNATIVES SUMMARY									
	Do Nothing	Upgrade Existing Radio System	UHF DMR Radio System	UHF Conventional Analog System	UHF Hybrid Analog P25 Conventional System	UHF P25 Conventional System	700/800 P25 Phase 2 Trunked System	Joining a neighboring P25 Trunked System	Join VSP VHF STARS System
System Functionality/ System Reliability	Not Public Safety Grade	Not Public Safety Grade	Not Public Safety Grade	Not Public Safety Grade	Public Safety Grade	Public Safety P25	Public Safety P25	Public Safety P25	Public Safety P25
Coverage / Sites	Existing Coverage 3 sites	Existing Coverage 3 sites	Improved Mobile/Portable Coverage 4-5 Sites	Improved Mobile/Portable Coverage 4-5 Sites	Improved Mobile/Portable Coverage 4-5 Sites	Improved Mobile/Portable Coverage 4-5 Sites	Improved Mobile/Portable Coverage 6 Sites	Improved Mobile/Portable Coverage 4-5 Sites UHF) or 6 Sites (700/800)	Improved Mobile Coverage using existing STARS Sites
Capacity / Channels	3 Channels	3 Channels	12-15 Channels	4 Channels	4 Channels	4 Channels	4 Channels	4 Channels	4 Channels
Operability	Separate Systems/Frequency Bands	Separate Systems/Frequency Bands	One System/Frequency Band	One System/Frequency Band	Separate Systems / Same Frequency Band	One System/Frequency Band	One System/Frequency Band	One System/Frequency Band	One System/Frequency Band
Interoperability	Gateways / Manual Patch Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe	Gateways / Manual Patch Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe	Gateways / Manual Patch Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe	Gateways / Manual Patch Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe	Seamless for Sheriff's Office Any user on Neighboring System or P25 Capable in the same frequency band	Seamless P25 Capable in the same frequency band Gateways / Manual Patch Non-P25 surrounding	Seamless Roanoke Gateways / Manual Patch Alleghany, Botetourt, Montgomery, Giles, Monroe	Seamless Any user on Neighboring System or P25 Capable in the same frequency band Gateways / Manual Patch Non-P25 surrounding	Seamless VSP Gateways / Manual Patch Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe
Costs		\$2,000,000 - \$2,300,000	\$3,000,000 - \$3,500,000	\$3,500,000 - \$4,000,000	\$4,250,000 - \$4,750,000	\$4,250,000 - \$4,850,000	\$6,500,000 - \$7,000,000	\$5,500,000 - \$6,000,000	\$3,500,000 - \$4,000,000
Alternatives Score	104.43	171.86	376.57	334.00	357.29	394.71	373.00	355.00	392.21
Alternatives Ranking	9	8	3	7	5	1	4	6	2

Table ES-1 Alternative Summary

When comparing the results of each alternative, it is clear that the options related to remaining in the UHF Band are the highest ranked alternatives for Craig County. The overall highest ranked alternative is a ***UHF Simulcast P25 Conventional Radio System***.

This alternative stands out, primarily in the areas of:

- System Functionality / System Reliability
- Capacity / Frequency Availability
- Interoperability
- Costs

Upgrading the existing systems within Craig County will provide the needed public safety grade coverage, capacity, and interoperability for all current public safety and non-public safety radio users within the County for the next 15+ years. In CTA's opinion, a UHF Simulcast P25 Conventional Radio System is the BEST FIT for Craig County.

Conceptual Design

The new system configuration will operate in the UHF public safety band and reuse some of the County's existing licensed frequencies. The design includes updates for important auxiliary systems, such as the existing paging system, consoles, and fixed control stations, and will provide adequate radio coverage for Craig County. This new system will provide reliable public safety grade service for the next 15-20 years. This architecture may be procured turn-key, or via separate procurements using an open and competitive Request for Proposals (RFP) from a variety of system vendors.

This conceptual design addresses the following overarching technical concerns:

- Aging, support-limited radio system, subscriber units, and dispatch consoles
- Lack of capacity causing interference from users talking over each other
- Countywide coverage issues
- Portable outdoor coverage issues
- Portable in-building coverage issues

Figure ES-2 shows a diagram of the conceptual system design.

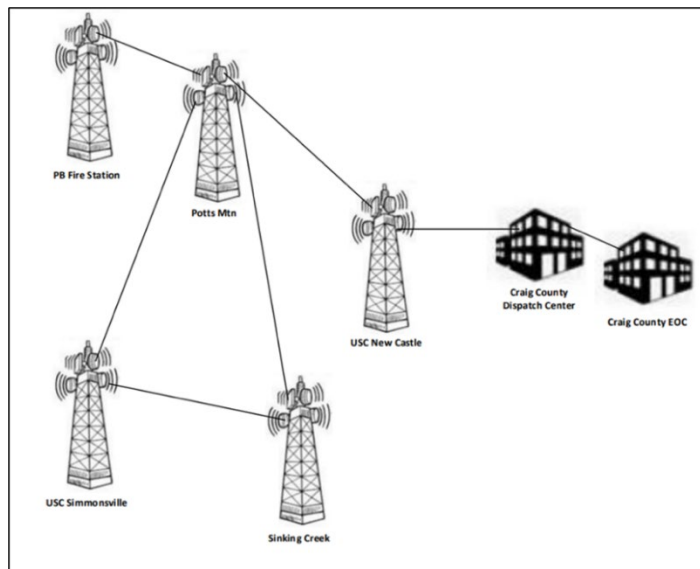


Figure ES-2 Conceptual Design Block Diagram

We performed an analysis of the potential coverage a UHF P25 conventional system could provide. Our goal is to evaluate the total coverage that can be delivered by using existing tower sites which are locality owned, existing state-owned sites, or existing commercial sites.

After analyzing the coverage advantages and disadvantages of various tower sites, we concluded that the base configuration that best meets the County's stakeholder needs is 4 RF sites in a P25 conventional simulcast site design. The 5th site shown in Figure ES-2 is for microwave only to connect all the radio sites. Figures ES-3 thru ES-5 illustrate the performance of this configuration at the two coverage levels needed by County agencies: mobile, and portable outdoor.

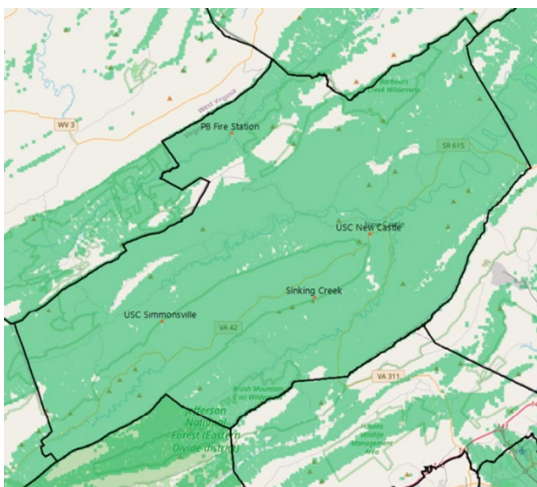


Figure ES-3 P25 Mobile Talk-out Conceptual Coverage

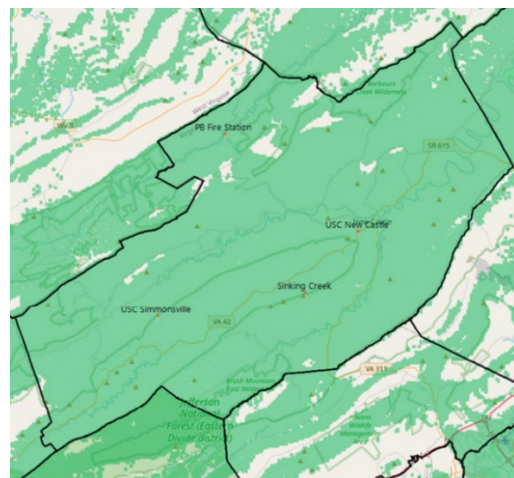


Figure ES-4 P25 Mobile Talk-in Conceptual Coverage

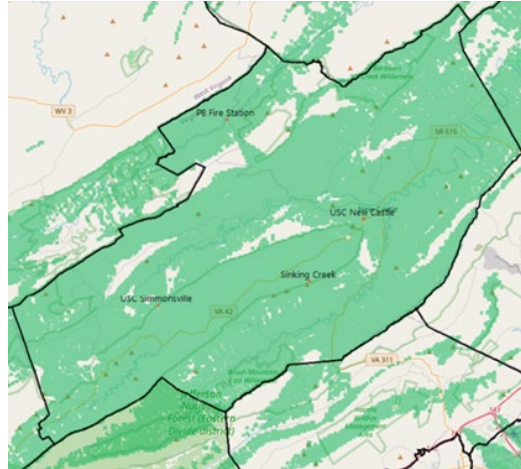


Figure ES-5 Portable Outdoors Balanced Conceptual Coverage

Utilizing a microwave network is a common way to ensure highly reliable radio system connectivity. To function reliably, the radio system requires a highly reliable telecommunications backbone to connect the radio system tower sites and the Craig County EOC to the Dispatch Center. Reliability is a function of equipment and path redundancy, as well as path dependability. This reliability is most often provided by a dedicated digital microwave system. For the Craig County radio system, there should be a public safety grade microwave network configured in a ring topology with Monitored Hot Stand-By (MHSB) equipment for all microwave spur links. A microwave ring topology provides redundancy and reroutes data traffic in the opposite direction around the ring in case of microwave equipment failure, or link outages.

The new UHF P25 conventional simulcast radio system will fundamentally operate similar to the radio systems currently in use. The major operational difference is the improved operability between different agencies in the County, the interoperability between Craig County and other neighboring systems operating UHF P25 conventional systems, and simulcast system operation.

This opinion of probable cost represents the conceptual system design, uses mostly existing sites and operates in the UHF frequency band. The system includes the radio infrastructure, any upgrades to the physical facilities, upgrades to the paging system, a microwave system, dispatch consoles, subscriber equipment, vendor services, consulting, and contingency funds.

Craig County, VA
UHF P25 Conventional Simulcast Radio System

Cost Elements	List Estimate	Negotiated Estimate	Competitive Estimate	MULTI-VENDOR ESTIMATE
RADIO INFRASTRUCTURE	\$ 1,155,700	\$ 1,155,700	\$ 1,155,700	\$ 1,155,700
COMMUNICATIONS CENTER	\$ 334,500	\$ 334,500	\$ 334,500	\$ 334,500
MICROWAVE SYSTEM	\$ 604,900	\$ 604,900	\$ 604,900	\$ 502,100
PHYSICAL FACILITIES	\$ 1,443,800	\$ 1,443,800	\$ 1,443,800	\$ 816,700
SUBSCRIBERS	\$ 1,342,700	\$ 1,033,900	\$ 966,700	\$ 939,900
VENDOR SERVICES	\$ 707,800	\$ 707,800	\$ 707,800	\$ 545,800
DISCOUNT	\$ -	\$ (867,000)	\$ (1,300,400)	\$ (1,063,200)
SPARES - SUBSCRIBERS	\$ 25,600	\$ 19,700	\$ 18,400	\$ 11,800
SPARES - FIXED NETWORK	\$ 88,100	\$ 88,100	\$ 88,100	\$ 66,100
CONSULTING	\$ 225,000	\$ 225,000	\$ 225,000	\$ 337,500
CONTINGENCY (5%)	\$ 285,200	\$ 226,100	\$ 201,000	\$ 165,500
RADIO SYSTEM TOTAL	\$ 6,213,300	\$ 4,972,500	\$ 4,445,500	\$ 3,812,400
MAINTENANCE (After 1 year warranty)	\$ 185,000	\$ 185,000	\$ 185,000	\$ 138,800

Table ES-2 UHF P25 Phase 1 Conventional Simulcast Radio System

Recommendations

Now is the time for Craig County to upgrade your public safety communications to protect your public safety users. Your current systems have reached the end of their usable life and their ability to be supported. Spare parts are becoming scarce which will lead to potentially dangerous system issues.

Public Safety radio communications within the County are characterized by poor portable coverage in some areas, both in-buildings and outdoors, as well as aging equipment. These major deficiencies, plus other operational and technical concerns, currently inhibit public safety personnel from operating at full capacity and efficiency. Mutual aid between the surrounding Counties and Craig County routinely occurs, and without the ability to communicate with all public safety personnel in these jurisdictions, users will find themselves in potentially dangerous conditions.

The public safety personnel in the County have made valiant efforts to provide necessary services to your citizens using the communications resources made available to them. We believe the County recognizes the potential advantages of designing and implementing a Public Safety Radio System that will address the needs of the Sheriff's Office, Emergency Management, Fire, EMS, and Schools.

CTA recommends Craig County procure and install a UHF P25 Conventional Simulcast Radio System consisting of 4 RF sites, 5 MW sites, and 5 channels.

By doing so, the County will provide a public safety grade communications network for all users within Craig County. A well designed, implemented, and tested radio system will provide the public safety users in Craig County:

- ***Simplified communications*** – removing the dispatch communications relay barriers and differences in equipment and capabilities from agency to agency.
- ***The ability to communicate as needed*** – within the guidelines of organizational structure, users can push to talk with those they need to. Equipment is no longer a barrier, and with cooperative agreements, political boundaries are less of a barrier. The tools are in place for true interoperable communications.
- ***Consistently dependable system*** – uniform design, deployment, operation, and maintenance of the system means that robust equipment is designed for the task, placed where it is needed, and users can depend on reliable service every day.

Go Forward Plan of Action:

1. Initiate planning and budgeting for a new UHF P25 Conventional System.
2. Identify and submit grants to support the cost of the system.
3. Review and approve the upgraded radio communications conceptual design contained in this report. Work with CTA to complete any adjustments in preparation for specifications development.
4. Adopt Project 25 (P25) technology as the interoperability standard for Craig County. This will help maintain interoperability with some surrounding jurisdictions that have already migrated to P25 systems.

5. Prepare a set of functional specifications, scope of work, and terms and conditions in preparation for issuance of Request for Proposals. Construct the RFP package targeting a competitive multi-vendor procurement. We recommend the specifications allow the following to be examined and evaluated for each proposal:
 - Overall viability of the configuration
 - Communications throughput and performance, matched to consider present and future voice needs
 - Guaranteed (95%) coverage over the Craig County service area
 - Redundancy and Backup Failure Modes
 - Fifteen-year life cycle costs, including keeping the number of tower sites as low as possible, while retaining the requisite coverage – mobile, and portable outdoors and inside buildings
 - Degree to which the system requirements are addressed
6. License additional UHF frequencies and modify existing UHF licenses for use on the new P25 radio system, to ensure sufficient spectrum is under Craig County license to build the systems.
7. Implement a digital microwave network as a stand-alone, fault tolerant, dedicated emergency system to provide long-term cost savings and improved reliability.
8. Any new replacement subscriber radios, whose lifecycle is anticipated to span into new upgraded P25 infrastructure, should be P25 capable.
9. Retain CTA to provide implementation oversight for the following items:
 - Project Kickoff Meeting
 - System Design
 - Physical Facilities Site Upgrades
 - Detailed Design Review
 - Radio System Staging Test
 - Microwave System Staging Test
 - Radio System Installation
 - Microwave System Installation
 - Site Inspections
 - Physical Facilities Completion
 - Equipment Installation Completion
 - Final Acceptance
 - Field Acceptance Testing
 - Radio System Testing
 - Subscriber Radio Testing
 - Microwave Network Testing
 - Coverage Testing
 - Fleet Mapping Workshop
 - Training
 - Radio User Training
 - System Administrator Training Console User Training
 - Maintenance Training
 - System Cutover
 - Final Documentation/ System As-builts Review
 - Final Acceptance

1.0 Introduction

Craig County contracted CTA Consultants LLC (CTA) to provide an evaluation/assessment and recommendations for a Public Safety Grade Radio/Paging Communications System to serve Sheriff, Fire and Rescue, EMS, and Craig County Public Schools. Craig County has a land area of 331 square miles and is bordered by Alleghany, Botetourt, Giles, Montgomery and Roanoke Counties in Virginia and Monroe County in West Virginia.

Craig County agencies operate different radio systems, which include hybrid low-band VHF and UHF analog radio systems. The goal of this project is to design an upgraded radio system which will allow for seamless interoperability for the County's Sheriff, Fire and Rescue, and EMS Departments, Public Safety Dispatch Center and Craig County Schools, with considerations to improve interoperability with agencies in the surrounding counties.

For a radio system to be viable, it must function as designed. We understand systems "grow-up" over time, and best efforts are employed for necessary repairs and updates. Our goal, on your behalf, is to provide recommendations that will:

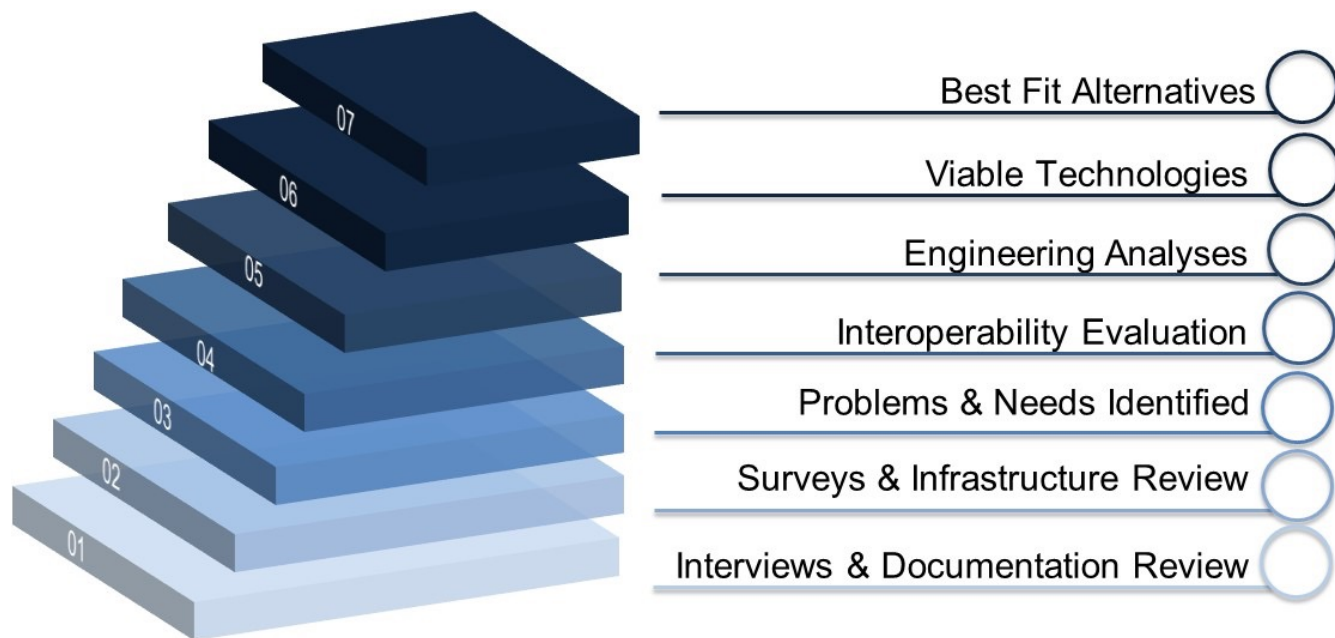
- Investigate Public Safety Grade System Alternatives
- Improve Coverage
- Improve Operability
- Improve Interoperability
- Realize Operational Efficiencies
- Realize Cost Savings

CTA interviewed Craig's Emergency Management Services (EMS), Volunteer Rescue Squad, Sheriff's Office, Dispatch Center, County Fire, five Volunteer Fire Departments and the County School Board. CTA surveyed the radio system sites at Potts Mountain, Craig County Emergency Operations Center, Craig County Sheriff's Office and Dispatch Center, and Simmonsville Volunteer Fire Department. CTA also reviewed information on the Sinking Creek site. We use all information gathered to evaluate the existing systems, determine future operational and technical requirements, and develop viable approaches to upgrade or replace the existing radio system.

We reviewed statistical documentation from the County's public safety agencies to document your current operations environment. We factored in the system issues shared with us and the results of our site surveys, then completed the following analyses:

- Frequency Analysis
- Traffic Loading Analysis
- Coverage Analysis
- Backhaul Connectivity Analysis

The results of the documentation review and analyses provide a well-rounded picture of your current communications environment. We then considered viable system technologies to develop best fit alternatives and rough order of magnitude (ROM) cost estimates for your radio system.



Upon reviewing the alternatives and their associated costs with you, we recommend the best fit alternative which we use to develop a conceptual design and budgetary estimate. This information will be the foundation for a functional specification document to solicit the needed radio system for Craig County.

This report provides a summary of the information gathered, the results of our analyses, considerations for system alternatives, and details the advantages and disadvantages of each, along with cost estimates and other considerations for your public safety radio communications system. This assessment addresses the feasibility of the proposed alternatives:

- Options and considerations related to upgrading public safety communications systems and technologies
- Considerations recognizing the need for interoperable communications within Craig County for Public Safety agencies and Schools, as well as surrounding communities' public safety agencies, schools, and hospitals
- A risk benefit analysis
- A conceptual system design, addressing future needs for the next 15 to 20 years
- Budgetary cost estimates, and projected timeline/transition information

CTA will present the findings to Craig County key radio system stakeholders. CTA will also be available to support meetings with the Craig County Board of Supervisors.

2.0 Current Communications Environment

2.1 Operational

Craig County agencies provide public safety services throughout the County, and provide Mutual Aid to Monroe WV, Alleghany County, Botetourt County, Giles County, Roanoke County and Montgomery County.

CTA conducted interviews with each of the following Agencies utilizing the Craig County radio system and/or dispatch services:

- Craig County Emergency Management Services
- Craig County Fire Division
- Craig County School Board
- Craig County Sheriff's Office and Dispatch Center
- Craig County Volunteer Rescue Squad
- John's Creek VFD
- New Castle VFD
- Paint Bank VFD
- Simmonsville VFD
- Upper Craig Creek VFD

CTA gathered information directly from these stakeholders about current operations, coverage issues, radio system features and future needs. We asked about technical and operational issues the existing system faces and identified the County's interoperability and mutual aid relationships. CTA gained an understanding of the current technology/infrastructure and tactical communications environment to determine if there were any issues/limitations for the existing equipment.

Craig County agencies primarily use the radio system to communicate with Dispatch, however they also communicate with:

- County Animal Control
- Giles County
- Alleghany County
- Montgomery County
- Monroe County, WV
- Roanoke County and Botetourt County VFD
- Newport Volunteer Fire and Rescue
- National Forest Service
- Virginia State Police (VSP)
- Department of Wildlife Resources (DWR)

2.2 Technical

There are three different radio systems operating in Craig County: Craig County Sheriff's System, Craig County Fire and Rescue System, and Simmonsville Volunteer Fire and Rescue System.

The Craig County Sheriff's system is a hybrid talk-out Low-Band VHF and talk-in UHF system. The talk-out Low-Band VHF is used to communicate to the deputies in the field, and the talk-in UHF is used for communications from deputies in the field. The system consists of one low-band VHF channel and one UHF channel. The Sheriff's Office has a single VHF (High-band) frequency used with vehicular repeaters to allow the deputies to use VHF portable radios outside their vehicles. The low-band VHF transmits from the repeater site on Potts Mountain and the UHF receivers at the Potts Mountain site, Sinking Creek site, and at the Simmonsville VFD site.

The Craig County Fire and Rescue system is a two channel UHF radio system with repeater sites on Potts Mountain and Sinking Creek Mountain. County Fire and Rescue use separate UHF channels for their dispatch.

Simmonsville Volunteer Fire and Rescue System is a one channel UHF repeater system at the Simmonsville VFD building. The Simmonsville Volunteer Fire and Rescue System owns and maintains their own radio equipment; however, they house a UHF receiver at their site to communicate with the Sheriff's Department.

The Sheriff's Office system has better talk-out coverage than the Fire and Rescue system, because they use VHF low band to talk out. This system was funded from a grant submitted by and awarded to the Sheriff's Office. The Sheriff's Office works with ProComm for maintenance, who specified the equipment for the grant. The system was not designed to meet a specific coverage reliability.

All sites for the Sheriff's Office, County Fire, County Rescue, and Simmonsville Volunteer Fire and Rescue are linked to the County Dispatch via UHF radio links. Appendix D contains our projected coverage from existing sites, which show the expected coverage County users currently receive. *It is important to note that you will see both Talk-in (user to dispatcher) and Talk-out (dispatcher to user) coverage maps. While one direction may show good coverage, successful communications must work in both directions.* The existing frequencies licensed for Craig County, Simmonsville Volunteer Fire and Rescue Department, and New Castle Volunteer Fire Department are included in Appendix C Frequency Analysis.

Based on user comments, while the current radio system works better than the previous system, many users, especially on the Fire and Rescue system must often rely on their cell phones for communication.

2.3 Issues and Concerns

All of the Craig County agencies (Rescue, EMS, Sheriff, Dispatch, and Volunteer Fire Departments) share many of the same problems with the current radio system. We discuss the most common shared issues and concerns.

2.3.1 Equipment

The Craig County Radio systems are aging and at the end of their useful life to safely provide communications for Craig County. The repeaters are used 24/7, some are not temperature controlled, and can burn out and require repair. Users report the current radios are not reliable for various reasons. The overall system (dispatch,

repeaters, towers, as well as radios themselves) have encountered a wide range of issues and failures over the years, which may be linked to maintenance issues.

As recently as the last ice storm in February 2021, antennas on the sites were rendered unusable and caused our public safety users to implement extraordinary measures to continue with any form of communications.

2.3.2 Coverage

There are coverage issues, especially with talk-in from users in the field. At times, dispatch is unable to hear users, so the users end up relying on cell phones. There are geographic areas where coverage is lacking or weak. Areas along the ridges are problematic, and just a few miles can make a difference in whether or not a user can be heard on the radio system. Talk-in coverage is problematic inside buildings and the schools in particular. The school buses have similar coverage issues near the Giles County line and towards Botetourt.

Coverage for pagers is limited throughout the county, especially in the New Castle area. Although not a coverage issue, most VFD volunteers work in other areas like Blacksburg/Christiansburg, where pager coverage is spotty or non-existent.

Figure 2-1 indicates the areas with coverage issues, as indicated by our interviews. The north end of the County has been designated as having poor coverage, while the southeast part of the county has spotty coverage, with the differing terrain being a major factor. The map below was recreated to show where users reported coverage issues on the County's current radio system. Areas of darker red shading indicate that multiple user agencies described coverage issues in those areas.

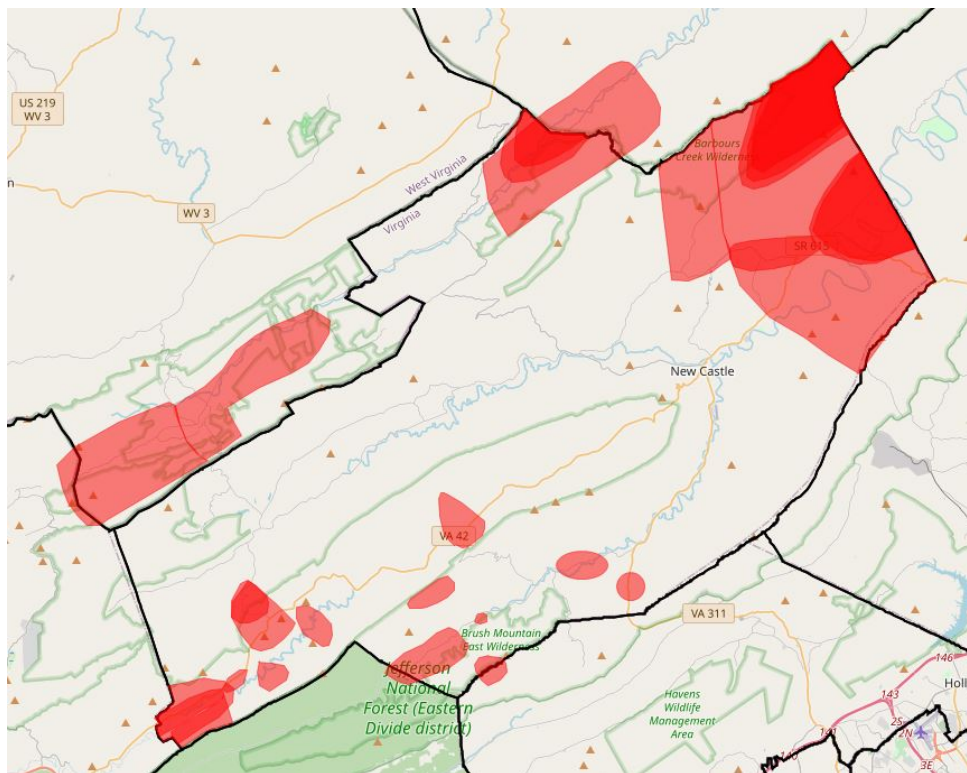


Figure 2-1: Coverage Problem Areas

2.3.3 Interference

Users report interference issues close to Montgomery County and near Potts Mountain, and can hear communications from the school buses. There is also interference from local businesses talking on the radios. Alleghany County also causes interference but is currently removing their equipment from Potts Mountain.

2.3.4 Crowding

Having only one dispatch frequency for the Sheriff's Office and a single dispatch frequency for fire and rescue may seriously endanger both members of the community and first responders. With all radio transmissions reliant on a single channel, crowding is a common and significant issue. In addition, because Craig County Dispatch only has a single console for all Fire and Rescue, agencies can speak over each other when responding to dispatch calls. When this occurs, Dispatch is unable to hear anyone's responses, and vital communications are missed by both dispatcher and users in situations when the repetition of voice calls delays mission critical information. Channel crowding has not been significant in the past, but it is becoming more frequent. The occurrence of multiple concurrent incidents is unpredictable, but the communications overwhelm Dispatch at those times. It can be difficult for Dispatch when they are working two unrelated incidents at the same time. Crowding issues also happen when two or more fire departments are responding at the same time, or when communicating with multiple buses, because the school buses are all on the same frequency.

2.4 Future Requirements

The Craig County agencies expressed future requirements and needs that will assist them in using an upgraded radio system. Agencies expressed the need for Encryption for Law Enforcement, Mobile Data, Computer-aided Dispatch (CAD) location, additional channels, and updated radio equipment. A microwave or a fiber link between the existing Dispatch and Emergency Services building will be beneficial, and a maintenance contract that includes preventative maintenance is also important.

It will be beneficial to have Mobile Data terminals (MDT) for at least the coordinator, assistants, and on the first run trucks, along with CAD location / Global Positioning System (GPS) location on a screen in the station showing active calls and locations, and the ability to use a phone mapping application (without having to request a repeat from Dispatch) for call locations. This will require cellular data or Wi-Fi to use notification apps. Utilizing applications to indicate when users are en route to an incident and on-scene will cut down on unnecessary communication on the Dispatch channel.

Additional features which will be useful to responders are an emergency feature, which allows Rescue to press a button to discretely reach law enforcement for assistance; using radios that require less channel changing; adding DVRs for some agencies; and providing intrinsically safe portables.

The agencies will benefit by having a separate channel for both Fire /Rescue and Dispatch, a channel for each VFD department, and an additional channel for countywide talk around.

Future Interoperability should include the ability to talk to Virginia Department of Transportation (VDOT), Roanoke County, Giles County, Montgomery County, Botetourt County, and Monroe, West Virginia and their respective Dispatch centers.

Interviews were documented and sent to the person(s) interviewed for their review and comment. These complete records are included as Appendix B Interview Records.

2.5 Current Communications Sites

CTA visited the following sites:

- Simmonsville Volunteer Fire Department
- Craig County Emergency Operations Center
- Craig County Sheriff Office and Public Safety Answering Point (PSAP) Dispatch Center
- Potts Mountain Tower and Equipment Shelter

CTA was unable to visit the Sinking Creek Mountain site; however, Craig County shared photos and information on the site.

CTA reviewed the sites for proper grounding and overall site aesthetics and reviewed current installation quality, equipment, and identified any site deficiencies. We are familiar with radio tower site design and know the applicable standards and best practices that should be in place at a public safety site. The site survey report, which catalogues these items and recommends any site improvements necessary to make the sites public safety grade, is documented in this section.

CTA rates each site based on the current conditions and the standards we believe necessary for a secure, functional, public safety grade communications site. The table below shows the rating for all aspects of the sites. Rating System is based on 0 - 5 as shown:

0 = Non-existent, 1 = Poor, 2 = Fair, 3 = Average, 4 = Good, 5 = Excellent

	Potts Mtn	Sinking Creek Mtn	Simmonsville VFD	Emergency Operation Center	Craig County Dispatch
Site Access	5	1	5	5	5
Adequate Parking	5	1	5	5	5
Perimeter Fencing	5	4	0	3	N/A
Room for Additional Shelter	5	0	5	5	N/A
Tower Condition	4	3	4	4	N/A
Tower Loading	3	4	4	3	N/A
Tower Grounding	5	1	3	3	N/A
Shelter Condition	3	3	4	3	4
Shelter Outside Grounding	4	0	0	2	0
Equipment Room Condition	4	2	4	2	4
Equipment Room Grounding	5	0	2	4	0
HVAC	3	0	1	3	0
Electrical	3	1	4	4	3
Backup Power	4	4	0	4	3

Table 2-1 Sites Rating System

2.5.1 Simmonsville Volunteer Fire Department

Simmonsville Volunteer Fire Department maintains its own two-way radio repeater at the facility. The facility has a 40 ft Roan style tower located near the north-west corner of the building. The tower is lightweight and in good condition, with three mounted antennas. The radio equipment is housed in the office area of the fire house building. The room housing the equipment is 9.5 ft by 7 ft. Removing the office equipment and furniture from the room will create space for two racks of equipment. Currently the radio equipment is housed in a single quarter rack, mounted on a shelving unit. There are two UHF repeaters, Kenwood and Icom, for the Sheriff and Simmonsville VFD. There are Icom radios that provide the UHF link to the dispatch center located in New Castle. There is room for a new shelter and tower next to the building or in the building's parking lot. A perimeter fence can be added for greater security.



Simmonsville Volunteer Fire Department

2.5.2 Craig County Emergency Operations Center

The Craig County Emergency Operations Center (EOC) is located in New Castle, Virginia. The EOC has an 80 ft self-supporting tower located on the west side of the building. The tower looks to be in very good condition. It is a medium duty tower, with a light to medium load. The EOC has a communications room and equipment room. The Communications room houses the control station radios and backup Zetron console. The control station radios provide communications with Fire, EMS, and the Sheriff's Office. The equipment room is the entry point for all incoming transmission lines and cables. It also houses the remote radios for Statewide Interdepartmental Radio System (SIRS), Sheriff Office, Fire/Rescue and a Virginia Department of Emergency Management (VDEM) server. It will be beneficial to limit the use of the equipment room exclusively to storage for the radio and IT equipment.



Craig County EOC

2.5.3 Craig County Sheriff's Office/Dispatch

The Craig County Sheriff's Office, located within the Craig County Circuit Courthouse, houses the Dispatch Center. The radio equipment for the dispatch center is located in a small equipment closet, which contains a single rack of equipment. Adding additional racks to the equipment room may not be possible. The Dispatch Center currently uses Zetron model 4010 consoles with desktop microphones at both dispatch positions. There is a backup control station and a Zetron model 15B encoder next to the first position. Antennas for the radio equipment are located on the roof of the courthouse. Connectivity to Potts Mountain, Sinking Creek and Simmonsville VFD is provided via UHF control links. Upgrading the grounding for the equipment may help with the equipment reliability.



Craig County Radio Equipment – Dispatch Center

2.5.4 Potts Mountain

The Craig County Potts Mountain site is located 0.3 mi off Rt. 311 west of New Castle on national forest land. The site contains a 12 x 18 ft prefabricated shelter and 140 ft tower. The tower is a medium build, supporting a medium load of antennas. The eastern leg of the tower has very little space for new antennas. There are two 15 KW generators, one for the County and the other for the Craig-Botetourt Electric Co. Grounding at the site was good but does not follow the preferred single-point grounding method. One of the Heating Ventilation and Air Conditioning (HVAC) units was not operational. There is space in the shelter for more equipment racks. There is space for a small tower or an equipment cabinet on the south side of the compound, but as this site is located in the national forest. It is a time consuming process when approving additional structures with the U.S. Forestry Service.



Potts Mountain

2.5.5 Sinking Creek Mountain

We were not able to visit the Sinking Creek Mountain site due to weather and other issues. This summary is based on photos and information provided by Craig County. The Sinking Creek Mountain site is located in the eastern part of Craig County. Access is limited to high clearance 4-wheel drive on vehicles. The tower at the site is a 110 ft guy wire tower and is lightly loaded. The radio equipment is housed in an equipment cabinet at the base of the tower. There is a small LPG Generac generator to provide a backup power for the equipment. Fuel is provided by 100 lb. fuel tanks. There is a chain link fence securing the site, but the compound is very small. Expanding the compound and adding a shelter will allow for more space for equipment.



Sinking Creek Mountain

3.0 Communications System Considerations

3.1 Public Safety Grade

The Public Safety Community requires a wide variety of interoperable, standards based Communication Services, Configurations, and Capabilities with well-defined performance, interoperability, and testing specifications. One of the areas to consider is: What is a Public Safety Grade Communications System?

The following excerpts from the National Public Safety Telecommunications Council (NPSTC) paper published 5/22/14 and titled: “*Defining Public Safety Grade Systems and Facilities*” highlight the content and intent of that report: “The term “Public Safety Grade” is a conceptual term that refers to the expectation of emergency response providers and practitioners that their equipment and systems will remain operational during and immediately following a major natural or manmade disaster on a local, regional, and nationwide basis.” “PSG communications systems are systems used by public safety responders that have been evaluated by public safety officials to provide reliant and resilient operations in the event of natural or manmade disasters or events.” “Communications is vital to both public safety field and command personnel during routine, local incidents and even more so during major incidents covering a larger area. Public safety voice LMR networks today are among the most reliable networks available in the United States. Today’s commercial wireless networks are not built to the same standard.”

“This report seeks to further define the phrase “Public Safety Grade” and to provide measurable characteristics which will differentiate a mission critical communications system from a standard or commercial grade network. Qualitatively, we define PSG communications simply as the effect of reliable and resilient characteristics of a communications system. The system should be designed to minimize the impact of, or eliminate entirely, equipment or component failures that result in a loss of data throughput or coverage and be designed in a manner that promotes the system’s quick return to optimal performance. This report seeks to further define the phrase “Public Safety Grade” and to provide measurable characteristics which will **differentiate a mission critical communications system from a standard or commercial grade network.**”

For the full NPSTC report and a document with frequently asked questions visit the following sites:
https://npstc.org/download.jsp?tableId=37&column=217&id=3066&file=Public_Safety_Grade_Report_140522.pdf
http://project25.org/images/stories/ptig/White_Papers/PTIG_Whitepaper_Is_Project_25_Public_Safety_Grade_FIN_AL_160229.pdf

3.2 Frequency Bands

3.2.1 VHF

VHF is still one of the highest used frequency bands for public safety. The public safety Very High Frequency (VHF) band consists of non-contiguous channels between 150 to 174 MHz. Frequencies for VHF are licensed as a single frequency, not as a transmit/receive pair. Given the high usage and the lack of pairing, VHF is significantly more complex when it comes to licensing additional frequencies. Due to this complexity, the Federal Communications Commission (FCC) mandated channel narrow-banding, from 50 kHz channel width to 25 kHz channel width, then to 12.5 kHz channel width. **While this narrow-banding improved the spectral efficiency of VHF frequencies, it reduced the effective coverage after each round of narrow-banding.**

We note there are FCC Title 47, Part 22 VHF frequencies that can be purchased; however, the cost of these frequencies can potentially be between \$10,000 and \$100,000 per frequency. Additionally, the purchaser must ensure the frequency does not interfere with others prior to making it operational.

VHF provides larger coverage areas for the same power levels as higher frequency bands due to the longer wavelength of VHF frequencies. VHF radio systems work exceptionally well in areas with greatly varying terrain, due to the ability to travel over hills and mountains more effectively. Since VHF RF signals travel long distances, the VHF frequency band tends to be more susceptible to co-channel interference. This makes finding available frequencies for use very difficult. VHF radio systems are generally designed for mobile only coverage, due to the lack of tower top amplifiers, and higher body loss and the lower transmit power for VHF portable radios (10 watt maximum). VHF systems that use portable subscribers must have satellite receivers and voter systems installed within the coverage areas. The use of Digital Vehicular Repeaters (DVR's) may also be required to extend the range of VHF portable radios. VHF also has issues with in-building penetration due to several issues including inefficiencies with portable VHF antennas.

3.2.2 UHF

The public safety Ultra High Frequency (UHF) high band consists of non-contiguous channels between 450 to 470 MHz. Frequencies are licensed as transmit/receive pairs with 5 MHz of separation between the transmit and the receive frequencies.

Many public safety agencies use the UHF band for their radio systems. UHF systems provide good coverage over varying terrain while still having better building penetration than VHF systems. It can be difficult to find available frequencies, but there are likely more available frequencies in the UHF band compared to the VHF band. UHF systems can be designed to be balanced for either mobile subscribers or portable subscribers. The UHF band can provide good coverage, but VHF provides better coverage at the same power levels.

3.2.3 700/800 MHz

For the purposes of this report, the 700 MHz band and 800 MHz band are interchangeable. In general, they have similar coverage and in-building performance. Radio equipment vendors generally manufacture their equipment capable of functioning the same way for either 700 or 800 MHz frequency bands.

700/800 MHz frequencies provide public safety users a balanced coverage footprint for both mobile and portable radios. 700/800 MHz systems provide the best in-building coverage for all public safety frequency bands because it is easier for the shorter wavelength frequencies to penetrate buildings. 700/800 MHz systems have some increased issues penetrating dense forests and traveling over greatly varying terrain. The use of tower-top amplifiers can greatly improve portable talk-in coverage. Typically, additional transmit sites are required for 700/800 MHz systems to provide coverage over a large area compared to VHF and UHF systems.

3.2.3.1 800 MHz

Public safety radio systems (such as those used by law enforcement, firefighters, and emergency medical technicians) operate in several portions of the 800 MHz band, which consists of spectrum

at 806-809 MHz paired with spectrum at 851-854 MHz. Frequencies are licensed as transmit/receive pairs with the 25 MHz separation.

To address the growing problem of harmful interference to 800 MHz public safety communication systems caused by high-density commercial wireless systems, the Commission adopted a comprehensive plan to reconfigure the band in July 2004. This plan is designed to protect the lives of first responders and other emergency personnel and fulfills the Commission's obligation to promote safety of life and property using wire and radio communications.

In 1987, the Commission set aside six megahertz of spectrum in the 800 MHz band for exclusive use by local, regional and state public safety agencies under guidelines developed by the National Public Safety Planning Advisory Committee (NPSPAC). The 800 MHz NPSPAC spectrum is administered on a regional basis by 55 regional public safety planning committees.

3.2.3.2 700 MHz

In response to the Balanced Budget Act of 1997, the FCC established a new 700-MHz public safety Land Mobile Radio (LMR) band. The FCC adopted rules for the 700-MHz band (764-776/794-806 MHz) with three basic concerns in mind:

- A. Efficiency. The FCC seeks to promote spectrum efficiency in the band by requiring an aggressive standard of one voice channel, or one data channel of 4800 bits per second (bps), per 6.25 kHz of bandwidth.

The FCC has not mandated a specific technology for meeting this requirement, but all systems licensed for this band must use some form of digital modulation. By 2015, all equipment manufactured and marketed for use in the 700-MHz band was required to meet the 6.25-kHz efficiency mandate, and no new applications for systems operating at 12.5-kHz efficiency will be accepted. By 2017, all systems in the band were required to operate at 6.25-kHz efficiency.

- B. Interoperability. The FCC has set aside a significant portion of the band (2.6 MHz) for interoperability. Although the FCC has refrained from mandating standards for the rest of the band, it has mandated Project 25 Phase 1 as the standard for use on the narrowband interoperability channels.
- C. Flexibility. The FCC recognized that by mandating the adoption of specific technology standards, it may actually inhibit the acceptance of more advanced and spectrum-efficient technology. Therefore, it allows the market to drive the technology providing flexibility in the licensing of frequencies in the 700-MHz band. The band is divided into 960 narrowband 6.25-kHz channels and 120 wideband 50-kHz channels.

A licensee may aggregate two or four narrowband channels to create a single 12.5- or 25-kHz channel, if the overall spectrum efficiency is one voice channel, or one data channel of 4800 bps, per 6.25 kHz.

The general use channels, and some of the narrowband low power channels, are subject to regional planning. There are 55 Regional Planning Committees (RPCs), whose task is to create a plan for General Use in their area is used and submit it to the FCC.

3.3 Message Transmission Types

3.3.1 Analog

Analog radio uses a carrier wave to send a message from one radio to another. The message is only transmitted one time and is sent as a single unit. Analog messages can be problematic because if the signal is interrupted or is interfered with and the message is lost, there is no way to get it back. Analog messages are transmitted much faster than digital messages because there is no processing involved in transmitting and receiving the message.

3.3.2 Digital

A Digital radio breaks up a message into numbered fragments. The message fragments are sent many times, to increase the chance that the receiver will get all the parts of the message. The digital receiver collects all the fragments of the message, and then puts them in order to complete the message. It takes some time for a digital radio to process the incoming signal so there will be a delay between the time that the message fragments are received and when the message is heard. Digital messages are transmitted on frequencies much higher than analog messages.

3.4 Architectures

3.4.1 Conventional

A conventional system has dedicated channels for specific groups and users, and the user manually selects the channels they will use. For example, channel 1 may be dedicated to law enforcement, while channel 2 may be dedicated to fire personnel. The users are responsible for selecting the correct channel, and they are free to use any of the channels available to them, assuming no one else is currently using the channel. If user 1 is on the channel, user 2 needs to wait until user 1 is no longer transmitting to prevent transmission traffic jams. It is possible for one user to “step-on” another user’s transmission by transmitting at the same time, which causes the transmission to be garbled or inaudible. Given the nature of a conventional system, the number of users who can successfully use the system is directly related to the number of channels available. Conventional systems are typically best suited for businesses, organizations, or public safety agencies with a smaller number of users.

3.4.2 Trunking

Trunked radio systems are complex channel-controlled systems that use talk groups, which users can select depending on who they need to communicate with. Trunked systems are more efficient than conventional systems because of the ability to dynamically switch between channels, allowing talk groups to utilize any available channel. Trunked systems do not increase the number of simultaneous calls that can be made; however, it decreases the chance of not being able to transmit due to a busy channel.

Table 3-1 below summarizes the technical, operational, and cost differences between Conventional and Trunked Systems.

Category	Conventional	Trunked
Redundancy	If a conventional channel goes down, primary operations for that channel must go to a secondary channel. If no secondary channel exists, must install backup control stations (limited coverage).	If a channel failure occurs, then the system assigns another frequency pair to the requested talk group since all frequencies are pooled together.
Capacity	Frequency pairs are tied to specific channels. Meaning each agency has a set number of channels	Frequency pairs are pooled together so that the first frequency pair available is used for voice messages
Coverage	No significant differences in coverage between conventional and trunked systems	
Maintenance	Less equipment (hardware and software) to maintain for conventional systems	Significantly more equipment (hardware and software) to maintain for trunked systems.
Interoperability	Offers seamless interoperability both within and outside of your jurisdiction, by allowing the radios to switch directly to interoperability channels on all radios for other conventional radio systems. Will require additional interoperability gateways to talk to neighboring DMR and Trunked systems.	Offers seamless interoperability with agencies outside of your jurisdiction by reverting trunked radios to conventional mode to operate on conventional interoperability channels. Interoperability with outside agencies coming into your jurisdiction will require conventional channel gateways for surrounding agencies that do not have trunked system features on their radios. Offers seamless interoperability inside and outside of your jurisdiction for neighboring jurisdictions with trunked radio systems.
Cost	System infrastructure is less expensive due to not having core equipment. Subscriber radios are less expensive due to less features.	System infrastructure more expensive due to additional core equipment to control the trunked radio system. Subscriber radios more expensive due to the requirement for trunking features.

Table 3-1 Conventional versus Trunked Radio Systems

3.4.3 Simulcast

Simulcast is an abbreviation for simultaneous broadcast, and in the context of LMR, it means the simultaneous transmission from two or more repeater sites on the same radio frequency (RF) and with the same modulation. Simulcast has been around since the 1960s, but its popularity has increased recently — in part because modern technology has made simulcast more reliable.

Simulcast networks offer several advantages:

- Overlapping coverage without handoff complexity
- Better trunking efficiency
- Simpler operation, especially for conventional (non-trunked) repeater systems

Simulcast networks also employ voting receivers, which offer macro-diversity improvement on the inbound path.

Disadvantages of simulcast include high cost and signal distortion in simulcast-overlap regions. The increased cost results from more complex timing and control hardware, but also from the simple fact that each site must be populated with one repeater for each frequency used in the network. Signal distortion in simulcast overlap regions is also referred to as time delay interference (TDI). TDI occurs when two or more simulcast signals arrive at the user's radio antenna with comparable amplitude, but with inverse signal phase, causing signal cancellation.

3.4.4 Voted Receive System

A voting system allows multiple receivers in strategic locations to receive the incoming signal and choose the receiver with the best audio quality to be repeated or sent to the console. The use of voted receiver systems can significantly improve the talk-in coverage from portable and mobile radios.

3.5 Technologies

3.5.1 DMR

Digital Mobile Radio (DMR) is a commercial grade digital trunking radio open standard specified for mobile radio users. The primary goal of this standard is to specify affordable digital systems with low complexity. DMR Tier III trunking allocates channels on demand, making it frequency efficient and enabling a large number of users to share a relatively small number of channels. DMR provides voice, data, and other supplementary services, and DMR radio systems are used worldwide. DMR systems are not considered "Public Safety Grade" systems in the U.S. despite the usage of these systems for public safety personnel in Europe. DMR does not meet the standards for reliability and redundancy of public safety personnel in the United States.

MOTOTRBO is a Motorola digital radio product designed for use by business and industrial users. The format is compatible with DMR and uses Time Division Multiple Access (TDMA) to accommodate two users operating simultaneously on the same channel. A MOTOTRBO system can also have a voice and data call operating simultaneously on the same channel. MOTOTRBO can operate on different talk groups like a trunking system and can achieve wide-area operation through IP connectivity. Even though some public safety agencies in the U.S. use MOTOTRBO systems for mission critical communications, these systems are not considered "public safety grade" by organizations such as the Association of Public Safety Communication Officials (APCO) and National Emergency Number Association (NENA). Our experience is that jurisdictions that installed MOTOTRBO systems have had to replace the system in 5-8 years due to degradation of service. This degradation is caused by the 24/7/365 usage of equipment that is not designed to withstand this level of usage.

3.5.2 Push to Talk over Cellular (PoC)

PoC generally refers to a service that operates on commercial 3G, 4G, Long-Term Evolution (LTE) cellular providers, but can include First Responder Network Authority (FirstNet), Private LTE, and Wi-Fi. These services utilize a device with a dedicated Push to Talk (PTT) button, or an application installed on a smart phone, and can be integrated into LMR systems with the use of radio gateways.

PoC does not meet the requirements of public safety grade communications. However, LMR systems can be transitioned to PoC while maintaining the ability to contact users on the radio system. This will include non-first responder uses, such as public utility workers, roads or transportation departments, or similar users, who do not require the guaranteed connectivity of a public safety radio system.

3.5.2.1 Commercial Cellular Providers

Most of the major commercial cellular service providers, including AT&T, Sprint, and Verizon, have some type of PoC service operating on the mobile data infrastructure. They can provide nationwide coverage, but only where the service providers have coverage, with no coverage guarantees. These services can include user to user calls, group calls, dispatch software and user location services.

3.5.2.2 FirstNet

The First Responder Network Authority (FirstNet) of the United States was created under the Middle Class Tax Relief and Job Creation Act of 2012 (MCTRJCA) as an independent authority within the National Telecommunications and Information Administration (NTIA). The purpose of FirstNet is to establish, operate, and maintain an interoperable public safety broadband network. To fulfill these objectives, Congress allotted \$7 billion and 20 MHz of valuable radio spectrum to build the network. The authority board created a public-private partnership with AT&T in March 2017 to build out FirstNet. In December 2017, all 50 states opted into the network plan with AT&T.

FirstNet and AT&T desire to improve public safety communications by using private sector resources, infrastructure, and cost-saving synergies to deploy and operate the nationwide broadband network. AT&T will deploy and operate a nationwide high-speed broadband network for public safety over 25 years. AT&T can use FirstNet's spectrum when it is not being used by public safety for other purposes. The company states their intent to prioritize first responders over any other commercial users.

FirstNet acts as the mobile broadband service provider, and it does not include PoC service or interface into LMR systems without using a radio or Inter-RF Subsystem Interface (ISSI) gateway of some type, depending on the radio system. It is important to recognize this system is dependent upon having sufficient towers to provide the needed coverage, which is problematic in rural, less populated areas of the US.

3.5.2.3 LMR Vendors

This is not meant to be a comprehensive list of LMR vendors or vendors who provide PoC solutions. Motorola and L3Harris both have proprietary PoC solutions. EF Johnson utilizes ESChat's PoC solution on their P25 radio systems. JPS Interoperability Solutions also use ESChat's PoC solution integration with its ACU technology and JPL's PoC application. The solutions use either cellular mobile data service providers (3G, 4G, or LTE) or FirstNet LTE service to provide connectivity between the PoC application and the LMR system via a radio gateway.

Motorola's PoC solution for LMR is a combination of WAVE and Critical Connect applications. First responders can use their ASTRO 25 radios for PTT communication with each other as well as with personnel using smartphones and the WAVE broadband PTT application. Critical Connect is a Motorola cloud-based application that allows interoperability between radio systems and/or cellular service providers based on ISSI gateway.

L3Harris's solution for LMR uses an on-site server to connect and manage the BeOn mobile application. BeOn keeps you connected to your LMR system anywhere you have a cellular data signal, WiFi or other data connectivity, and provides a direct connection to the backbone of your LMR system, fully supporting the features of a P25 radio network. ESChat's PoC solution for LMR can integrate with many different radio system types, such as: Analog LMR, P25, DMR, Tetra, MOTOTRBO or any other format. Some system capabilities may be limited depending on the system type and the method of integration.

3.5.3 NEXEDGE

NEXEDGE is a Kenwood radio system that was the first to offer trunking, and the first radio system to be able to communicate with both analog and digital radios. This makes NEXEDGE very useful for clients with older systems that want to migrate to a new system because they can keep the old system's radios for use with the new system. NEXEDGE is an open standard and is supported by many vendors making NEXEDGE compatible with other vendor products.

3.5.4 Project 25 (P25) Standards

This technology is standards-based and is available from multiple LMR vendors. The P25 standards (as defined by the Telecommunications Industry Association [TIA] TIA-102 series of standards) have been in development for years and have matured to the point that the goal of having interoperable digital radio equipment from multiple vendors has become a reality.

The P25 standards have been adopted by the Federal Communications Commission (FCC) for use on the interoperability channels in the 700-MHz Public Safety Communications Band. Federal and State grant programs for communications technology typically require equipment compatible with the P25 standards, and the federal government has adopted P25 for its own law enforcement needs. These developments have rapidly expanded acceptance of the P25 standard in the marketplace.

The major radio system vendors focused their research and development efforts on P25, and as existing radio systems (such as the County's) will not be supported by the vendor past 2021, they are being replaced with new P25 systems. Systems and equipment are available from several manufacturers. L3Harris and Motorola are the predominant market players, but Airbus DS Communications, Tait and EF Johnson have system and subscriber offerings as well. Other vendors such as Icom and Kenwood offer P25 subscriber equipment. Zetron, Avtec, Catalyst Communications, and Pantel offer dispatch console solutions that integrate with the trunked radio system equipment.

The key to P25 is the common air interface (CAI), an over-the-air protocol that all P25 radios can encode and decode to provide voice communications. Other interfaces have been standardized, such as the console subsystem interface (CSSI) and the inter-RF subsystem interface (ISSI); these interfaces are starting to be deployed. The LMR industry is improving in the area of mixing and matching system fixed

infrastructure among various vendors. The ability to utilize P25 subscribers from different vendors is now realized.

P25 standards have been developed in 2 phases. Phase 1 is based on a frequency-division multiple-access (FDMA) CAI providing 1 voice communication (talk) path per 12.5-kHz channel. Phase 2 includes a CAI for TDMA communication, where 2 talk paths share a single 12.5-kHz channel. Each talk path, in this case, is assigned a separate time slot.

While Phase 1 has been available for over 10 years, Phase 2 TDMA standards have now also been finalized. Vendors are now routinely shipping Phase 2 systems, which allow an agency to double capacity with the same number of channels. Most new Phase 1 equipment (whether subscriber units or fixed infrastructure equipment) can be upgraded via software to Phase 2 operation.

P25 standards are designed so a Phase 2 system is backward compatible with Phase 1 subscriber units. However, the benefits of a Phase 2 system are not realized until subscriber units capable of Phase 2 operation are purchased.

In theory, P25 subscriber radios from one vendor should work on another P25 vendor's infrastructure. The P25 Compliance Assessment Program (CAP) is a voluntary compliance test with certification conducted by an independent third-party testing lab. The program tests the subscriber's P25 standard features work on known-compliant P25 systems. CAP certification lists may be found on the www.project25.org website and the manufacturers' sites. Requiring CAP certification will ensure equipment is compatible with other vendor systems.

Of course, major P25 infrastructure vendors prefer you buy their radios. To encourage this behavior, most P25 infrastructure vendors add proprietary "value added" features, over and above the mandatory P25 standard features. Implementing proprietary features tends to lock the operator into purchasing subscriber units only from the system vendor. There are several proprietary features available, a common and popular feature is Over-The-Air Programming (OTAP). This allows operators to reprogram subscribers without recalling radios to a service shop.

The CSSI (which is a subset of the ISSI) allows dispatch consoles from other third-party vendors to be used on the P25 radio system. Some radio system vendors do not offer a dispatch console, so the CSSI must be used to interface consoles to the radio system. Other radio system vendors offer their own "native" dispatch consoles which connect directly to the radio system's core control and switching equipment. Just as with subscriber equipment, there may be proprietary features, and the implementation of features with the native consoles may be different than those same features implemented through the CSSI.

An example of this is patching and simulcast. The TIA has not yet standardized a dynamic method of handling patching and simulselect across the CSSI. So currently using the CSSI, patching multiple talk groups together can result in multiple simultaneous calls on the radio system, with each talk group using its own talk path. On a native console, patching may be accomplished through a more dynamic means such that only one talk path is assigned for the patched call.

3.5.5 TETRA

TETRA (Terrestrial Trunked Radio) is a set of standards developed by the European Telecommunications Standardization Institute (ETSI) that describes a common mobile radio communications infrastructure throughout Europe. This infrastructure is targeted primarily at the mobile radio needs of public safety groups (such as law and fire departments), utility companies, and other enterprises that provide voice and data communications services throughout Europe.

In recent years, when European disasters have struck, emergency response teams from several European nations had a difficult time communicating with each other, due in part to the lack of standardization in their mobile radio equipment. The TETRA standards evolved to answer this communication challenge as well as others faced or anticipated by the European Commission (EC) in its efforts to unify European countries. TETRA was developed in Europe to provide interoperability for mutual aid. TETRA is not commonly used in the U.S. because it is a European standard. The U.S. chose to implement its own interoperability standard, P25, which is the leading public safety radio system technology.

3.6 Connectivity

3.6.1 Microwave

Microwave connectivity is a technology that consists of using RF signals in the 1-100 GHz frequency range between two highly directional antennas to transport large amounts of data between radio sites and communications centers. Microwave radio is regarded as the most reliable form of connectivity because of the low Mean-Time-Between-Failures (MTBF) for the equipment and minimal hazards due to human intervention. Microwave RF signals are however susceptible to high signal loss during storms, and periods of heavy rain. Microwave signals can also be degraded due to growing trees, or new urban development directly in the microwave path.

3.6.2 Fiber

Fiber connectivity provides a high-speed data transport through commercial or private fiber optic cables. Data is transported through fiber cables using light, which can provide very high data throughput with low latency. Fiber cables are run underground making them susceptible to being broken or cut due to digging near the cables. This can cause large downtime windows as it can be difficult to determine where the cable break is in 100's of miles of buried cables. If using commercial fiber, it can take even longer to get the fiber connection operational again, because no single user is necessarily the commercial provider's highest priority.

3.6.3 Leased Lines

Commercial copper leased lines, also referred to as POTS (Plain Old Telephone Lines), have been used for many legacy radio systems as the primary method of connectivity. Typically, these leased lines provide low data rates, in the kilobits per second range. For newer VOIP (Voice Over IP) based radio systems with heavy data usage, commercial leased lines are typically not used because they cannot meet demands for data speeds.

4.0 System Alternatives

There is an urgent need for a new radio system in Craig County to provide public safety grade coverage when and where needed. CTA evaluated the following alternatives to meet this need:

- Do Nothing
- Upgrade Existing Radio Systems
- UHF DMR Radio System
- UHF Conventional Analog Radio System
- UHF Hybrid Analog/P25 Conventional Radio System
- UHF P25 Conventional Radio System
- 700/800 MHz P25 Phase 2 Trunked Simulcast Radio System
- Join a Neighboring P25 Trunked Radio System
- Join Virginia State Police VHF STARS System

4.1 Radio System Alternatives Analysis

We use an Impact Analysis process to help evaluate the system alternatives in combination with of all the information gathered during this Needs Assessment. The results help narrow down the alternative(s) that best fit your needs. The Impact Analysis is an interactive process between Craig County and CTA. These inputs include problems and needs identified during interviews, new system attributes based on your needs, and your attribute importance rankings. Below is a visual representation of the process flow:

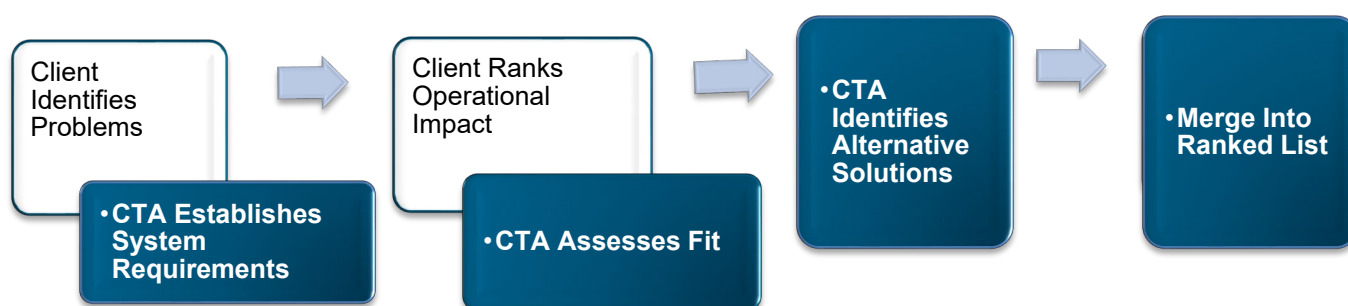


Figure 4-1 Impact Analysis Flow Chart

- System Attributes – Positive characteristics of a new system that may be emphasized during the conceptual design. Attributes are identified by CTA following our interviews.
- Attribute Rankings – Attribute's importance ratings solicited from Craig County.

The ranking criteria used during this process is as follows:

- 0 Attribute is NOT IMPORTANT to the user.
- 1 Attribute is MINIMALLY IMPORTANT to the user.
- 2 Attribute is NICE TO HAVE and can enhance operations.
- 3 Attribute is USEFUL and will promote more efficient day to day operation.
- 4 Attribute is QUITE IMPORTANT and not having may result in degradation of mission, injury, or loss of property.
- 5 Attribute is CRITICAL and not having may result in injury, loss of property, or degradation of mission.

CTA evaluates each of the alternatives with your inputs in mind to develop our opinion of technical fit. A panel of CTA engineers and technical personnel independently assessed how well each design alternative can fulfill the attributes identified for Craig County. Each panelist considered the alternatives, one attribute at a time, and scored the ability of that alternative to deliver that attribute. Scoring ranges from a value of 0 (nonexistent capability) to 5 (95 % of the function/attribute) based on how well the alternative satisfies the requirement.

The criteria for evaluating and ranking each item were established as follows:

- 0 Required function (Attribute Does Not Exist)
- 1 Required function (Available but Totally Insufficient)
- 2 Generally inadequate (Unacceptable Alternative)
- 3 Marginally Adequate (Approximately 60% Functionality)
- 4 Reasonably adequate (A Good Alternative)
- 5 95% of Function / Attribute Available (Excellent Alternative)

The results are combined and summed to provide a score for how well the alternatives served the attributes as a whole. The results are used as an input to the Impact Analysis process. Attribute scores are then weighted using the average ranking submitted by Craig County. In this way, characteristics which are important to you carry more weight, and lower importance attributes carry less weight. The result is a weighted ranking of the system alternatives for overall suitability. The following Alternatives Ranking Matrix contains the results of the impact analysis for each alternative for Craig County.

ALTERNATIVES RANKING MATRIX																			
ATTRIBUTE	Craig County	Do Nothing		Upgrade Existing Radio System		UHF Countywide DMR (MOTOTRBO)		UHF Simulcast Conventional Analog		UHF Hybrid Analog/P25 Conventional		UHF Simulcast P25 Conventional		700/800 MHz P25 Phase 2 Trunked		Join a Neighboring County's P25 Trunked Radio System		Join Virginia State Police STARS	
	Weight Factor	Average Score	Ranking	Average Score	Ranking	Average Score	Ranking	Average Score	Ranking	Average Score	Ranking	Average Score	Ranking	Average Score	Ranking	Average Score	Ranking	Average Score	Ranking
Coverage - Mobile	4.86	2.0	9.7	2.0	9.7	5.0	24.3	5.0	24.3	5.0	24.3	5.0	24.3	3.0	14.6	3.0	14.6	4.5	21.9
Coverage - Portable Outdoors	4.43	0.0	0.0	0.0	0.0	4.0	17.7	4.0	17.7	4.0	17.7	5.0	22.1	2.0	8.9	2.0	8.9	4.5	19.9
Coverage - Portable Inside Buildings	3.86	0.0	0.0	0.0	0.0	3.0	11.6	3.0	11.6	3.0	11.6	4.0	15.4	1.0	3.9	1.0	3.9	3.0	11.6
Dispatch Operational Concept	3.86	1.0	3.9	1.0	3.9	5.0	19.3	3.0	11.6	4.0	15.4	5.0	19.3	5.0	19.3	4.0	15.4	4.0	15.4
Flexibility in Channel/Talk Group Structure	3.57	0.0	0.0	0.0	0.0	4.0	14.3	1.0	3.6	2.0	7.1	2.0	7.1	5.0	17.9	3.0	10.7	2.0	7.1
Survivability	4.00	0.0	0.0	3.0	12.0	5.0	20.0	4.0	16.0	4.0	16.0	4.0	16.0	5.0	20.0	5.0	20.0	5.0	20.0
Redundant System Equipment	3.29	0.0	0.0	0.0	0.0	4.0	13.1	4.0	13.1	3.0	9.9	3.0	9.9	5.0	16.4	5.0	16.4	5.0	16.4
Capacity / Frequency	3.43	2.0	6.9	2.0	6.9	5.0	17.1	3.0	10.3	3.0	10.3	4.0	13.7	5.0	17.1	5.0	17.1	4.0	13.7
Infrastructure Scalability	3.00	0.0	0.0	2.0	6.0	4.0	12.0	4.0	12.0	4.0	12.0	4.0	12.0	5.0	15.0	4.0	12.0	3.0	9.0
Interoperability	4.00	2.0	8.0	2.0	8.0	1.0	4.0	3.0	12.0	3.0	12.0	3.0	12.0	1.0	4.0	2.0	8.0	3.0	12.0
No Interference	3.29	1.0	3.3	1.0	3.3	5.0	16.4	5.0	16.4	5.0	16.4	5.0	16.4	5.0	16.4	5.0	16.4	4.0	13.1
Maintainability	3.86	0.0	0.0	3.0	11.6	5.0	19.3	5.0	19.3	5.0	19.3	5.0	19.3	5.0	19.3	5.0	19.3	5.0	19.3
Reliability	4.86	1.0	4.9	3.0	14.6	3.0	14.6	4.0	19.4	4.0	19.4	5.0	24.3	5.0	24.3	5.0	24.3	5.0	24.3
System Operational Transparency	3.57	4.0	14.3	4.0	14.3	5.0	17.9	3.0	10.7	3.0	10.7	5.0	17.9	5.0	17.9	5.0	17.9	5.0	17.9
Emergency Access	3.57	0.0	0.0	0.0	0.0	4.0	14.3	4.0	14.3	4.0	14.3	4.0	14.3	5.0	17.9	5.0	17.9	5.0	17.9
Encryption	2.71	0.0	0.0	0.0	0.0	4.0	10.9	0.0	0.0	5.0	13.6	5.0	13.6	5.0	13.6	5.0	13.6	5.0	13.6
Security (Physical and Software)	2.86	0.0	0.0	2.0	5.7	5.0	14.3	3.0	8.6	4.0	11.4	5.0	14.3	5.0	14.3	5.0	14.3	5.0	14.3
Initial Cost	3.43	5.0	17.1	5.0	17.1	3.5	12.0	3.0	10.3	3.0	10.3	2.0	6.9	0.0	0.0	0.5	1.7	3.8	12.9
Long-Term Cost	3.43	1.0	3.4	2.0	6.9	2.0	6.9	3.0	10.3	3.0	10.3	3.0	10.3	3.0	10.3	4.0	13.7	4.0	13.7
Cost Effectiveness	3.14	0.0	0.0	2.0	6.3	2.0	6.3	2.0	6.3	3.0	9.4	4.0	12.6	0.0	0.0	1.0	3.1	4.0	12.6
Competitive Procurement	3.29	0.0	0.0	1.0	3.3	5.0	16.4	4.0	13.1	4.0	13.1	5.0	16.4	5.0	16.4	1.0	3.3	0.0	0.0
Commonality of Infrastructure Equipment	4.00	3.0	12.0	3.0	12.0	5.0	20.0	5.0	20.0	4.0	16.0	5.0	20.0	5.0	20.0	5.0	20.0	5.0	20.0
Alarms & Monitoring	3.14	0.0	0.0	3.0	9.4	5.0	15.7	5.0	15.7	5.0	15.7	5.0	15.7	5.0	15.7	4.0	12.6	5.0	15.7
Training	3.71	3.0	11.1	3.0	11.1	5.0	18.6	5.0	18.6	5.0	18.6	5.0	18.6	5.0	18.6	5.0	18.6	5.0	18.6
Console Features	3.57	2.0	7.1	2.0	7.1	4.0	14.3	3.0	10.7	4.0	14.3	4.0	14.3	5.0	17.9	5.0	17.9	5.0	17.9
Additional Subscriber Features	2.71	1.0	2.7	1.0	2.7	2.0	5.4	3.0	8.1	3.0	8.1	3.0	8.1	5.0	13.6	5.0	13.6	5.0	13.6
			104.43		171.86		376.57		334.00		357.29		394.71		373.00		355.00		392.21
RANKING			9		8		3		7		5		1		4		6		2

Table 4-1 Craig County Radio System Alternatives Ranking Matrix

At the left side of the Alternatives Ranking table are the attributes established earlier in the project, which refer to the attribute definitions provided in Appendix E of this report. The Weight Factor column is Craig County's importance ranking for each attribute. Under each Alternative are two numerical columns: CTA's average evaluation and the final Ranking for each attribute and each alternative. The ranking column shows the weighted results, which are CTA's average assessment multiplied by Craig County's rank from the weighting factor. Each of the Results columns are totaled at the bottom, arriving at an overall score for each alternative. The totals are summarized below.

When comparing the results of each alternative, it is clear the options related to moving all users to a single frequency band are the highest ranked alternatives for Craig County. The overall highest ranked alternative is a **UHF Simulcast P25 Conventional Radio System**. As seen in Table 4-1, This alternative stands out, primarily in the areas of:

- Coverage
- Dispatch Operational Concept
- No Interference
- Security
- Maintainability
- Reliability
- Encryption

- Security
- Competitive Procurement
- Commonality of Infrastructure Equipment
- Alarms and Monitoring
- Training

ALTERNATIVES SUMMARY									
	Do Nothing	Upgrade Existing Radio System	UHF DMR Radio System	UHF Conventional Analog System	UHF Hybrid Analog P25 Conventional System	UHF P25 Conventional System	700/800 P25 Phase 2 Trunked System	Joining a neighboring P25 Trunked System	Join VSP VHF STARS System
System Functionality/ System Reliability	Not Public Safety Grade	Not Public Safety Grade	Not Public Safety Grade	Not Public Safety Grade	Public Safety Grade	Public Safety P25	Public Safety P25	Public Safety P25	Public Safety P25
Coverage / Sites	Existing Coverage 3 sites	Existing Coverage 3 sites	Improved Mobile/Portable Coverage 4-5 Sites	Improved Mobile/Portable Coverage 4-5 Sites	Improved Mobile/Portable Coverage 4-5 Sites	Improved Mobile/Portable Coverage 4-5 Sites	Improved Mobile/Portable Coverage 6 Sites	Improved Mobile/Portable Coverage 4-5 Sites UHF) or 6 Sites (700/800)	Improved Mobile Coverage using existing STARS Sites
Capacity / Channels	3 Channels	3 Channels	12-15 Channels	4 Channels	4 Channels	4 Channels	4 Channels	4 Channels	4 Channels
Operability	Separate Systems/Frequency Bands	Separate Systems/Frequency Bands	One System/Frequency Band	One System/Frequency Band	Separate Systems / Same Frequency Band	One System/Frequency Band	One System/Frequency Band	One System/Frequency Band	One System/Frequency Band
Interoperability	Gateways / Manual Patch Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe	Gateways / Manual Patch Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe	Gateways / Manual Patch Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe	Gateways / Manual Patch Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe	Seamless for Sheriff's Office Any user on Neighboring System or P25 Capable in the same frequency band	Seamless P25 Capable in the same frequency band Gateways / Manual Patch Non-P25 surrounding	Seamless Roanoke Gateways / Manual Patch Alleghany, Botetourt, Montgomery, Giles, Monroe	Seamless Any user on Neighboring System or P25 Capable in the same frequency band Gateways / Manual Patch Non-P25 surrounding	Seamless VSP Gateways / Manual Patch Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe
Costs		\$2,000,000 - \$2,300,000	\$3,000,000 - \$3,500,000	\$3,500,000 - \$4,000,000	\$4,250,000 - \$4,750,000	\$4,250,000 - \$4,850,000	\$6,500,000 - \$7,000,000	\$5,500,000 - \$6,000,000	\$3,500,000 - \$4,000,000
Alternatives Score	104.43	171.86	376.57	334.00	357.29	394.71	373.00	355.00	392.21
Alternatives Ranking	9	8	3	7	5	1	4	6	2

Table 4-2 Craig County Radio System Alternatives Summary

Upgrading the existing systems within Craig County will provide the needed public safety grade coverage, capacity, and interoperability for all current public safety and non-public safety radio users within the County for the next 15+ years. In CTA's opinion, a UHF Simulcast P25 Conventional Radio System is the BEST FIT for Craig County.

4.2 Analysis Considerations

CTA uses the following overarching system considerations when developing our System Alternatives: coverage, capacity, and interoperability. The ability of a public safety communications system to meet the requirements of the users will rely heavily upon meeting these system considerations. Based on the alternative summary above, the alternatives analysis is presented in the order listed above. The recommended alternative is described in Section 4.3.6.

Coverage – the number of sites necessary to meet your needs:

Coverage is one of the most important aspects of any public safety radio system, as radio system coverage determines whether first responders can communicate effectively in emergency situations. When performing the coverage analysis, the frequency band analyzed significantly impacts the coverage provided by each tower site used for a radio system.

Based upon preliminary coverage estimations, 3 sites may provide public safety grade (95%) mobile coverage for the Craig County service area in the VHF band. VHF frequencies provide excellent mobile radio coverage over varying terrain and large distances compared to UHF and 700/800 MHz frequencies. However, portable coverage is greatly decreased because of the high body loss for VHF portable radios.

Based upon preliminary coverage estimations, 4-5 sites may provide public safety grade (95%) portable outdoor coverage for the Craig County service area in the UHF band. UHF radio coverage performs well over varying terrain and large distances for both portable and mobile radios, while still providing some in-building portable radio coverage.

Based on preliminary coverage estimation, 6 sites may provide public safety grade (95%) portable outdoor coverage for the Craig County service area in the 700/800 MHz band. Additionally, it is estimated this will provide increased in-building portable coverage.

Capacity – the number of channels necessary to meet your needs:

Based upon preliminary capacity estimations, a conventional analog simulcast system may require 4 channels, with several added channels for tactical operations. (Note that each channel requires 2 frequencies – transmit and receive.) If the system is not simulcast, this channel requirement will be multiplied by each site in the system design. This estimation is based upon all users within the county service area operating on a single radio system.

A trunked DMR system will need 3 channels. DMR Tier III systems do not use simulcast technology as part of the standard, so each site will require 3 channels to provide the required capacity for a new DMR radio system. This means that a 4-5 site design will require a total of 12-15 channels to implement a new DMR radio system, depending on the frequency band.

A P25 Phase 1 Conventional Simulcast system will require 4 channels. With the use of the current P25 Phase 2 technology, a P25 Phase 2 Trunked Simulcast system will also require 4 channels. If either the P25 Phase 1 Conventional or P25 Phase 2 Trunked system is not simulcast, the channel requirement will be for each site in the system design. This estimation is based upon all users within the county service area operating on a single radio system.

Interoperability:

Interoperability for the local jurisdictions operating around Craig County is critically important and must be considered as we look at potential system alternatives. CTA developed an interoperability chart as part of the interview process, which clearly shows the need for law enforcement, fire, and EMS to be able to communicate directly with each other in emergency situations. It also reflects the need for users to communicate with other agencies outside of the local jurisdictions, and the ability to use dedicated channels to communicate directly with each other without overloading the primary dispatch channels.

Table 4-3 below provides the current interoperability environment and future needs of the users within Craig County.

Craig County VA Interoperability Matrix											
Agencies	Craig County E911 Dispatch Center	Craig County Sheriff's Office	Emergency Management Services and Rescue	Paint Bank Vol Fire and Rescue Dept	John Creek Vol Fire Dept	Upper Creek Vol Fire Dept	Simmons ville Vol Fire Dept	Craig County Rescue Squad	Craig County School Board	New Ccastle Fire	Craig County Search & Rescue
Craig County E911 Dispatch Center		X		X		X	X	X	O	X	X
Craig County Sheriff's Office	X		X			X	N		O	X	X
Emergency Management Services and Rescue		X		O		O	O	O		X	X
Paint Bank Vol Fire and Rescue Dept		X	x				O	O		X	X
John Creek Vol Fire Dept		X		X			X	O		X	X
Upper Craig Creek Vol Fire Dept		X	x	O			O	O		X	X
Simmons ville Vol Fire Dept		X	x	O		X		O		X	X
Craig County Vol Rescue Squad		X	x	X		X	x			X	X
Craig County School Board		X									
New Castle Vol Fire Dept			X			X	X	O			
Craig County Search & Rescue		X	X					O			
Alleghany County Agencies			N	X				N			
Botetourt County Agencies			N					O		X	X
Roanoke County Agencies						O	N	N			X
Montgomery County Agenceis						O	N	O			
Giles County Agencies				O			O	O			
Monroe County, WV				X				N			
Virginia State Police						N					
Virginia Dept of Wildlife Resources											
National Forest Service						O					
VDOT						N					

Ratings

X = Talk to Frequently on the current system

O = Talk to infrequently on the current system

N = Need to Talk but unable to on the current system

Table 4-3 Craig County Interoperability Matrix

Frequency Band

Craig County currently operates radio equipment in three different frequency bands – VHF Low-band, VHF, and UHF. The Sheriff's office uses VHF Low-band for talk-out communications to their mobile radios, then they use UHF mobile radios for talk-in communications. They also use vehicular repeaters to extend coverage to VHF portable radios. The Fire/EMS in the county use UHF for both talk-out and talk-in communications. The current setup is problematic because public safety personnel within the county are unable to talk with agencies on different frequency bands. These agencies also have difficulty interoperating with surrounding jurisdictions using different frequency bands and must rely on patches

and Dispatch relaying information from mutual aid agencies. It will improve operability and interoperability for Craig County for all radio users to be on the same frequency band.

Frequency bands are described in previous sections, below we discuss the advantages and disadvantages of the different frequency bands as they apply to Craig County.

VHF Low-Band

VHF Low-band is primarily used for mobile only coverage, as VHF Low-band portable radios have a significantly higher body loss compared to the other higher frequency bands. It is also very hard to license new VHF Low-band frequencies due to how far the VHF Low-band signals travel, and their potential for interference with already licensed radio systems.

For these reasons, CTA does not believe implementing a new VHF Low-Band radio system for all Craig County users is a feasible or sustainable option.

VHF

Craig's County terrain is a mixture of mountain ranges and low valleys, so VHF frequencies can provide good coverage for the Craig County service area. Like VHF Low-band, VHF is primarily used for mobile only coverage. VHF frequencies are poor at providing portable outdoor coverage and offer little in-building portable coverage. Most public safety agencies who use VHF must also use vehicular repeaters to enhance both portable outdoor and in-building coverage.

VHF frequencies are not licensed as channel pairs, so for each frequency pair needed, two separate frequencies will have to be licensed.

CTA does not believe implementing a new VHF radio system for all Craig County users is a feasible alternative due to the difficulty in licensing new VHF frequencies.

UHF

The UHF frequency band (450 - 470 MHz) is widely used for public safety radio systems and performs well in areas with varying terrain and populated areas with light to medium buildings. UHF frequencies provide better in-building coverage and body loss for UHF portables is less than VHF, allowing UHF to provide good portable radio coverage without the need for vehicular repeaters.

There may be some additional UHF frequencies that can be licensed by Craig County, if needed, to implement a new radio system.

CTA believes implementing a UHF radio system for all Craig County users is the most feasible alternative.

700/800 MHz

700/800 MHz frequencies are commonly used in suburban localities and urban areas with significantly populated areas, with light to heavy buildings. 700/800 MHz frequencies do not travel well over large areas, requiring more sites to provide the same coverage as VHF and UHF radio systems. However, 700/800 MHz frequencies provide significantly better in-building coverage compared to VHF / UHF and provide the best portable radio coverage due to low body loss.

There are 700/800 MHz frequencies available, because the FCC has mandated that each locality be assigned a certain number of frequencies based on population. The FCC region 42 700/800 MHz planning committee has allocated five (5) 700 MHz frequency pairs to Craig County. However due to the mountainous terrain.

CTA does not believe implementing a new 700/800 MHz radio system for Craig County users is a feasible alternative.

Backhaul Connectivity and Paging

Another critical component to your radio system is Backhaul Connectivity. Connectivity to all radio sites is required to ensure the required data rates for the radio system are provided. Backhaul Connectivity can be provided using various mediums such as commercial leased lines, control stations, fiber, microwave, etc.

CTA understands the paging functionality is critical, and Fire/EMS pager's existing functionality cannot be lost moving forward. The paging functionality will be integrated into each alternative described.

Subscriber Units

Existing subscriber units may need to be replaced with mobiles and portables compatible with the chosen technology alternative. Consoles will also need to be replaced as they are currently at the end of the manufacturer's supportable life.

Training

Craig County will need to train all users on the features and functionality of the chosen radio technology. This is critically important to ensure the proper use of a mission critical life-saving communications system. A training refresh plan should also be implemented so that users receive training on the new radio system at regular intervals.

Maintenance

Craig County will need to hire dedicated system maintenance technicians who are experienced in the technology chosen or enter into a maintenance agreement with the selected system vendor.

4.3 Alternatives Analysis

The following sections include the analysis of 9 potential system alternatives. We describe each alternative, highlighting both the technical and operational aspects, review the advantages and disadvantages of the alternatives, and a high-level budgetary estimate.

4.3.1 Do Nothing Alternative

Craig County may consider staying the course and continue to communicate using the existing radio systems when they are operational. Under this course of action, significant costs will be incurred just to maintain today's communications with no improvements. Coverage will continue to be severely inadequate. Capacity will continue to be limited. Interoperability will remain fragmented both within and outside of Craig County. Overall communications will not improve, and Craig County will be no closer to its goal of safe and reliable communications for its public safety users.

Craig County is currently surrounded by P25 radio systems which you need to interoperate with on a regular basis. Each of these localities realize that a reliable critical communications system is a necessary infrastructure investment that must be a priority for the safety of their users and their citizens.

Budgetary Estimate

There is no rough order of magnitude cost for the alternative of doing nothing. There are too many unknowns to develop an estimate.

Analysis

Our interviews revealed a significant need for a reliable communications system to improve operability and interoperability within the county and with agencies outside the county. Some agencies shared personnel safety issues due to the inability to reliably communicate to dispatch and to each other.

*In CTA's opinion, Doing Nothing is **NOT** a feasible or best fit alternative*

4.3.2 Upgrade Existing Radio Systems

Technical

Craig County can upgrade their existing radio systems, keeping the same general technical system configuration used today. The County should also consider augmenting existing coverage and capacity. *This alternative keeps the County's public safety agencies on different frequency bands, as they are configured today.* Without licensing additional frequencies, there may not be enough capacity on the existing systems to allow Craig County's public safety personnel to communicate effectively.

The first step to upgrading the existing radio systems will require replacement of equipment which will not be supported by the vendor past 2021. This includes equipment older than 15 years, or that is no longer manufactured or supported by the system vendor, such as base stations, subscriber units, antennas, transmission cables, and other aging equipment. Craig County may see some improvement in coverage and radio system functionality after replacing aging equipment, due to the degradation of equipment over time.

If the existing systems are upgraded, additional coverage is needed to provide reliable communications county-wide for mobile and portable radios. An additional 1 to 2 tower sites should be added to improve the coverage for the existing radio systems, prior to licensing new frequencies. Additionally, existing vehicular repeaters can be upgraded to improve the portable coverage.

Another consideration is the need for additional capacity, which will require additional frequencies. As previously stated, it is very difficult to license new VHF frequencies. It is easier to license additional UHF frequencies for use on the existing systems. However, based on the usage of UHF by other surrounding areas, the number of available frequencies may be limited.

Licensing additional frequencies can take from 4 months to a year to achieve, if there are available frequencies identified that do not cause interference to nearby counties. In addition, it will require significant effort to complete engineering analyses and letters of concurrence to prove the use of identified frequencies will not interfere with nearby users on the same frequencies.

There is a possibility that VHF Part 22 frequencies can be purchased from current license holders, but these frequencies tend to be expensive, with the price ranging from \$10,000 to \$100,000 or more per frequency.

It is important to recognize that all consoles operating within the county are aged and will soon be operating beyond their useful life. Therefore, it is critical they are replaced within the next 2-3 years. Costs to upgrade consoles are included in this alternative.

If the County upgrades the existing equipment and keeps operating multiple conventional analog radio systems, the systems will technically function as it does today. Existing capacity issues will not be resolved by upgrading the existing radio systems unless additional VHF, or UHF frequencies are licensed and added to the existing radio systems.

Operational

If Craig County decides to upgrade their existing radio systems, there will be very few operational changes, and the overall functionality of the radio systems will remain the same. However, there should be a training update for all public safety personnel to ensure proper radio etiquette is being practiced, to prevent people talking over each other on the radio system. Users may need to be trained on any new subscribers, although most of the radio features will be similar to radios currently in use.

Upgrading the existing radio system does not address the current operability and interoperability issues. Currently, since Craig County public safety agencies are on different frequency bands, they are unable to talk between Fire/EMS and Law Enforcement agencies directly on their radios. Instead, they must rely on Dispatch to relay information between agencies in the county, which can delay mission critical information and put first responders at risk. It is also difficult for public safety agencies within the county to talk to surrounding jurisdictions for mutual aid, due to being on different frequency bands. Many of the County's subscriber units are not even capable of operating on neighboring jurisdictions' radio systems because they are not compliant with newer communication technologies such as P25 systems.

Budgetary Estimate

A rough order of magnitude cost for upgrading the existing radio systems is \$2,000,000 - \$2,300,000.

Analysis

Upgrading the existing radio systems in Craig County is not a sustainable alternative and does not provide public safety grade coverage, capacity, and interoperability for all public safety users in Craig County.

*In CTA's opinion, upgrading the existing radio systems in Craig County is **NOT** a feasible or best fit alternative.*

4.3.3 UHF DMR Radio System

Some public safety agencies throughout the Commonwealth of Virginia have installed DMR radio systems. DMR is a digital radio system infrastructure developed based on the Digital Mobile Radio (DMR) standards established by ETSI. DMR configurations are available for VHF, UHF, and the 700/800 MHz frequency bands, however we believe the best frequency band for this alternative is UHF. *This alternative moves all the County's public safety radio users to a single system using a single frequency*

band. DMR is considered a commercial grade system and is not considered public safety grade equipment by APCO for mission critical public safety communications within the United States. DMR systems are more widely used by public service and utility companies than public safety departments in the United States.

Technical

As discussed in an earlier sections DRM is a **commercial grade** technology. A new UHF DMR Radio System can provide mobile and portable outdoor coverage for reliable public safety communications in Craig County; however, there are challenges that do not allow a DMR system to provide the same capacity, interoperability, and reliability as an APCO P25 radio system.

DMR Tier III (Trunked) radio systems are not capable of simulcast operation. This means that unique frequency pairs (channels) are needed for each transmit site. Craig County currently has a limited number of existing UHF frequencies licensed and will need 12-15 total UHF channels (frequency pairs).

CTA believes this will be very difficult as previously stated and may not be possible to license enough additional frequencies in the UHF band.

DMR radio systems use trunking combined with two-slot TDMA to effectively double the number of simultaneous talk paths by splitting a single frequency pair into two unique time slots, effectively doubling the capacity of the radio system. However, this does not fix the problem of needing a significant number of additional frequencies, as simulcast cannot be used on a DMR radio system.

Interoperability gateways and P25 control stations are needed to communicate with all surrounding jurisdictions, as DMR radios are not compatible with P25 radios.

CTA recently worked with other public safety jurisdictions in Virginia that implemented DMR public safety radio systems and are now moving to P25 radio systems after only having the DMR radio systems for 5-8 years. In CTA's experience, DMR subscriber radios do not perform consistently or hold up to the rugged duty usage of Public Safety personnel compared to P25 subscribers. These subscriber radios are significantly less expensive than typical radios used by public safety personnel, however there are concerns about the reliability of these units as they are not designed to withstand the 24/7/365 level of usage required by public safety. Utilizing equipment that does not have the longevity of public safety grade equipment can lead to more equipment failures, risking the lives of first responders. Craig County needs subscriber radios that are reliable, durable and can withstand the harsh conditions encountered by public safety personnel.

Operational

Interoperability for DMR subscriber radios is challenging because they are generally not able to communicate on P25 radio systems or directly with P25 subscriber radios. Craig County dispatchers will need to patch channels/talk groups together, or the dispatchers can relay information from surrounding jurisdictions to Craig County's public safety personnel for mutual aid scenarios, as the subscribers may not be able to operate on neighboring jurisdictions' P25 systems. This alternative does not provide seamless interoperability, will require radio users to change operational procedures, and can potentially put first responder safety at risk in emergency situations.

Craig County public safety radio users will need training on how to properly communicate on a trunked radio system since the radio systems used today by law enforcement and Fire/EMS are conventional,

requiring users to change the radio channels based on who they want to communicate with (i.e., Fire, Law Enforcement, etc.).

Budgetary Estimate

A rough order of magnitude cost for a DMR Radio System is \$3,000,000 - \$3,500,000.

Analysis

DMR radio systems are commercial grade and as such will not withstand the 24 hour/7 days per week over the long term. We find this type of system will need to be replaced at least one time over the expected 15 years lifespan of a public safety grade system.

Implementing a DMR radio system will have many obstacles to overcome, not the least of which is the difficulty in achieving the desired level of interoperability with neighboring jurisdictions. This alternative does not provide Craig County a **sustainable** public safety grade system that will provide reliable mission critical communications for the next 15-20 years.

*In CTA's opinion, implementing a DMR Radio System in Craig County is **NOT** a best fit alternative.*

4.3.4 UHF Simulcast Conventional Analog Radio System

Craig County can install a UHF Conventional Analog Radio System, keeping the same general technical system configuration used today. The County can also consider augmenting existing coverage and capacity. Conventional Analog system configurations are available for VHF, UHF, and the 700/800 MHz frequency bands; however, we believe the best frequency band for this alternative is UHF. *This alternative moves all the County's public safety agencies to the UHF frequency band.* Without licensing additional UHF frequencies, there may not be enough capacity using existing UHF frequencies to allow Craig County's public safety personnel to communicate effectively. This alternative is very similar to the Upgrade Existing Radio Systems option, except it places all Craig County users on a single frequency band to improve interoperability and operability.

Technical

This alternative requires the County to replace all existing radio systems with a new UHF Simulcast Conventional Analog Radio System and uses the existing transmit/receive tower sites. Craig County may see some improvement in coverage and radio system functionality after replacing aging equipment, due to the degradation of equipment over time, however CTA does not believe there will be a significant improvement in coverage with this alternative.

CTA believes additional coverage is needed to provide reliable public safety grade communications county-wide for both mobile and portable radios. An additional 1 to 2 tower sites should be added to improve the coverage for the existing radio systems, prior to licensing new frequencies. Additionally, a UHF radio system will not require the use of digital vehicular repeaters.

CTA recommends using a simulcast system because this will decrease the total number of UHF frequencies needed, since the same frequency pairs are used at all the tower sites. Using simulcast will only require the County to have 4 UHF channels to provide the necessary capacity on the new radio system. Licensing additional frequencies can take from 4 months to a year to achieve, if there are available frequencies identified that do not cause interference to nearby counties.

It is important to recognize that all consoles operating within the county are aged and will soon be operating beyond their useful life. Therefore, they must be replaced within the next 2-3 years. Costs to upgrade consoles are included in this alternative.

Operational

If Craig County decides to implement a new UHF Simulcast Analog Conventional Radio System, there will be a few operational changes, but the overall functionality of the radio system will remain the same. The biggest operational change will be switching the Craig County Sheriff's Office from VHF Low-Band, and VHF-to-UHF DVR's to a similar setup that is currently used by Fire and Rescue. There should be a training update for all public safety personnel to ensure proper radio etiquette is being practiced, to prevent people talking over each other on the radio system. Users may need to be trained on any new subscribers, although most of the radio features will be similar to radios currently in use.

Implementing a new UHF Simulcast Conventional Radio System will improve operability, as all County users will be on the same system. However, interoperability will not improve because most of the surrounding jurisdictions are migrating to P25 radio systems and the County's system will not work directly with their P25 radio systems. Interoperability issues can be improved by using control stations and patching at the Dispatch Center.

Budgetary Estimate

A rough order of magnitude cost for implementing a UHF Simulcast Conventional Analog Radio System is \$3,500,000 - \$4,000,000.

Analysis

Implementing a UHF Simulcast Radio System in Craig County may improve operability and provide a maintainable solution for the foreseeable future. However, this alternative does not improve interoperability. Radio coverage may improve but will still not be comparable to a P25 radio system.

*In CTA's opinion, implementing a UHF Simulcast Conventional Analog Radio System in Craig County is **NOT** a best fit alternative.*

4.3.5 UHF Hybrid Analog/P25 Conventional Radio System

Craig County can replace their existing systems with a new UHF Hybrid Analog/P25 Phase 1 Trunked Simulcast Radio System, which may improve radio communications for all users in Craig County. Conventional Analog system configurations are available for VHF, UHF, and the 700/800 MHz frequency bands; however, we believe the best frequency band for this alternative is UHF. *This alternative moves all the County's public safety agencies to the UHF frequency band.* Without licensing additional UHF frequencies, there may not be enough capacity using existing UHF frequencies to allow Craig County's public safety personnel to communicate effectively. This alternative is very similar to the Upgrade Existing Radio Systems, except it places all Craig County users on a single frequency band which improves interoperability and operability.

Technical

Implementing a hybrid system allows Craig County Fire and Rescue users to stay on UHF analog, while allowing the Craig County Sheriff's Office to operate on digital P25 channels. CTA believes the Sheriff's

Office will need two P25 Conventional channels, and Fire and Rescue will need two Analog conventional channels. Simulcast operation is also preferred for this alternative as it will only require 4 total UHF frequency pairs for the entire radio system.

This alternative allows the Sheriff's Office to add newer features such as encryption and mobile data. This will also allow the Fire and Rescue agencies to purchase cheaper subscriber units, because they will only operate in analog mode.

However, there are some disadvantages to a hybrid system. Fire and Rescue will be limited in the new features they can use on an analog system, they will also be unable to talk directly to the Sheriff's Office on their P25 channels, as their radios will not be capable of P25 operation. For Fire and Rescue and the Sheriff's Office to communicate with each other, the Sheriff's Office radio users will have to switch their radio to one of the Fire and Rescue analog channels and operate their P25 radios in analog mode. This makes operability inside the county difficult.

Operational

Fire and Rescue radio users operating in UHF analog mode will not experience many operational differences in this alternative. Sheriff's Office radio users will experience a bigger change using P25 digital radios with new features enabled. All users should receive refresher training so proper radio etiquette is followed on the new radio system.

Standard operating procedures will need to be modified to include switching between P25 and analog Channels for the Sheriff's office to be able to communicate with Fire and Rescue personnel on their radios. Interoperability procedures will also need to include the process of patching UHF and 700/800 MHz channels together at dispatch, so users can communicate with surrounding jurisdictions for mutual aid. Any surrounding jurisdictions using a UHF P25 Conventional radio system can be programmed directly into the Sheriff's Office's radios in this alternative. Fire and Rescue users will still rely on Dispatch to relay information to users in the field or patch together a Craig County UHF channel with a neighboring UHF P25 Conventional channel. Dispatchers and radio users will need to be properly trained on using the new interoperability configurations.

Budgetary Estimate

A rough order of magnitude cost to implement a new UHF Hybrid Analog/P25 Conventional Radio System is \$4,250,000 - \$4,750,000.

Analysis

Implementing a UHF Hybrid Analog/ P25 Conventional Radio System will provide some improvement for users in Craig County. However, interoperability and operability will be challenging due to Craig County Fire and Rescue, and Sheriff's Office operating on a different radio mode (analog vs digital).

*In CTA's opinion, implementing a UHF Hybrid Analog/P25 Conventional Radio System in Craig County is **NOT** a best fit alternative.*

4.3.6 UHF Simulcast P25 Conventional Radio System

Craig County can replace their existing system with a new UHF Simulcast P25 Conventional Radio System, which will provide a public safety grade, reliable, mission critical voice and data communications for all first responders in Craig County. P25 Conventional system configurations are available for VHF, UHF, and the 700/800 MHz frequency bands; however, we believe the best frequency band for this alternative is UHF. *This alternative moves all the County's public safety agencies to the UHF frequency band.*

Technical

The P25 standards facilitate interoperability by allowing any P25 certified radio subscriber to operate on any P25 Conventional system infrastructure regardless of the system vendor. This system alternative will allow Craig County to have dedicated channels for specific groups and users, and the users manually selects the channels they will use.

Craig County will need to license additional UHF frequency pairs for a UHF P25 Phase 1 Conventional Simulcast Radio System. CTA believes that there are available UHF frequency-pairs that can be licensed for countywide use in Craig County. Final frequency availability cannot be guaranteed until the frequencies have been coordinated by an FCC certified coordinator and licensed to the County.

Operational

If Craig County procures a UHF P25 Phase 1 Conventional Simulcast Radio System, interoperability will be seamless with Alleghany County. Montgomery and Botetourt Counties interoperability will improve, if they decide to implement UHF P25 Conventional systems. Interoperability with Roanoke, and other surrounding 700/800 MHz systems will require interoperability gateways, using a control station to patch into a Craig County UHF radio channel.

Operationally, a new UHF P25 Phase 1 Conventional Simulcast Radio System will function similarly to the existing Craig County radio system. There should be a training update for all public safety personnel to ensure proper radio etiquette to prevent users talking over each other on the radio system.

Budgetary Estimate

A rough order of magnitude cost to implement a new UHF Simulcast P25 Conventional radio system is \$4,250,000 - \$4,850,000.

Analysis

Implementing a UHF Simulcast P25 Conventional Radio System will provide the needed public safety grade coverage and provide capacity for all users in Craig County that desire to participate in the system.

In CTA's opinion upgrading to a UHF Simulcast P25 Conventional Radio System in Craig County is THE BEST FIT alternative.

4.3.7 700/800 MHz P25 Phase 2 Trunked Radio System

Craig County can replace their existing system with a new 700/800 MHz P25 Phase 2 Trunked Simulcast Radio System, which will provide a public safety grade, reliable, mission critical voice and data communications for all first responders in Craig County. P25 Phase 2 Trunked system configurations are

available for VHF, UHF, and the 700/800 MHz frequency bands; however, we believe the best frequency band for this alternative is 700/800 MHz. *This alternative moves all the County's public safety agencies to the UHF frequency band.*

Technical

The P25 standards facilitate interoperability by allowing any P25 certified radio subscriber to operate on any P25 system infrastructure regardless of the system vendor. This system alternative will allow Craig County to significantly increase capacity using the same number of frequency pairs as a P25 Conventional or Phase 1 Trunked system.

CTA reviewed the Region 42 700/800 MHz Frequency Plan to determine the availability of frequencies in the 700/800 MHz frequency band. 800 MHz frequency availability is unclear at this time. However, there are 700 MHz frequencies allocated for Craig County in the Region 42 700 MHz frequency plan. In the plan there are five (5) 700 MHz frequency pairs allocated to Craig County. Five frequency pairs provide more than sufficient capacity for a new Craig County 700 MHz radio system as five channels will provide eight simultaneous talk-paths on a P25 Phase 2 system.

Operational

If Craig County procures a 700/800 MHz P25 Phase 2 Trunked Simulcast Radio System, all neighboring jurisdictions will not be able to communicate with Craig County during mutual aid events because Craig County will have radios in a different frequency band (700/800 MHz) than most of their surrounding jurisdictions (UHF). This will require Craig County to have all dual band radios (UHF/700/800 MHz) in order to easily communicate with surrounding jurisdictions. Dual-band radios are significantly more expensive than single band radios. To achieve interoperability with mutual aid agencies coming into Craig County, UHF control stations will need to be connected by interoperability gateways so Craig County dispatchers can patch the UHF and 700/800 MHz channels together. Operating in a different frequency band than most of the surrounding jurisdictions will add significant infrastructure and subscriber costs.

Craig County public safety radio users must be trained on how to properly communicate on a trunked radio system. The radio systems used by Craig County first responders today are conventional, requiring the users to change the radio channels based on their operational requirements.

Interoperable operating procedures will need to be modified to include switching between frequency bands on the dual-band radios and the process of patching UHF and 700/800 MHz channels together at Dispatch. Dispatchers and radio users will need to be properly trained on using the new interoperability configuration.

Budgetary Estimate

A rough order of magnitude cost to implement a new 700/800 MHz P25 Phase 2 Trunked radio system is \$6,500,000 - \$7,00,000.

Analysis

Implementing a 700/800 MHz P25 Phase 2 Trunked Simulcast Radio System will provide the needed public safety grade coverage and capacity for users in Craig County that desire to participate in the system. However, interoperability will be challenging due to Craig County operating on a different frequency band than the surrounding jurisdictions with whom they interoperate.

*In CTA's opinion, implementing a 700/800 MHz P25 Trunked System in Craig County is **NOT** a best fit alternative.*

4.3.8 Join a Neighboring County's P25 Trunked Radio System

Craig County can connect their radio system equipment to a neighboring jurisdiction's system that already exists. Alleghany and Rockbridge Counties have successfully implemented a Regional UHF P25 Phase 2 Trunked Radio System. Roanoke operates an 800 MHz P25 Trunked system. Craig County can connect their new radio system to either of these systems to join a regional radio system. *This alternative moves all the County's public safety agencies to the same frequency band.*

Technical

If Craig County were to join a neighboring P25 Trunked Radio System, the Technical information will be as described in Section 4.3.7 with the following additional considerations.

Craig County can potentially use one of the neighboring jurisdiction's tower sites if the location is close to the border of both Counties. This may provide useful coverage for Craig County without requiring new tower sites to be constructed, and it can also extend Craig County's coverage into a neighboring jurisdiction for use during mutual aid events. There is also a possibility of two counties sharing a radio system, and potentially using each other's Dispatch Centers as a backup Dispatch Center if their primary Dispatch Center becomes non-operational.

Craig County can partner with Alleghany/Rockbridge, Roanoke, Botetourt, or Montgomery Counties to create a regional radio system. There is a potential for some cost savings by sharing tower sites and the system core, however there is not much other infrastructure equipment that can be shared in a P25 radio system. Therefore, we do not believe there will be a significant cost savings by joining a neighboring P25 radio system.

Operational

If Craig County were to Join a Neighboring P25 Trunked Radio System, the Operational information will be as described in Section 4.3.7 with the following additional considerations.

Craig County will be required to sign a Memorandum of understanding (MOU) with the neighboring jurisdiction they are connecting to and pay a percentage of the maintenance costs for any shared equipment. Agreements between the parties on policies, procedures, and governance documents are necessary to ensure the best interests of all users are considered in the shared system.

Budgetary Estimate

A rough order of magnitude cost to join a neighboring County's P25 trunked radio system is \$5,500,000 - \$6,00,000.

Analysis

This alternative will require a good working relationship with the neighboring jurisdiction(s) Craig County will join. However, the governance and level of control Craig County has over the radio system may be a challenging factor for joining a neighboring radio system. This system can provide a reliable public safety grade system, depending on the type of equipment and configuration of the neighboring jurisdiction's radio system.

*In CTA's opinion, joining a neighboring jurisdiction's P25 Trunked Radio System is **NOT** a best fit alternative.*

4.3.9 Join Virginia State Police STARS VHF P25 Trunked Radio System

The Commonwealth of Virginia's Statewide Agencies Radio System (STARS) is a P25 Phase 1, multi-site VHF radio system designed for mobile only radio coverage for the entire state of Virginia. VSP's procedure to evaluate a locality request to join STARS, includes, but is not limited to purchasing approved subscriber units, transferring the locality's licensed VHF frequencies to VSP for use in their locality, adding additional VHF frequencies if necessary, to provide for the locality users, and paying a per-user fee to cover maintenance and upgrade costs. STARS is in the planning stage of migrating the existing system to P25 Phase 2 system, yet it is unknown when such a transition may be complete.

Technical

STARS has a single site in Craig County on Potts Mountain near the existing Craig County site. CTA performed a preliminary coverage study using 4-5 additional existing STARS sites in surrounding jurisdictions and believes the STARS system provides public safety grade mobile coverage throughout Craig County. Connectivity for the STARS system has already been implemented and will not require any modifications to add Craig County to the STARS system.

The existing STARS site at Potts Mountain currently operates with 4 channels, 1 control channel and 3 working channels. Based upon a preliminary capacity study, Craig County may not be required to add additional channels based on the number of radio users in Craig County. However, final determination of existing channel capacity will need to be confirmed with VSP.

If additional VHF channels are needed for Craig County to join STARS, it can be very difficult to license new VHF frequencies due to the widespread use of the VHF band for public safety radio systems. Also, unlike UHF and 700/800 MHz public safety frequencies, VHF frequencies are not licensed as Receive/Transmit pairs.

Licensing additional VHF frequencies can take 4 months to a year to achieve, if there are available frequencies identified that do not cause interference to nearby counties in Virginia and West Virginia. It will require significant engineering analyses and many letters of concurrence to prove the use of identified frequencies for Craig County will not interfere with nearby users on the same frequencies. Even after all this effort, the probability is low that Craig County can license additional VHF frequencies.

All Craig County subscriber units must be replaced with VHF mobiles, digital vehicular repeaters, and 700/800 MHz portables that are P25 capable.

Operational

STARS is designed for VHF mobile service. Users have portable radios that operate on 700 MHz frequencies. They are connected to their VHF mobile radios via a crossband Digital Vehicular Repeater (DVR). The use of DVRs allows for portable outdoor and some in-building coverage. If using the STARS network, a DVR is required on all law enforcement vehicles, ambulances, and fire apparatus. The DVR will add significant costs; however, it will provide the needed coverage and interoperability with surrounding 700/800 MHz systems.

Craig County public safety radio users must be trained on how to properly communicate on a trunked radio system. The law enforcement and Fire/EMS radio systems used by Craig County first responders today are conventional, requiring users to change the radio channels based on their operational requirements or geographic location relative to different transmit tower sites.

Budgetary Estimate

A rough order of magnitude cost to join the VSP VHF STARS is \$3,500,000 - \$4,000,000.

Analysis

This alternative will have many obstacles to overcome, not the least of which will be the difficulty in obtaining the necessary VHF frequencies. There is also a requirement to purchase only the prescribed subscriber units/ DVRs currently operating on STARS, which can be cost prohibitive for a locality.

*In CTA's opinion, joining STARS is **NOT** a best fit alternative.*

5.0 Recommended Conceptual Design

In this section, we describe the conceptual design prepared for Craig County. The recommended conceptual design that meets the needs of Craig County radio users is a ***new UHF P25 Conventional Simulcast Radio System***.

5.1 Conceptual System Design

5.1.1 System Architecture

CTA performed an operational and engineering analysis based upon the information gathered from County stakeholders. ***We conclude the architecture which best meets the County's needs is a UHF P25 Conventional Simulcast Radio System with 5-channels, 4 radio frequency (RF) sites, and 5 microwave (MW) sites.*** The new system configuration will operate in the UHF public safety band and reuse some of the County's existing licensed frequencies. The design also links the existing Dispatch Center and the EOC into the system with MW links. The design includes updates for important auxiliary systems, such as the existing paging system, consoles, and fixed control stations, and will provide adequate radio coverage for Craig County. This new system will provide reliable public safety grade service for the next 15-20 years. This architecture may be procured turn-key, or via separate procurements using an open and competitive Request for Proposals (RFP) from a variety of system vendors. While the system only requires four sites to meet the coverage requirements, we will need an additional microwave only site to fully connect all of the radio sites.

This conceptual design addresses the following overarching technical concerns:

- Aging, support-limited radio system, subscriber units, and dispatch consoles
- Lack of capacity causing interference from users talking over each other
- Countywide coverage issues
- Portable outdoor coverage issues
- Portable in-building coverage issues

This section summarizes the analysis that supports this design. This is a *conceptual* design, not a *detailed* design. The purpose of the conceptual design is to determine the feasibility of the concept, provide a basis for cost estimates and for the development of an RFP. It will be the radio system vendor's responsibility to prepare a detailed system design to meet the requirements of the RFP. There can be differences between the conceptual radio system design and the final system design provided by the vendor(s). The main goal for the vendor(s) is to meet the functional requirements of the RFP. The RFP will be crafted to allow vendor(s) the opportunity to be creative with the system design and leverage their technological edge to best meet the project objectives. The figure below shows a diagram of the conceptual system design.

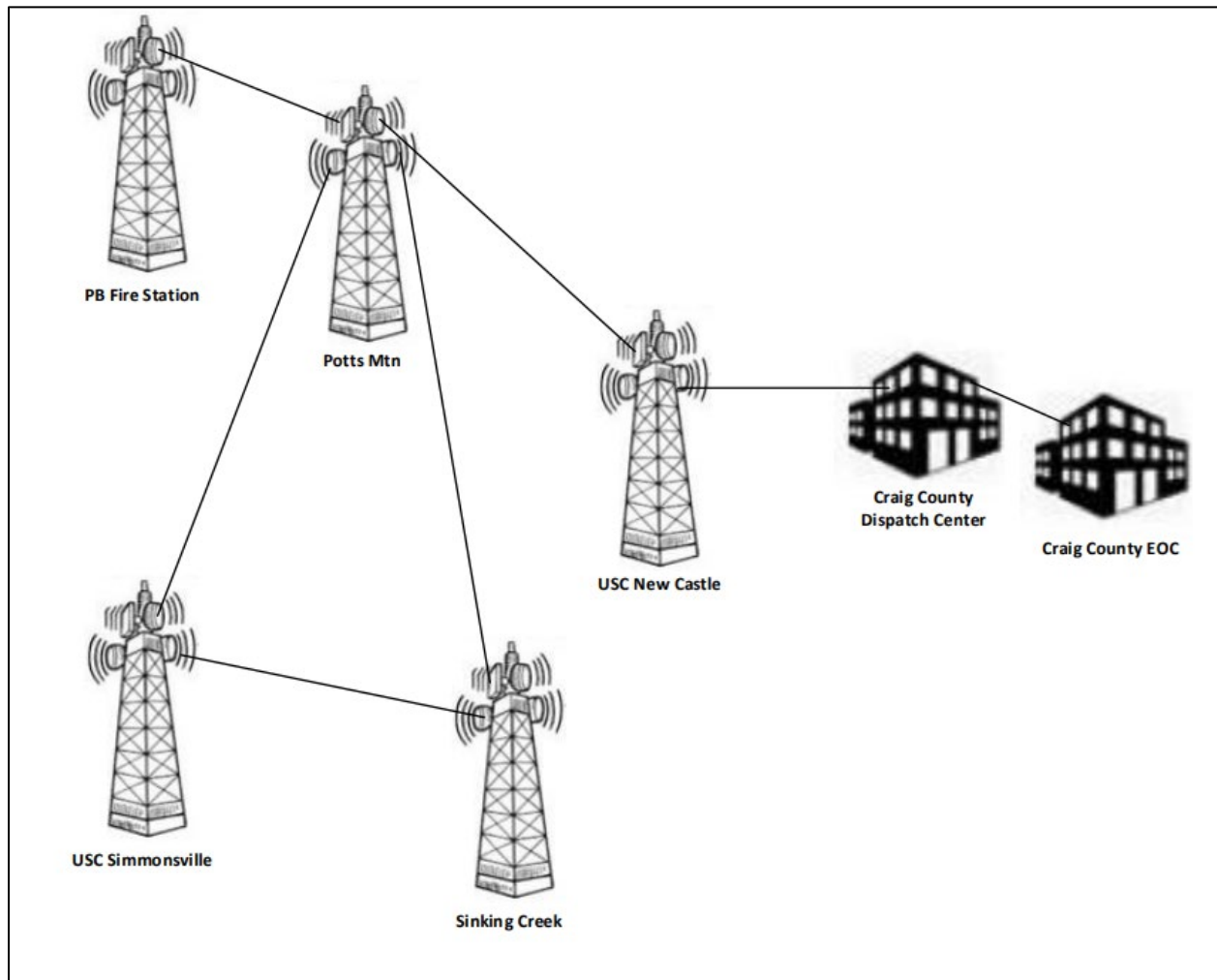


Figure 5-1 Conceptual Design Block Diagram

5.1.2 System Coverage Design

CTA evaluated the stakeholder's needs for radio coverage. Information received from stakeholders about the system's current coverage is summarized as follows:

- Talk-out mobile coverage is adequate in most of the county
- Talk-in is *problematic* the further you travel away from the tower sites
- Sheriff, EMS and Fire have *significant problems* with portable coverage (outdoors and inside buildings)
- Interoperability between Craig County agencies, and other jurisdictions is *problematic* due to using multiple frequency bands for Craig County radio systems

5.1.2.1 Coverage Design Constraints

NRAO/frequency limitations and avoiding new tower sites were the two significant constraints considered in the coverage design.

NRAO/Frequency Limitations

Some of the UHF frequencies necessary for the new system are currently licensed by the County and are already approved by the National Radio Astronomy Observatory (NRAO); however, they are not all licensed for countywide use. We try to prevent using sites in the National Radio Quiet Zone (NRQZ) to avoid strict Effective Radiated Power (ERP) limitations however, to provide countywide coverage, at least one site will likely be required in the NRQZ. This will require a modification of existing frequency licenses to change these frequencies for countywide use in the new radio system. Modifying licenses will require re-coordination with the NRAO and an FCC-certified frequency coordinator and can result in lowering of the existing ERP that is licensed. We used conservative ERP's; in case the FCC requires the ERP to be lowered to prevent interference with neighboring jurisdictions using the same frequencies. In our coverage predictions, we assumed 200 Watts of effective radiated power outside the NRQZ quiet zone and 60 Watts ERP inside the NRQZ quiet zone. This results in acceptable performance, and what we believe is a realistic licensable transmit power level.

Avoiding New Tower Sites

In our conceptual design, we try to avoid constructing new tower sites. Our site surveys and additional research confirm that either existing or leased sites are available for use. We understand the County does not wish to add cost for new tower sites to their project budget if it can be avoided.

5.1.2.2 Radio System Coverage Characteristics

Radio coverage depends on several user radio characteristics:

- Frequency Band
- Subscriber type - mobile or portable
- Use of Tower Top Amplifiers (TTA)
- Talk-in portable operation – antenna location: head-level or hip-level
- Indoor portable operation – density of buildings

Frequency Band

Different frequency bands provide advantages and disadvantages depending upon the geography and radio use in each area. Lower frequency bands such as VHF, and UHF provide better coverage for areas with varying terrain, due to their ability to travel further over hills and mountains. Lower frequency band signals also propagate further due to having a longer wavelength, requiring fewer transmit sites overall to provide adequate coverage. Higher frequency bands, such as 700/800 MHz, provide improved in-building coverage, as shorter wavelengths give them better building penetration. However, these higher frequency signals travel shorter distances and do not travel as well over varying terrain; therefore, additional tower sites are often required to provide adequate coverage.

Subscriber Type – Mobile or Portable

In most public safety radio systems, there are two common types of radio subscribers: mobile and portable radios. Mobile radios are large heavy radios, typically mounted in emergency response vehicles, with external antennas mounted to the roof of the vehicles. Portable radios are lighter, hand-held radios, which are typically worn on the hip of public safety personnel and can easily be carried indoors. Mobile radios typically provide better coverage than portable radios because they have a higher transmit power and use higher mounted roof-top antennas. Public safety users can take portable radios into areas that their vehicle cannot reach, like inside buildings or when moving away from roads in a search and rescue incident. It is common practice for public safety personnel to have both a mobile and portable radio for everyday use.

Use of Tower Top Amplifiers (TTAs)

Typically, in public safety radio systems, the talk-out coverage (Dispatch talking out to field users) is significantly better than the talk-in coverage (field users talking into Dispatch) because of the higher antenna placement and higher transmit power at the tower sites. The mobile and portable radios typically have a significantly lower antenna height and transmit power than the tower sites. This imbalance in talk-out and talk-in coverage can be corrected by using a Tower Top Amplifier. TTA's boost the signal received at the tower sites from mobile and portable radios so that talk-in coverage is almost identical to the talk-out coverage. Balanced talk-out and talk-in coverage ensures that mission critical public safety voice communications are reliable and efficient.

Talk-in Portable Operation – Antenna Location

There are two common configurations for talk-in portable radio operation: talk-in at hip-level or talk-in at head-level. Most of the Craig County public safety radio users currently use talk-in at head-level by taking their portable radios off their belt clip to talk in to dispatch and other radio users. However, some users have the shoulder speaker/mic configuration. Talk-in at the head configuration eliminates additional body loss for talk-in coverage caused by talking in at the hip level using a shoulder mounted speaker mic. CTA has used talk-in at the hip configuration for our coverage analysis to represent the worst-case scenario.

Indoor Portable Operation

Craig County radio users require in-building portable radio coverage. We observed that the predominant building construction in Craig County is considered "light building," with a few medium and heavy density buildings. Below are definitions for the different categories of building density. Lower frequency bands such as VHF have significantly higher building loss compared to the UHF and 700/800 MHz frequency band.

- Light buildings - includes residential, and commercial structures of less than four stories, constructed of brick veneer, wood, or block, and other buildings with similar radio signal penetration characteristics. The signal attenuation typically associated with these buildings for a UHF system is 10 dB. That is, to be able to communicate inside these buildings, the predicted signal strength must be 10 dB higher than what is required to communicate outside. Typically, buildings within Craig County are classified as light buildings.
- Medium buildings - includes medium-size buildings: large apartment complexes, large houses (4+ stories tall), middle & high schools (4 stories or less) and medium size commercial buildings and strip malls. These buildings are characterized by a UHF signal attenuation of 15 dB.

- **Heavy buildings** - includes large commercial buildings including shopping malls and major hospitals, international airports, jails/prisons, large high schools, and other large structures consisting of multiple layers of thick concrete, steel, brick, or other building materials. These buildings are characterized by a UHF signal attenuation of 25 dB.

The coverage requirements in the forthcoming RFP will be designed to solicit competitive offers for the highest percentage of county coverage. Proposers will be strongly encouraged to take advantage of the existing County sites or other existing commercial sites in Craig County because of their proven performance, their valuable assets, and the fact that new site development is not part of the project financial plan. Beyond that, the vendor should be given the freedom to make the tower selections they feel are appropriate to create the best offer. Qualified proposers will understand the siting constraints of the project. We anticipate that through improvements in P25 technology and optimized tower siting, coverage improvements will be realized in the project implementation.

5.1.2.3 Coverage Analysis

We performed an analysis of the potential coverage a UHF P25 conventional system can provide. Our goal is to evaluate the total coverage that can be delivered by using existing tower sites which are locality owned, existing state-owned sites, or existing commercial sites.

We individually studied the existing towers sites and nearby potential towers listed below:

- AEP (Potential Site)
- Craig County Dispatch Center
- Hall Rd. (Potential Site)
- Mountain Lake
- Paint Bank Fire Station
- Paint Bank Cemetery
- Potts Mountain (Craig County)
- Potts Mountain (STARS)
- Simmonsville
- U.S. Cellular Hall Rd.
- U.S. Cellular New Castle
- U.S. Cellular Simmonsville

Table 5-1 lists the defining radio parameters of the radio sites included in our analysis. The sites selected, and antenna gains and heights are conceptual. CTA selected sites for this conceptual design based on their probable availability and the coverage they can provide. Actual sites, and antenna gains, mounts, azimuths, and heights are the decision of the radio system contractor and must be coordinated with site owners. Please note that we tried to avoid new greenfield tower sites but needed a new tower in the Paint Bank area to provide public safety grade coverage in the Northwest Region of the County. There is also an alternative design that uses a new Hall Road tower site as a replacement for the existing Sinking Creek site. Further details of the Hall Road alternative design can be found in Appendix F.

Site Name	Paint Bank Fire Station	Sinking Creek	US Cellular New Castle	US Cellular Simmonsville
Latitude	37 34 6.36 N	37 26 31.48 N	37 29 26.84 N	37 25 24.09 N
Longitude	80 15 35.84 W	80 10 43.79 W	80 7 31.59 W	80 19 41.26 W
Elevation (ft AMSL)	1865	3553	1920	2952
Tower Height (ft AGL)	150	110	190	190
Transmit Antenna Height (ft AGL)	100	115	140	140
Transmit Antenna Gain (dBd)	6	6	6	6
Transmit Antenna Azimuth	Omni	Omni	Omni	Omni
Receive Antenna Height (ft AGL)	80	95	140	140
Receive Antenna Gain (dBd)	6	6	6	6
Receive Antenna Azimuth	190	Omni	Omni	Omni
ERP (W)	60	200	200	200

Table 5-1 Radio Site Parameters

5.1.2.4 Coverage Maps

The following is a summary of coverage prediction conditions and assumptions:

- RF power and antenna patterns result in typical ERP's, licensable for the UHF frequency band.
- The infrastructure and user radios are transmitting in P25 Phase 1 conventional mode.
- The UHF frequencies are simulcast at the four radio tower sites, meaning the same frequencies are used at each site.
- The voice quality target is Delivered Audio Quality (DAQ) 3.4, a common public safety target.
- Portable radios are operated from the user's hip level for both talk-out and talk-in.
- Two coverage levels were evaluated: mobile and portable outdoors.

We draw multiple conclusions from the coverage studies:

1. The county has many areas of greatly varying terrain. Using UHF frequencies, coverage can be provided for most areas of the county.
2. Utilizing TTA's coverage can be balanced for talk-out and talk-in directions.
3. Utilizing a 4 RF site UHF simulcast radio system, our conceptual design will fill reported coverage gaps. Depending on the RFP coverage requirements, vendors may meet the objective with a different tower site configuration.
4. With the improvements in the receivers for P25 portable and mobile radios, our conceptual coverage analysis shows that we can provide 95% public safety DAQ 3.4 mobile and 90% or greater portable outdoor coverage throughout the entire county with a four-site configuration.

After analyzing the coverage advantages and disadvantages of various tower sites, we concluded that the base configuration that best meets the County's stakeholder needs is 4 RF sites in a P25 conventional simulcast site design. The 5th site shown in Figure 5-1 is for microwave only to connect all the radio sites. Figures 5-2 – 5-4 illustrate the performance of this configuration at the two coverage levels needed by County agencies: mobile, and portable outdoor. You will also find a large version of these maps in Appendix D.

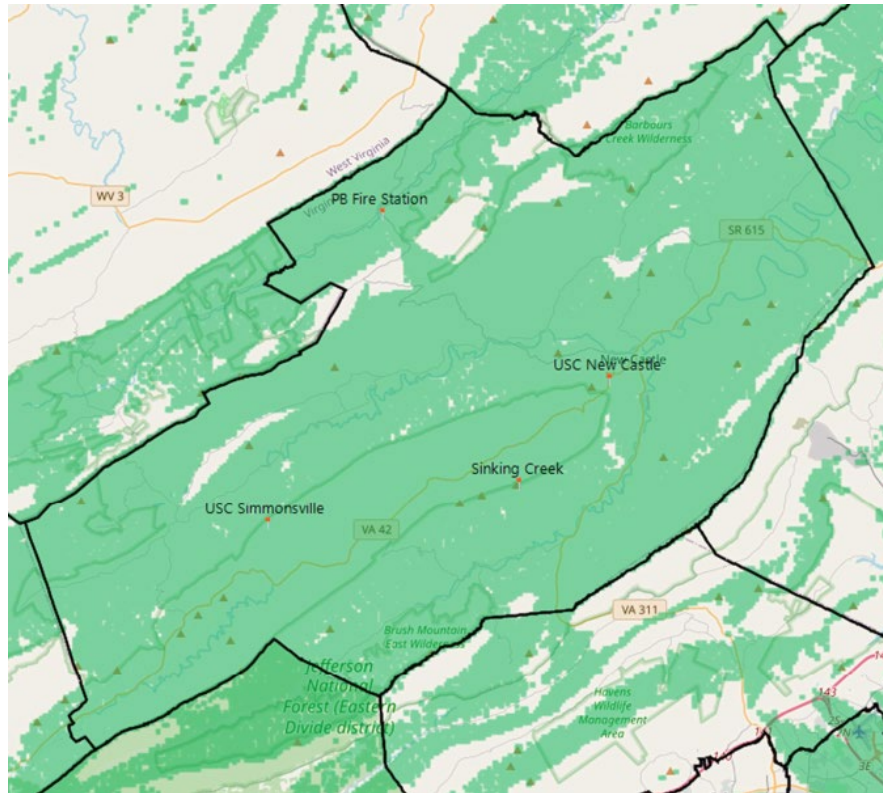


Figure 5-2 P25 Mobile Talk-Out Conceptual Coverage

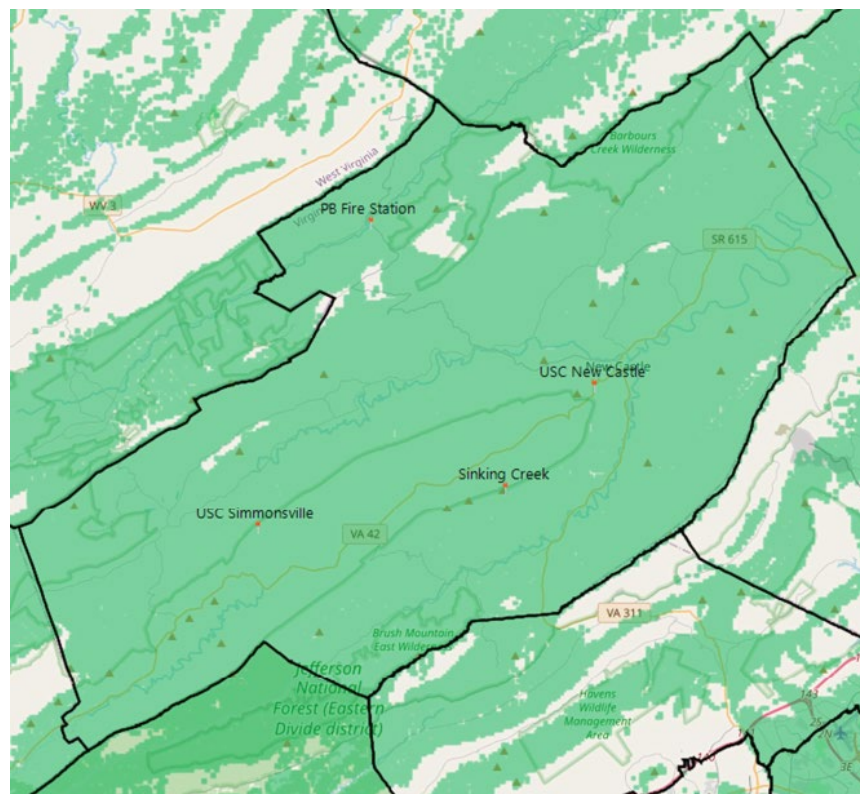


Figure 5-3 P25 Mobile Talk-In Conceptual Coverage

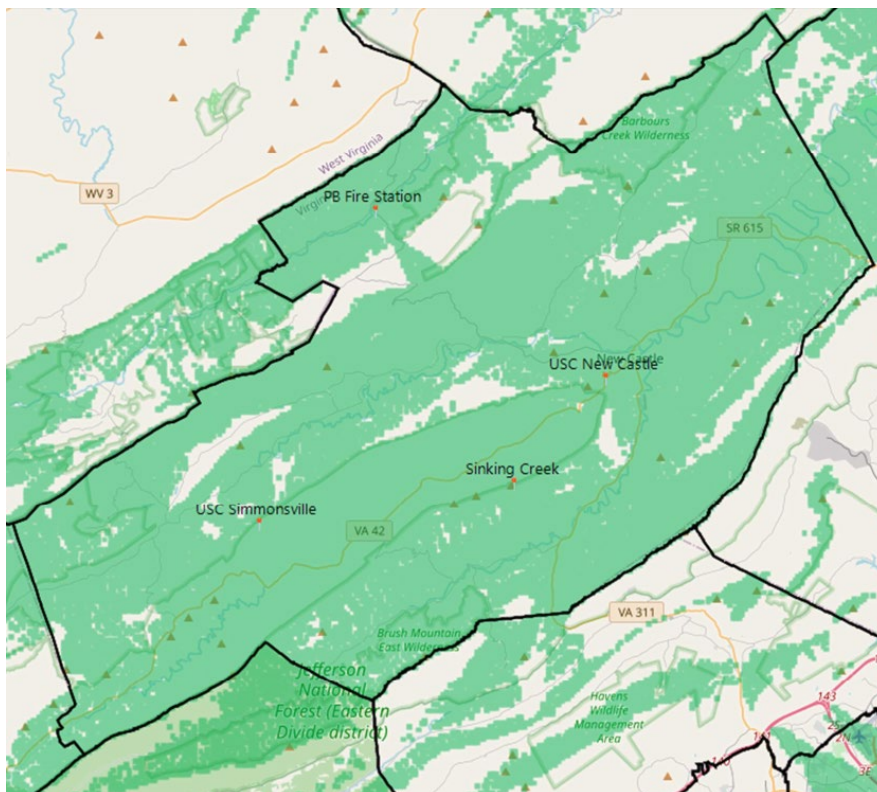


Figure 5-4 P25 Portable Outdoors Balanced Conceptual Coverage

5.1.2.5 In-building Radio Coverage Improvement Options

Indoor coverage issues were identified by public safety agencies. There are several approaches to improving indoor coverage. One is to arrange the next generation tower site layout to place sites closer, with presumably stronger coverage, to areas with affected buildings. A potential problem with this tower siting approach is that one does not know if buildings of interest are covered until the money is spent and the test results are in. Due to the minimal number of areas with a large population and the fact that buildings in the county are well-distributed rather than concentrated, it is not feasible to provide 95% countywide in-building portable coverage, as it will require multiple additional tower sites.

Our recommended approach is to install Bi-Directional Amplifiers (BDA's) in specific buildings that prove needy after the coverage testing results are in. The County then has an advantage in making an informed BDA cost estimate of buildings needing treatment. Public County facilities, such as schools, are funded either from the radio project or other County funding sources. Some clients recognize the burden of maintaining BDA systems and avoid taking on that responsibility.

5.1.3 System Traffic Loading

The upgraded radio system must be designed to handle the communications (voice) traffic, which is expected both now and over a 15-year lifespan. CTA performed a system traffic loading analysis to ensure the conceptual design provided is feasible.

Craig County currently operates one conventional Fire/EMS system and one conventional Sheriff's Office system and does not have usage data that allows us to identify a potential busy hour. In lieu of this

information, we have used our 30+ years of experience analyzing traffic loading for public safety radio systems to determine the appropriate number of channels needed for a new Craig County UHF P25 Phase 1 Conventional Simulcast Radio System.

In the current conventional radio systems, users often talk over each by transmitting at the same time when multiple incidents occur in the county at once. Considering this issue, the current radio systems in Craig County are heavily loaded and may be overwhelmed in the event of a large-scale emergency or multiple simultaneous emergencies in the county.

The new radio system must be capable of handling the expected future peak traffic load. A properly designed system will provide users with communications during routine and peak conditions without major operational differences. Traffic analysis and the design for a public safety conventional radio system are based on a proven methodology. The following terms and parameters are used:

- **Busy hour:** The busiest one-hour period during which the system experiences the peak traffic load over a typical week.
- **Erlang:** Radio traffic is measured in Erlangs. One Erlang is equivalent to one conversation or call occurring continuously (one call lasting 3,600 seconds per hour). Therefore, the system load measured in Erlangs is the average number of conversations occurring at any moment during the designated time period.
- **Average call duration:** The average length of time PTT is held. We model average call duration (assuming transmission trunking) in a range from 3.8 – 10 seconds depending on the radio agency. Sheriff and Fire tend to make shorter calls and public service tends to make longer calls.

The upgraded P25 radio system will utilize P25 Phase 1 radio call operation. Our calculations and resulting channel requirements are based on P25 Phase 1 operation. Our modeling is based on accumulated statistics collected from operational public safety systems. Table 5-2 shows the number of P25 Phase 1 conventional radio channels needed to support the traffic load, from 2023 (the year of system cutover) through 2038 (15-year lifespan). This data is based on an analysis of the Craig County agency radio inventory provided by each agency.

Year	Phase 1 Conventional Channels Required
2023	5
2038	5

Table 5-2 Required Radio Channels

Our traffic loading analysis concludes that Craig County will need 5 total conventional channels (five total UHF frequency pairs) to provide the necessary capacity for the next 15-20 years. The channels will be allocated by discipline (Sheriff, Fire/EMS, and Schools).

5.1.4 Frequency Analysis

Based on CTA's traffic loading analysis, Craig County needs five UHF channel pairs to support voice communications over the next 15 years. A UHF channel pair consists of one transmit frequency and one receive frequency. The UHF band for public safety is a structured band.

A structured band has a consistent offset between the transmit frequency and the receive frequency in the band design, and this new license will include the fixed base station frequency (outbound) and the associated mobile frequency (inbound).

Appendix C lists the existing UHF frequencies licensed by Craig County public safety agencies that can potentially be modified for countywide use on the new P25 Phase 1 conventional radio system. Currently, the fixed base frequencies below are not licensed at the same location or at the same ERP, however relicensing to a different location within Craig County should not be an issue. Frequencies can be used at lower ERPs than they are licensed for, but if higher ERPs are needed, modifying the existing frequencies for countywide use will require the frequencies to be re-coordinated and relicensed.

The station class types listed are FB2 and MO. FB2 used for fixed base station repeaters. MO is used for transmitting frequencies in mobile and portable subscribers. A UHF channel pair consists of one FB2 and one MO frequency. We believe that 2 or 3 existing channels can be relicensed for countywide use from the existing Craig County licenses.

5.1.5 Interoperability Interfaces

The current Craig County radio systems provide dispatchers with access to communications with multiple neighboring jurisdictions within the region. These agencies are named throughout Section 2. The new infrastructure will include interoperability gateway equipment so that the Dispatch Center can continue to communicate to the identified regional agencies.

These interoperability gateways operate at the Dispatch Center either by using a control station or via wireline termination in the Dispatch Center to connect to another jurisdiction's radio equipment. The existing interoperability connections will not need to change during the system upgrade and will be integrated into the new interoperability gateway equipment. The new system's interoperability equipment, located at the Dispatch Center, will be provisioned with 24 external interfaces, enough to accommodate the current interoperability channels and allow for future growth.

The County will need at a minimum, interoperability with the following jurisdictions/agencies:

- Alleghany County, VA
- Botetourt County, VA
- Giles County, VA
- Monroe County, WV
- Montgomery County, VA
- Roanoke County, VA
- Virginia State Police

5.1.6 System Core and Simulcast Control Equipment

The new Craig County radio system will require P25 conventional equipment and simulcast control equipment due to the complex call routing between tower sites necessary for simulcast operation. In our conceptual design, we include redundancy simulcast control equipment. Two of the tower sites will house a geo-diverse redundant set of simulcast control equipment that operates in a monitored hot-standby

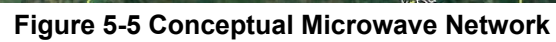
configuration. Our conceptual design houses one set of redundant simulcast control equipment at the U.S. Cellular New Castle tower site and another set of simulcast control equipment at the U.S. Cellular Simmonsville site, but the second set of simulcast control equipment can be installed at any of the other transmit tower sites. P25 conventional equipment and simulcast control equipment sites should be chosen so that they are easily accessible even in severe weather emergencies.

Since the new radio system will be a P25 Conventional system, it will not require P25 core equipment, as core equipment is only needed to control the complex call routing of a Trunked P25 radio system.

5.1.7 Connectivity System

Utilizing a microwave network is a common way to ensure highly reliable radio system connectivity. To function reliably, the radio system requires a highly reliable telecommunications backbone to connect the radio system tower sites and the Craig County EOC to the Dispatch Center. Reliability is a function of equipment and path redundancy, as well as path dependability. This reliability is most often provided by a dedicated digital microwave system. For the Craig County radio system, there should be a public safety grade microwave network configured in a ring topology with Monitored Hot Stand-By (MHSB) equipment for all microwave spur links. A microwave ring topology provides redundancy and reroutes data traffic in the opposite direction around the ring in case of microwave equipment failure, or link outages. Due to the terrain of Craig County, the Paint Bank Fire Station tower site can only be connected by using MHSB spur links with a microwave repeater site at the existing Craig County Potts Mountain tower site. The Dispatch Center and EOC face the same challenge and can only be connected using MHSB spur links. This configuration will provide reliable, high data rate, backhaul connectivity to the new radio system. A minimum of 50 Mbps of data bandwidth will be required between each of the tower sites and the Dispatch Center.

Figures 5-5, and 5-6 illustrate the configuration for the conceptual microwave ring topology between the 4 RF sites, additional MW site, the Dispatch Center, and the EOC. The primary 6 GHz, 11 GHz, and 18 GHz (or 22 GHz) licensed microwave frequencies will provide the required data rates and reliability. The conceptual microwave topology is shown below based on our preliminary path studies.



5.1.8 Site Development

The sites in our conceptual design are in fair condition and appear to be well maintained. However, Craig County needs to include budget for some site refurbishment and need to bring the existing sites up to public safety grade standards. The sites may also need commercial power circuit expansion, temporary rental shelter space, rental of extra backup generators, major servicing of existing generators or the altogether replacement of generators.

Specifically, the existing Sinking Creek tower site needs significant upgrades. Currently in inclement weather County personnel are unable to access the tower site to perform maintenance. Our conceptual design includes significant upgrades to the access road for this site. We also include a new shelter to house the new radio system equipment at the Sinking Creek site.

The Paint Bank Fire Station tower is the only greenfield tower site used in the conceptual design. We include a new 150 ft self-supporting tower beside the fire station. We also include cost to upgrade the HVAC systems at the Fire Station so the radio system equipment can be stored inside the Fire Station, which eliminates the need for a new shelter or outdoor equipment cabinet.

We include new emergency backup generators, and UPS systems at all sites in the conceptual design.

There are also site costs which are likely to arise, including grounding system expansion and tower structural analysis. The governing tower structural requirements are slightly more stringent since the towers in the county were built. The strengthening or replacement can become the largest unforeseen site cost, dependent on the findings of the structural study. At this point in the project, it is prudent for the County to plan for contingency funding for tower reinforcement/replacement. CTA's cost estimate includes potential site refurbishment costs and a project contingency.

5.1.9 Dispatch Equipment

5.1.9.1 Console System

The new console system will be an IP-based P25 console system and will interface to the existing conventional radio systems for use until after cutover. We envision this will be via control stations on the existing radio systems. We also include a back-up control station for each console position in the Dispatch Center.

CTA plans for 2 dispatch console positions which will both operate as 911 call taker and dispatch positions.

Each dispatch console position consists of:

- PC, monitor, keyboard, mouse
- 2 speakers
- 1 headset jack for a six-wire headset with transmit capability (the training position will have dual headset jacks)
- Audio box or audio enclosure for microphone and speaker connections
- Single pedal footswitch
- Custom dispatch keyboard

On the new radio system, each dispatch console will have a unique radio ID to identify its transmissions. The backup control station at each position will be set up with a unique radio ID, similar to the dispatch console's ID at that position.

The new console system will also support the following functionality:

- Auxiliary inputs/outputs (AUX I/O)
- Tone encoding for paging
- Multi-Band Gateway – interoperability for all neighboring jurisdictions
- Patching
- Simul-select
- Emergency calls
- Caller ID
- Recent call history
- Encryption
- Alert tones
- Instant Recall Recorder (IRR)

5.1.9.2 Logging Recorder

A new IP-based logging recorder system will be installed at the Dispatch Center. The new logging recorder will also be redundant and must be capable of recording the following:

- All Telephone lines (Emergency 911 trunks and Administrative lines)
- All Existing analog conventional channels
- All UHF P25 digital conventional channels
- AES (Advanced Encryption Standard) Encrypted Channels
- Additional conventional channels for interoperability.

5.1.9.3 Paging System

Fire and EMS agencies within Craig County rely on the existing paging system to alert them of calls for service. Currently, not all Fire/EMS departments issue radios to every volunteer/career staff member. There is also not enough capacity on the County's existing system to accommodate all Fire/EMS staff with their own radios. There are two ways the paging system for the new UHF P25 system can be configured. The first way is to upgrade the paging system to integrate the tone paging with the UHF radio system and page Fire/EMS users using P25 pagers issued to all Fire/EMS staff. This configuration may require an additional fixed base transmit frequency to activate the P25 pagers. The second option is to issue a portable radio to all Fire/EMS members and tone page over the main Fire/EMS dispatch channel on the new radio system. Issuing portable radios to all Fire/EMS members is more expensive initial; however, you will realize long term cost savings by maintaining only one infrastructure only portable radios. re/EMS members is more expensive initial; however, you will realize long term cost savings by maintaining only one infrastructure only portable radios.

5.2 Operational

The new UHF P25 conventional simulcast radio system will fundamentally operate similar to the radio systems currently in use. The major operational difference is the improved operability between different agencies in the county, the interoperability between Craig County and other neighboring systems operating UHF P25 conventional systems, and simulcast system operation.

5.2.1 Improved Operability and Interoperability

With all the region's public safety and public service agencies being on a single radio system, operability and interoperability are simplified for public safety personnel using radios in the field. The Sheriff will be able to talk directly (radio to radio) with Fire and EMS personnel on scene, without causing a delay in mission-critical information by relaying information through dispatch. Craig County radio users can program other neighboring UHF P25 conventional systems into their radios for simple interoperability and mutual aid.

5.2.2 Simulcast Operation

The County's current radio systems are currently set up with non-simulcast conventional channels. This means that the radio user must switch channels on their radio based on their geographic location. In our conceptual design, all frequencies used at the tower sites will be simulcast, meaning each tower will be transmitting on the same frequencies. This will simplify the dispatcher's and the field users' daily radio usage because they will no longer have to select which site to transmit to, based on the field users' geographic location, because the field user radios will automatically select the transmit site with the strongest RF signal.

5.3 Schedule

The new Radio System implementation will require the development of a project roadmap, and these are the major tasks that must occur (many tasks will occur in parallel):

- **Specifications & Develop the RFP** – Development of technical specifications, completing and publishing a Request for Proposals for radio system vendors.
- **Procurement** – Includes publishing the RFP, proposal evaluation, and successful contract negotiation with selected vendor.
- **FCC Licensing** – Licensing the required frequencies for the new P25 radio system and modifying existing licenses for reuse of frequencies currently in use.
- **Detailed Design Review (DDR)** – Review of the Vendor's complete Detailed Design and finalize the Design with County approval at the Detailed Design Review meeting.
- **Physical Facilities** – Physical facilities work will often impact a project's critical path. Structural and foundation analysis can impact towers, as an old tower may not be safe and must be replaced with a new tower. If the planned radio site is found unusable, a new location must be found. This activity is ongoing from the start of the project through system installation.
- **Microwave System** – Design, staging, and installation of the new microwave system.

- **Radio Infrastructure** - After approval of the detailed design, the system vendor will order and manufacture the fixed network equipment (FNE). They will then configure and integrate the different system equipment in the factory for the staging test. Representatives for radio user agencies (and CTA) should attend at the staging test, so the staging test can be approved prior to shipping the system to the field. After approval of the staging test, the system vendor will install the radio system, and prepare the system for testing and cutover.
- **Acceptance** - inspections and testing will begin upon final system integration. Testing is critical to positive user acceptance, as it will validate that the users' requirements have been met.
- **Training** - It is important to train dispatchers, operations and maintenance personnel, and all radio users immediately prior to system cutover.
- **Cutover** - Completion of all required tests, documentation and approval, cutover planning, and system cutover.

The figure below shows the anticipated schedule for implementation of the conceptual design described in this section.

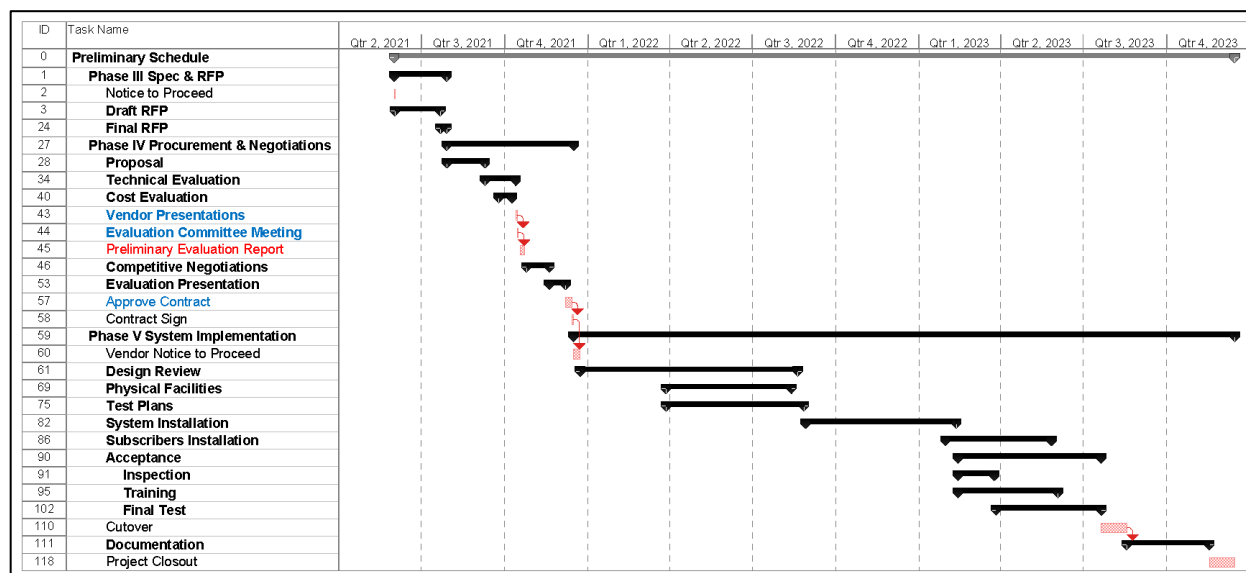


Figure 5-7 Project Schedule

5.4 Opinion of Probable Cost

In this section, we provide an opinion of total system costs. The opinion of probable cost represents the conceptual system design as described in Sections 5-1 thru 5-3. The configuration uses mostly existing sites and operates in the UHF frequency band. The system includes the radio infrastructure, any upgrades to the physical facilities, upgrades to the paging system, a microwave system, dispatch consoles, subscriber equipment, vendor services, consulting, and contingency funds. The following is the opinion of probable costs for a new UHF P25 Conventional Simulcast Radio System:

Craig County, VA
UHF P25 Conventional Simulcast Radio System

Cost Elements	List Estimate	Negotiated Estimate	Competitive Estimate	MULTI-VENDOR ESTIMATE
RADIO INFRASTRUCTURE	\$ 1,155,700	\$ 1,155,700	\$ 1,155,700	\$ 1,155,700
COMMUNICATIONS CENTER	\$ 334,500	\$ 334,500	\$ 334,500	\$ 334,500
MICROWAVE SYSTEM	\$ 604,900	\$ 604,900	\$ 604,900	\$ 502,100
PHYSICAL FACILITIES	\$ 1,443,800	\$ 1,443,800	\$ 1,443,800	\$ 816,700
SUBSCRIBERS	\$ 1,342,700	\$ 1,033,900	\$ 966,700	\$ 939,900
VENDOR SERVICES	\$ 707,800	\$ 707,800	\$ 707,800	\$ 545,800
DISCOUNT	\$ -	\$ (867,000)	\$ (1,300,400)	\$ (1,063,200)
SPARES - SUBSCRIBERS	\$ 25,600	\$ 19,700	\$ 18,400	\$ 11,800
SPARES - FIXED NETWORK	\$ 88,100	\$ 88,100	\$ 88,100	\$ 66,100
CONSULTING	\$ 225,000	\$ 225,000	\$ 225,000	\$ 337,500
CONTINGENCY (5%)	\$ 285,200	\$ 226,100	\$ 201,000	\$ 165,500
RADIO SYSTEM TOTAL	\$ 6,213,300	\$ 4,972,500	\$ 4,445,500	\$ 3,812,400
MAINTENANCE (After 1 year warranty)	\$ 185,000	\$ 185,000	\$ 185,000	\$ 138,800

Table 5-3 Opinion of Probable Cost - UHF P25 Phase 1 Conventional Simulcast Radio System

5.4.1 Estimate Categories

Table 5-4 has four (4) estimate categories:

- List Estimate: An estimate for the project based on the list costs based upon the CTA team's experience.
- Negotiated Estimate: List price costs adjusted for the effect of negotiating with a sole source vendor or system integrator. The list costs reduced by the percentages our team has seen in this type of procurement.
- Competitive Estimate: Estimates further reduced to reflect cost our team has seen in highly competitive procurements.
- Multi-Vendor Estimate: Estimates our team has experienced when we assist our client with the individual procurement of each system component.

5.4.2 Cost Elements

Table 5-4 is detailed by the cost elements, or the categories of equipment that make up a complete communications system.

5.4.2.1 Radio Infrastructure

The estimate for radio system infrastructure includes the fixed equipment located at the transmission and control sites as:

- Network Management System (alarm system)
- Redundant Simulcast Control Equipment
- Repeaters (transmit & receive station)
- Paging System
- Transmit and Receive Antennas, transmission lines

- Switches
- Routers
- Tower-top Amplifiers and Multicouplers
- Transmit Combiners
- Simulcast equipment
- OTAP (Over-The-Air Programming) System

5.4.2.2 Dispatch Center - Consoles/Logging Recorder/Paging System/CAD Interface

The estimate includes the necessary IP consoles, logging recorder, paging system, and computer aided dispatch software interface to facilitate dispatching by Craig County.

5.4.2.3 Microwave Connectivity System

The estimate for microwave infrastructure generally includes:

- Microwave radios
- Microwave antennas (dishes)
- Waveguide
- Cabling
- DC Power System (for microwave equipment)
- Network Management equipment
- Path surveys
- Licensing
- Staging test
- Installation
- Field acceptance testing
- Training

5.4.2.4 Physical Facilities

The estimate for physical facilities generally includes the following:

- Tower structural analyses for existing towers
- New towers or remediation existing towers
- Tower foundation inspections
- Geotechnical surveys
- New shelters and/or remediation existing shelters or buildings
- Uninterruptible Power Supplies (UPS) or
- DC Power systems
- Site clearing and development
- Security fencing
- Heating Ventilation and Air Conditioning (HVAC)
- Generators

- Grounding
- Alarm system
- Utilities
- Site road access and parking

5.4.2.5 Subscriber Units

This category includes pricing for new mobile units, portable units, tone & voice digital pagers, and control stations. For cost estimation purposes, we make the following assumptions:

- New mobile and portable radios include the capability to utilize OTAP.
- New portable and mobile radios include AES encryption for law enforcement.
- New portable accessories include standard single chargers, multi-charger units, spare batteries, belt clips, lapel speaker/mic. Special, intrinsically safe batteries and speaker/microphones for all Fire & Rescue equipment.
- Mobile and desktop control station estimates include the antenna, installation, remote control head, speaker, and a microphone.
- Mobile and control station antenna installations assume “normal” installation conditions.
- Warranty service for a subscriber is provided for one year.

5.4.2.6 Vendor Services

Some of the effort on the part of a major radio retailer and/or a systems integrator will be to outsource those efforts which are not part of their core business. As you may expect, in the outsourcing, the price for the service is escalated with pass-through fees and administrative additions, as well as risk factors for unanticipated activities.

In the cost estimate there is a category for Vendor Services, which accounts for the expenses the Vendor encounters to perform procedures for professional engineering, design, project management, and their own verification of performance for these elements to match requirements. We estimate vendor services at 20% of the radio infrastructure, Dispatch Center, microwave, physical facilities, and paging system cost.

5.4.2.7 Discount

Most vendors will provide a discount depending on the size of the project and/or the quantity of subscriber units to be purchased. This discount can be highly variable and often one vendor will attach the discount to the infrastructure and another vendor will attach the discount to the subscriber units. CTA has calculated a discount estimate based upon our team’s experience with multiple vendors.

5.4.2.8 Spares Subscribers & Fixed Network

We estimate spare parts for the system infrastructure at 5% of the infrastructure costs. We estimate spare parts for the subscriber units at 2%.

5.4.2.9 Consulting Services

The estimate contains the necessary fee to hire an independent consultant to develop the functional specification, assist with procurement and negotiations, implementation oversight, witness testing, and recommend acceptance of the system. This critical knowledge and experience will help to facilitate an efficient and effective procurement cycle and a smooth implementation through cutover. This will also provide management with the confidence that the radio and microwave systems purchased meet your contractual requirements and user needs.

5.4.2.10 Contingency

As with any major infrastructure project, unexpected occurrences and expenditures will occur. All the estimates and proposals will be predicated on such terms as “normal conditions,” assuming there are no zoning appeals and/or delays, suitable access will be available, and barring other such conditions. While successful and detailed negotiations can assist in protecting the project, the unexpected will occur. In our experience, 5% of the cost of the project, not including subscriber equipment, is an appropriate contingency fund.

5.4.2.11 Maintenance

The new radio system will come with a one-year comprehensive warranty that covers all new equipment and systems purchased. After the first year an annual maintenance contract with the system vendor will need to be established. Maintenance options include intrusion detection, software maintenance, software upgrades, infrastructure repair, subscriber repair, and technical support.

The maintenance contract can support all systems supplied under a turnkey project, including those not manufactured by the radio vendor. The maintenance cost for the conceptual system design will depend upon the number of sites and quantity of subscribers.

If the agencies choose to reuse existing equipment such as subscriber units, this equipment will not be covered by warranty and depending upon its age, the vendor may not be willing to include them in the maintenance contract.

6.0 Conclusions

Now is the time for Craig County to upgrade your public safety communications to protect your public safety users. Your current systems have reached the end of their usable life and their ability to be supported. Spare parts are becoming scarce which will lead to potentially dangerous system issues.

Public Safety radio communications within the county are characterized by poor portable coverage in some areas, both in-buildings and outdoors, as well as aging equipment. These major deficiencies, plus other operational and technical concerns, currently inhibit public safety personnel from operating at full capacity and efficiency. Mutual aid between the surrounding Counties and Craig County routinely occurs, and without the ability to communicate with all public safety personnel in these jurisdictions, users will find themselves in potentially dangerous conditions.

As recently as the last ice storm in February 2021, antennas on the sites were rendered unusable and caused your public safety users to implement extraordinary measures to continue to have any form of communications.

The public safety personnel in the county have made valiant efforts to provide necessary services to your citizens using the communications resources made available to them. We believe the County recognizes the potential advantages of designing and implementing a Public Safety Radio System that will address the needs of the Sheriff's Office, Emergency Management, Fire, EMS, and Schools.

6.1 Recommendations

Implement a UHF P25 Conventional Simulcast Radio System

It is critical for Craig County to meet the needs of its public safety users and its citizens by providing a new public safety grade communications system. This system must have coverage and capacity where and when they are needed. This system must also operate in a manner that supports the users' mission daily.

CTA recommends Craig County procure and install a ***UHF P25 Conventional Simulcast Radio System consisting of 4 RF sites, 5 MW sites, and 5 channels.*** The new configuration will operate in the UHF public safety band and take advantage of existing licensed frequencies, and new frequencies that will be licensed by Craig County in the future. The design includes updates for important auxiliary systems such as the paging, consoles, and fixed control stations to provide reliable public safety grade service for another radio generation. This architecture may be procured turn-key or via separate procurements using an open and competitive Request for Proposal (RFP) from a variety of system vendors.

A well designed, implemented, and tested radio system will provide the public safety users in Craig County:

- ***Simplified communications*** – removing the dispatch communications relay barriers and differences in equipment and capabilities from agency to agency.

- *The ability to communicate as needed* – within the guidelines of organizational structure, users can push to talk with those they need to. Equipment is no longer a barrier, and with cooperative agreements, political boundaries are less of a barrier. The tools are in place for true interoperable communications.
- *Consistently dependable system* – uniform design, deployment, operation, and maintenance of the system means that robust equipment is designed for the task, placed where it is needed, and users can depend on reliable service every day.

A primary concern presented by most users is the ability to interoperate with the surrounding jurisdictions, including Alleghany, Botetourt, Roanoke, Montgomery, Giles, and Monroe counties. To provide seamless interoperability, we created a conceptual design that includes the necessary interoperability gateways to provide reliable interoperability with all the County's mutual aid partners.

Craig County must view a public safety communications system as a major capital asset, in the same category as a water or sewage processing and distribution system, a new building or plant facility, or a school facility. Economics must be considered in the context of not only the upgrade of current deficiencies, but also the ability to support future needs. It is our opinion; Craig County needs a public safety grade communications system, and it is now a **critical** requirement for those who serve your community and for the citizens they protect. Continuing to delay will only see an increase in costs and a decrease in the ability to rely upon the current radio system, which may result in injury and loss of property due to lack of reliable communications.

6.2 Go Forward Plan of Action

1. Initiate planning and budgeting for a new UHF P25 Conventional System.
2. Identify and submit grants to support the cost of the system.
3. Review and approve the upgraded radio communications conceptual design contained in this report. Work with CTA to complete any adjustments in preparation for specifications development.
4. Adopt Project 25 (P25) technology as the interoperability standard for Craig County. This will help maintain interoperability with some surrounding jurisdictions that have already migrated to P25 systems.
5. Prepare a set of functional specifications, scope of work, and terms and conditions in preparation for issuance of Request for Proposals. Construct the RFP package targeting a competitive multi-vendor procurement. We recommend the specifications allow the following to be examined and evaluated for each proposal:
 - Overall viability of the configuration
 - Communications throughput and performance, matched to consider present and future voice needs
 - Guaranteed (95%) coverage over the Craig County service area

- Redundancy and Backup Failure Modes
 - Fifteen-year life cycle costs, including keeping the number of tower sites as low as possible, while retaining the requisite coverage – mobile, and portable outdoors and inside buildings
 - Degree to which the system requirements are addressed
6. License additional UHF frequencies and modify existing UHF licenses for use on the new P25 radio system, to ensure sufficient spectrum is under Craig County license to build the systems.
7. Implement a digital microwave network as a stand-alone, fault tolerant, dedicated emergency system to provide long-term cost savings and improved reliability.
8. Any new replacement subscriber radios, whose lifecycle is anticipated to span into new upgraded P25 infrastructure, should be P25 capable.
9. Retain CTA to provide implementation oversight for the following items:
- Project Kickoff Meeting
 - System Design
 - Physical Facilities Site Upgrades
 - Detailed Design Review
 - Radio System Staging Test
 - Microwave System Staging Test
 - Radio System Installation
 - Microwave System Installation
 - Site Inspections
 - Physical Facilities Completion
 - Equipment Installation Completion
 - Final Acceptance
 - Field Acceptance Testing
 - Radio System Testing
 - Subscriber Radio Testing
 - Microwave Network Testing
 - Coverage Testing
 - Fleet Mapping Workshop
 - Training
 - Radio User Training
 - System Administrator Training
 - Console User Training
 - Maintenance Training
 - System Cutover
 - Final Documentation/ System As-builts Review
 - Final Acceptance

Appendix A Acronyms

GLOSSARY and ACRONYMS

A

AES	Advanced Encryption Standard
APCO	Association of Public Safety Communication Officials
AUX I/O	Auxiliary Inputs/Outputs

B

BDA	Bi-Directional Amplifiers
bps	Bits per Second

C

CAD	Computer-aided Dispatch
CAP	Compliance Assessment Program
CSSI	Console Subsystem Interface
CTA	Communication Technology Advancement

D

DAQ	Delivered Audio Quality
DDR	Detailed Design Review
DMR	Digital Mobile Radio
DVR	Digital Vehicular Repeater
DWR	Department of Wildlife Resources

E

EC	European Commission
EMS	Emergency Management Services
EOC	Emergency Operations Center
ERP	Effective Radiated Power
ETSI	European Telecommunications Standardization Institute

F

FCC	Federal Communications Commission
FDMA	Frequency Division Multiple Access
FirstNet	First Responder Network Authority
FNE	Fixed Network Equipment

G

GHz	Gigahertz
GPS	Global Positioning System

H

HVAC	Heating Ventilation and Air Conditioning
------	--

I

IRR	Instant Recall Recorder
ISSI	Inter-RF Subsystem Interface

K

kHz	Kilohertz
-----	-----------

L

LMR	Land Mobile Radio
LTE	Long-Term Evolution

M

MCTRJCA	Middle Class Tax Relief and Job Creation Act of 2012
MDT	Mobile Data Terminal
MHSB	Monitored Hot Stand-By
MHz	Megahertz
MOU	Memorandum of Understanding
MTBF	Mean Time Between Failures

N

NENA	National Emergency Number Association
NPSPAC	National Public Safety Planning Advisory Committee
NTIA	National Telecommunications and Information Administration

O

OTAP	Over-The-Air Programming
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P

P25	Project 25
PoC	Push to Talk over Cellular
POTS	Plain Old Telephone Lines
PSAP	Public Safety Answering Point
PTT	Push To Talk

R

RF	Radio Frequency
RFP	Request for Proposal
RPCs	Regional Planning Committees
ROM	Rough Order of Magnitude

S

SIRS	Statewide Interdepartmental Radio System
STARS	Statewide Agencies Radio System

T

TDI	Time Delay Interference
TDMA	Time Division Multiple Access

TETRA Terrestrial Trunked Radio
TIA Telecommunications Industry Association
TTA Tower Top Amplifiers

U

UHF Ultra High Frequency
UPS Uninterruptible Power Supply

V

VDEM Virginia Department of Emergency Management
VDOT Virginia Department of Transportation
VHF Very High Frequency
VOIP Voice Over IP
VSP Virginia State Police

Appendix B Interview Records

Craig County Emergency Management Services

Craig County Fire

Craig County Rescue

Craig County School Board

Craig County Sheriff's Office and Dispatch

Craig County Volunteer Rescue Squad

New Castle Volunteer Fire Department

Paint Bank Volunteer Fire Department

Simmons ville Volunteer Fire Department

Upper Craig's Creek Volunteer Fire Department – Station 5



Date: November 6, 2020

Agency/Locality: Craig County Emergency Services
Contact Name: Jim Cady

Interviewed By: Cheryl Giggetts, Rachel Soward, Jeremiah Knowles

Interview Questions

Organization and Responsibilities

1. Please give us a brief overview of your agency.

Craig County Emergency Services currently has 22 employees, 5 full-time and 16 part-time, 1 paramedic and 1 EMT. They provide ALS truck 24/7. The volunteer rescue squad has 4 certified members and 10 total members. They are a small agency compared to surrounding municipalities. They have a dispatch center with 1 dispatcher on shift. Dispatch is managed by the Sheriff's Office.

Current Radio System:

2. How do you use the current radio system? (A general description of your radio system as you perceive it)

The system was not structured or designed, it resulted from a grant submitted by and awarded to law enforcement. Law Enforcement had previously worked with ProComm for maintenance, and they helped spec the equipment for grant, but there was no formal plan. Installation was complete somewhat haphazardly, without fleet mapping.

3. What is your agency's backup communications plan if the current system is not operational?

If the North and South towers go down, the Emergency Service building can work off of the tower on site, but talk around only, not repeated. If either one of the towers is operational, it may pick up signal and repeat it.

4. What radio channels are in your radios?

Geromy will provide the list of radio channels.

5. Quantities of subscriber equipment currently in use by your agency:

- | | |
|------------------------|--|
| a. Mobiles | 4 (3 ICOM and 1 Kenwood for each of the four vehicles) |
| b. Portables | 7-8 ICOM |
| c. Control Stations | 5 |
| d. Pagers | 0 |
| e. Vehicular Repeaters | 0 |

6. Additional quantities of subscriber equipment needed by your agency:

- | | |
|--------------|---------------------------------------|
| a. Mobiles | 5 and 1 spare |
| b. Portables | 26 (one each person and a few spares) |

Current Communications Environment:

7. Who do you communicate with on daily basis? Occasional basis?

Daily Emergency Services talks with Craig County Dispatch, Sheriff's Office, and Giles County.

Incident Based Interoperability on occasion:

Alleghany County VA

Monroe WV

Botetourt County VA

Roanoke County VA

Roanoke City VA

City of Salem VA

Montgomery County VA

Giles County VA

State Forestry

Federal Forestry

VDOT (especially in the winter)

(COMLINC not working)

8. Can you talk to them on your current radio system? If not, how do you talk with them?

Talk to them through dispatch at Emergency Services building, via the tower. They cannot communicate with the 800 MHZ system

Current Communications Issues

9. What are the current communications problems/ issues?

a. Coverage:

- Has your agency experienced radio coverage issues? (geographic areas of the County or in specific buildings)

They Coverage is poor on talk in and they do not know what is on each repeater. Jim Cady does a lot of relay from radios from his house to communicate to users in the field to dispatch, since talk-in is poor and dispatch cannot hear the users.

b. Interference (from other agencies in the County or from agencies outside of the County)

Montgomery School Bus are on the same channel as Craig Dispatch, which can be heard by Station 5. School bus is on the same frequency, they talk over users / dispatch with conversations between buses.

c. Crowding (too many users on a channel) Has your agency experienced delayed access or no access when using radios?

Not much, only when Alleghany was doing tone testing every day; better now believe they quit testing off the tower here.

d. People who need communications and are not on the current system?

VDOT

- e. Maintenance Issues (radio system or subscriber units) Has your agency experienced issues maintaining your radios or infrastructure? ProComm
- Who performs maintenance on your equipment?

ProComm takes care of system and subscribers

10. Has your agency experienced any other technical or operational issues in using the radio system?

Emergency Services have issues with IFLOWS. Their whole region is struggling with this as it all goes up to Potts Mtn, repeater (MapTech) which goes to Roanoke, for their servers to process.

Future Requirements

11. What new or expanded features should the new system be capable of incorporating, either purchased initially with the system, or capable of being added in the future? (e.g. intrinsically safe portables, encryption, mobile data terminals, GPS location, Wi-Fi/LTE, Bluetooth, etc.)

Microwave or a fiber link between the existing dispatch and Emergency Services building would be helpful. Data terminals for at least for coordinator and assistants and on the First run truck would be good to have.

12. What functions are currently performed by other communications means, such as cell phones, tablets, pagers could or should be assumed by the new system? (Any functionality is critical not to lose with a new system)

13. Your best estimate as to how your department will grow over the next 15 years: (i.e. twice the rate of County growth, etc.)
- 2% next five years

This Interview Record was reviewed and returned to CTA by Jim Cady on November 30, 2020.

Date: December 8, 2020

Agency/Locality: Craig County Fire

Contact Name: Jeff VanDyke, Division Chief of Fire

Interviewed By: Cheryl Giggetts, Curtis Johnson

Interview Questions

Organization and Responsibilities

1. Please give us a brief overview of your agency.

Craig County Fire acts as a liaison between the County and the Fire Departments. Each department normally handles their own business operations.

Jeff is also a member of the New Castle Volunteer Fire Department. There is no paid fire staff, only volunteers.

Current Radio System:

2. How do you use the current radio system? (A general description of your radio system as you perceive it)

Craig County Fire reply to calls on their handheld radios but it does not work well. Only miles apart make a difference in being able to connect to a call.

3. What is your agency's backup communications plan if the current system is not operational?

Cell phones are the only backup.

4. Quantities of subscriber equipment currently in use by your agency:

Radios are held by the individual Fire Departments and there can be differences in manufacturers, based on what each department purchases.

5. Additional quantities of subscriber equipment needed by your agency:

Radios are held by the individual Fire Departments, but some are running low as the equipment ages or membership increases.

Current Communications Environment:

6. Who do you communicate with on daily basis? Occasional basis?

The fire departments communicate with the Dispatch Center and Craig County Rescue on a routine basis. There will also be communication between the fire trucks and also between members in their personal vehicles.

7. Can you talk to them on your current radio system? If not, how do you talk with them?

They can talk with Dispatch and Rescue on their system if service allows. Otherwise, it will be through the cellular network.

8. Who do you communicate with outside of your agency and can you use the current radio system for this communication?

The fire departments will sometimes talk between each other on mutual aid calls and there have been times that communication with the Sheriff's Department would have been beneficial, but that is not currently available.

9. Who do you communicate with outside your jurisdiction and can you use the current radio system for this communication?

The fire departments work with neighboring counties, but we do not have the capability to communicate with them.

Current Communications Issues

10. What are the current communications problems/ issues?

Coverage is the primary issue throughout the County.

Future Requirements

11. What new or expanded features should the new system be capable of incorporating, either purchased initially with the system, or capable of being added in the future? (e.g. intrinsically safe portables, encryption, mobile data terminals, GPS location, Wi-Fi/LTE, Bluetooth, etc.)

It would be helpful to have MDT units.

12. What functions are currently performed by other communications means, such as cell phones, tablets, pagers could or should be assumed by the new system? (Any functionality is critical not to lose with a new system)

Craig County Fire use cell phones often when the radio system does not have coverage.

13. Your best estimate as to how your department will grow over the next 15 years: (i.e., twice the rate of County growth, etc.)

Do not forecast significant growth moving forward.

Additional Comments:

Montgomery County has a tower on Brush Mountain that may be usable.

I have also heard suggestions of being able to dispatch multiple departments at the same time, for a given call. This would decrease response times.

This Interview Record was reviewed and returned by Jeff VanDyke on December 30, 2020.

Date: November 9, 2020

Agency/Locality: Craig County Rescue

Contact Name: Darryl Humphreys

Interviewed By: Rachel Soward and Sylvia Newman

Interview Questions

Organization and Responsibilities

1. Please give us a brief overview of your agency.

The Craig County Rescue has 5 full-time (M-F) and 18 part-time volunteers. They have 5 vehicles which consists of 3 rescue squad vehicles and 2 emergency management vehicles. They may get 1 more vehicle if they get a grant approved. All of their vehicles have mobile ICOM radios. One vehicle has an older Kenwood radio. There are two station radios, and they keep a few radios for emergency. They do not use pagers.

Current Radio System:

2. How do you use the current radio system? (A general description of your radio system as you perceive it)

The Craig County Volunteer Fire Department talks to Dispatch and has the capability to talk to the Fire Department if they need to. They talk to dispatch and can talk with fire depts for accident for updates for patients.

They have to go to Paint Bank for ALS transports that go to Roanoke, Paint Bank is on a separate frequency (they have to switch radios or relay through dispatch). Sometimes they are able to change over to Fire North in order to speak with them.

3. What is your agency's backup communications plan if the current system is not operational?

They use their cell phones for back up, where there is cell service in the area. It is difficult since volunteers all do not have US cellular, which is the main cell service provider.

4. What radio channels are in your radios?

Geromy will supply list of all radio channels

5. What other departments/divisions use the same channel(s)?

N/A

6. Quantities of subscriber equipment currently in use by your agency:

- a. Mobiles - 5
- b. Portables - 5
- c. Control Stations - 2
- d. Pagers - 0

- e. Vehicular Repeaters 0
7. Additional quantities of subscriber equipment needed by your agency:
- a. Mobiles - 6
 - b. Portables – 10 or 15
 - c. Control Stations
 - d. Pagers
 - e. Vehicular Repeaters

Current Communications Environment:

8. Who do you communicate with on daily basis? Occasional basis?

Communicate the most with Sheriff, 2nd most career staff,

Craig County VFD talks to dispatch often and they occasionally talk to other the other County volunteer fire departments including Paint Bank VFD.

Craig County VFD uses their cell phones to talk to the hospital.

They have med channels programmed in their radio but use cell phones. They used the med channel in the past to communicate with Lewis Gayle Hospital, but the hospital could hear them in the field, but they could not hear the hospital.

They occasionally to the volunteer fire departments in Paint Bank and Alleghany County.

9. Can you talk to them on your current radio system? If not, how do you talk with them?

They use their cell phone or patching with dispatch.

10. Who do you communicate with outside of your agency and can you use the current radio system for this communication?

They have a channel programmed on the radios to talk to Giles County when in route to an incident.

11. Who do you communicate with outside your jurisdiction and can you use the current radio system for this communication?

Alleghany County and Montgomery County.

12. What is your current financial contribution to the radio system/equipment?

N/A

Current Communications Issues

13. What are the current communications problems/ issues?

Rescue south tower has coverage issues and there are also coverage issues in the ridges and quiet zone.

Paint Bank Vol Fire Dept is on a different frequency. Either Paint Bank needs to switch their radio channel to talk to rescue or it can be switched through dispatch. Some people do not know that they can switch over directly and not go through a third party.

If volunteers do not have a US cellular phone, once they're over the mountain, they lose signal on cell phones.

They cannot talk to Roanoke County because Roanoke County is on an 800 system. Craig County is on a UHF system.

When they are inside the ambulance and try talking to Lewis Gale hospital, the hospital could hear them, but they cannot hear them.

a. Coverage:

- Has your agency experienced radio coverage issues? (geographic areas of the County or in specific buildings)
- Has your agency experienced pager coverage issues? What locations?
They do not use pagers

b. Interference (from other agencies in the County or from agencies outside of the County)

There is interference with local businesses heard talking on the radios.

There is interference at the South tower, Sinking Creek, and towards all the way to Roanoke. They are on the same frequency but digital so they difficult to understand.

Potts Mountain can hear school buses on the radio. If they go off scanning on the north tower, there is school interference.

c. Crowding (too many users on a channel) Has your agency experienced delayed access or no access when using radios?

Dispatch has a single console for all fire and rescue. When one agency is trying to respond to a dispatch call, too many agencies end up overlapping and might speak over each other. Then the dispatch center is unable to hear anyone's response. This crowding does not happen weekly but more frequently than not at all.

It is unpredictable as to when multiple incidents happen. When it happens, dispatch gets overwhelmed because off fire talking and rescue talking at the same time.

It is cumbersome for Dispatch when they receive two incidents that are not related at the same time.

d. Are there people who need communications and are not on the current system?

Search and rescue may be on the same system, but they are not sure what frequency they are using.

e. Maintenance Issues (radio system or subscriber units) Has your agency experienced issues maintaining your radios or infrastructure?

- Who performs maintenance on your equipment?
ProComm

14. Has your agency experienced any other technical or operational issues in using the radio system?

They do not want to have to look at their radios to switch channels while driving.

Future Requirements

15. Who would you like to communicate with in the future to make your job more efficient?

They would like to communicate with Roanoke County, and they need to be able to talk to Giles, Montgomery, and Botetourt counties. They would at least like to be able to reach dispatch in those areas to request law enforcement.

16. What new or expanded features should the new system be capable of incorporating, either purchased initially with the system, or capable of being added in the future? (e.g. intrinsically safe portables, encryption, mobile data terminals, GPS location, Wi-Fi/LTE, Bluetooth, etc.)

- Encryption
- It would be good to have a TAC channel, that way they can switch and talk directly to Paint Bank or Fire Depts
- CADD location
- Rescue needs a mandown type feature, so they can press a button discretely to reach law enforcement for assistance.
- They would like to have DVRs, when at home and need to contact law enforcement. They have to leave their house and go outside in order to ping the tower and reach dispatch.

17. What functions are currently performed by other communications means, such as cell phones, tablets, pagers could or should be assumed by the new system? (Any functionality is critical not to lose with a new system)

18. Your best estimate as to how your department will grow over the next 15 years: (i.e. twice the rate of County growth, etc.)

2025 (5 years) 6 mobiles
2030 (10 years)
2035 (15 years)

This interview record was sent to Darryl Humphreys for review on November 17, 2020.

Date: November 9, 2020

Agency/Locality: Craig County School Board

Contact Name: Denny Williams - Oversees all buses and school maintenance

Interviewed By: Rachel Soward and Sylvia Newman

Interview Questions

Organization and Responsibilities

1. Please give us a brief overview of your agency.

The Craig County School district has base stations, one in the elementary and one in the high school and bus issues are handled in the base garage. The garage station is for buses that have broken down. Drivers communicate mainly with the school and buses can communicate with each other.

There are 16 buses, and each bus has a mobile. There are 2 trucks with mobiles and there are 2 portables. They use the repeater on Pott's Mountain stie.

Current Radio System:

2. How do you use the current radio system? (A general description of your radio system as you perceive it)

They have the ability to call the Sheriff's Office from the bus directly. The pickup truck has a radio and portable with same channels as the Craig County Rescue and Sheriff's Office.

3. What is your agency's backup communications plan if the current system is not operational?

They use cell phones as a backup communication plan, but the buses have to pull over to call in.

4. What radio channels are in your radios?
Geromy will provide list of radio channels.

Current Communications Environment:

5. Who do you communicate with on daily basis? Occasional basis?

They can talk to the Sheriff; however, ninety percent of the radio calls are used for school purposes.

Current Communications Issues

6. What are the current communications problems/ issues?

They have the same coverage issues near Giles line and lower end towards Botetourt.

- a. Coverage:
 - Has your agency experienced radio coverage issues? (geographic areas of the County or in specific buildings)

- Has your agency experienced pager coverage issues? What locations?
- b. Interference (from other agencies in the County or from agencies outside of the County)

No interference
- c. Crowding (too many users on a channel) Has your agency experienced delayed access or no access when using radios?

No crowding issues
- d. people who need communications and are not on the current system
no
- e. Maintenance Issues (radio system or subscriber units) Has your agency experienced issues maintaining your radios or infrastructure? ProCom

Future Requirements

7. What new or expanded features should the new system be capable of incorporating, either purchased initially with the system, or capable of being added in the future? (e.g. intrinsically safe portables, encryption, mobile data terminals, GPS location, Wi-Fi/LTE, Bluetooth, etc.)

Uncertain of any features they would need.

Really happy with the radio system and works really good for the school system even though it's old. Camera system has GPS (missing a part), but they do not have tracking systems on the buses.

8. Your best estimate as to how your department will grow over the next 15 years: (i.e. twice the rate of County growth, etc.)

2025 (5 years) don't expect it to change

2030 (10 years)

2035 (15 years)

This interview record was sent to Denny Williams for review on November 17, 2020.

Date: November 19, 2020

Agency/Locality: Craig County Sheriff's Office and Dispatch

Contact Name: Chief Deputy Geromy Nichols

Interviewed By: Cheryl Giggetts and Jeremiah Knowles

Interview Questions

Organization and Responsibilities

1. Please give us a brief overview of your agency.

Dispatch

Craig County Dispatch covers 334 sq miles throughout the County. They have 5 full-time dispatchers, 5 part-time dispatchers. Currently have 2 consoles at dispatch and 1 console at the EOC. There is 1 control station in the dispatch center used for encryption. There is also a control station in Simmonsville (UHF).

Crowding is an issue with one console and multiple calls come in at one time. Difficult when several officers try to answer at once.

Southern Software is the CAD and was installed in 2018.

The Dispatch center uses the 4 tower sites (Potts, Sinking Creek, Simmonsville, plus the EOC). There is a hybrid system of Rx UHF, and Tx Lo Band. Potts is only site that transmits to vehicles. Potts and Sinking Creek receive from vehicles and the VHF channel is used for portables to talk back to vehicles.

Sheriff

Craig County Sheriff's Office has 1 sheriff, 9 deputies, all officers are sworn officers. There is currently 1 deputy in training. There could use 3 more deputies. There are no part-time officers. One deputy handles animal control, and another is the 9-1-1 coordinator. The Sheriff's office handles courtroom security, civil process, as well as all law enforcement for all of Craig County.

They have 9 vehicles, with 1 vehicle on order. This includes 1 4x4 vehicle and animal control. There is a mobile radio in each vehicle and 1 spare mobile radio. They have 11 VHF portables (HT 750), and each portable is assigned to a vehicle, each vehicle is assigned to a person.

Current Radio System:

2. How do you use the current radio system? (A general description of your radio system as you perceive it)

The Sheriff's Office uses the radio system to communicate with Dispatch and animal control. They use the VHF channel for portables to talk back to vehicles. There is a building at Potts tower (140 feet), they have space inside. Craig County owns equipment at the site, the site is owned by National Forest, under Craig/Botetourt. VDOT and the Power company are also using site. The Power company funds the site power and generator (15kw, 1000 gallons). Alleghany is also on this tower, but maybe coming off soon.

3. What is your agency's backup communications plan if the current system is not operational?

Cell phones are used as the primary backup plan for communicating with the Dispatch Center.

4. What radio channels are in your radios?

Please provide list and confirm frequency licenses are correct.

5. Quantities of subscriber equipment currently in use by your agency:
- Mobiles - 30 (VHF, Lo-Band, and UHF - 3 radios in each vehicle)
 - Portables - 11 (VHF)
 - Control Stations - 0
 - Pagers - 0
 - Vehicular Repeaters - 0

Current Communications Environment:

6. Who do you communicate with on daily basis? Occasional basis?

The Craig County Sheriff's office communicates with the Dispatch Center on a daily basis. They also talk to VSP on a daily basis and they have Craig County frequencies in their SIRS radios. They talk to the National Forest Service and the Game Warden occasionally. and have Craig frequencies programmed in their radios.

7. Who do you communicate with outside your jurisdiction and can you NOT use the current radio system for this communication?

The Sheriff's office and talk to the Alleghany Highlands Drug Task Force with their cell phones. VSP will provide cache radios to communicate in event of incident.

Current Communications Issues

8. What are the current communications problems/ issues?

- a. Coverage:
- Has your agency experienced radio coverage issues? (geographic areas of the County or in specific buildings)
 - Has your agency experienced pager coverage issues? What locations?

Sheriff has fairly good coverage with all the radios, they can hear dispatch, however talk-in is problematic. In-buildings and school, UHF helps with talk-in.

b. Interference (from other agencies in the County or from agencies outside of the County)

There is not much interference since the Sheriff's office is off Lo Band. Radios scan Rescue and Fire.

c. Crowding (too many users on a channel) Has your agency experienced delayed access or no access when using radios?

There is only crowding issues when there is a major incident with multiple agencies involved. Also need to have channel to talk car to car.

- d. Maintenance Issues (radio system or subscriber units) Has your agency experienced issues maintaining your radios or infrastructure?
- Who performs maintenance on your equipment? Geromy Nichols

Future Requirements

9. What new or expanded features should the new system be capable of incorporating, either purchased initially with the system, or capable of being added in the future? (e.g., intrinsically safe portables, encryption, mobile data terminals, GPS location, Wi-Fi/LTE, Bluetooth, etc.)

It would be beneficial to have encryption, Mobile Data, and a CAD system to push call to vehicles. GPS location on the radios would help out. Preventative Maintenance and maintenance contract. Talk to dispatch on a channel, car to car encryption, and another channel.

Hoping to fund through grant awards.

This interview record was sent to Jeromy Nichols for review on December 8, 2020.

Date: November 9, 2020

Agency/Locality: Craig County Volunteer Rescue Squad
Contact Name: Robert Wrzosek
Interviewed By: Rachel Soward and Sylvia Newman

Interview Questions

Organization and Responsibilities

1. Please give us a brief overview of your agency.

Volunteer Rescue provides support to Career staff and on Saturday/Sunday and as back up on some calls. They use the same channels and equipment as the career rescue squad.

The Craig County Volunteer Rescue is not staffed 24/7 but has about 12-15 volunteers.

They have 2 trucks and both trucks have mobile radios.

They have the same ICOM radios as fire and dispatch.

They have about 20 portables radios.

They do not use pagers.

Current Radio System:

2. How do you use the current radio system? (A general description of your radio system as you perceive it)

They are toned out by dispatch, and communicate very little on the radio system, mostly to mark on scene or in route to scene, in route to hospital, or on scene at hospital. They do receive text messages.

They mainly talk to Dispatch and they use the same frequencies as career rescue.

3. What is your agency's backup communications plan if the current system is not operational?
N/A

4. What radio channels are in your radios?
Geromy will supply list of all agency channels

5. What other departments/divisions use the same channel(s)?

Interoperability channels on portable with Giles County and Newport Rescue, Alleghany and Monroe

6. Quantities of subscriber equipment currently in use by your agency:
- a. Mobiles - 2
 - b. Portables - 15
 - c. Control Stations - 0
 - d. Pagers - 0
 - e. Vehicular Repeaters 0

Current Communications Environment:

7. Who do you communicate with on daily basis? Occasional basis?

Craig County EOC mainly talks to the Dispatch Center.

They have interoperability with Giles and Allegany counties.

8. Who do you communicate with outside of your agency and can you use the current radio system for this communication?

Craig County Vol rescue can talk to Giles County and have a channel programmed on the radios to talk when in route to an incident.

9. What is your current financial contribution to the radio system/equipment?

N/A

Current Communications Issues

10. What are the current communications problems/ issues?

Rescue south tower has coverage issues, and there are coverage issues along the ridges and quiet zone.

There are coverage issues with dispatch which causes them to mainly communicate with cell phones.

The EOC works with the hospital.

- a. Coverage:

- Has your agency experienced radio coverage issues? (geographic areas of the County or in specific buildings) -
- Has your agency experienced pager coverage issues? What locations?

- b. Interference (from other agencies in the County or from agencies outside of the County)

Experience interference near the top of Potts Mountain from the schools.

- c. Crowding (too many users on a channel) Has your agency experienced delayed access or no access when using radios?

Dispatch has a single console for all fire and rescue. When one agency is trying to respond, too many agencies overlap.

When multiple incidents happen, which is unpredictable, Dispatch gets overwhelmed because off fire talking and rescue talking at the same time. Communications are missed, both by dispatcher, and by users. Believe Fire Depts use the radio more heavily and the system would benefit from having a TAC channel for them to use on scene and to mark in route.

11. Has your agency experienced any other technical or operational issues in using the radio system?

The radio system is aging. Repeaters are used 24/7 and are not temperature controlled. They burn out, then they have radio issues until it is fixed. There was a repeater that needed repair and they had to operate under fire channel for a day.

Future Requirements

12. Who would you like to communicate with in the future to make your job more efficient?

Roanoke County

13. What new or expanded features should the new system be capable of incorporating, either purchased initially with the system, or capable of being added in the future? (e.g. intrinsically safe portables, encryption, mobile data terminals, GPS location, Wi-Fi/LTE, Bluetooth, etc.)

Phone map application without having to request a repeat from dispatch, and other APPs to mark in route to an incident.

14. What functions are currently performed by other communications means, such as cell phones, tablets, pagers could or should be assumed by the new system? (Any functionality is critical not to lose with a new system)

Encryption to keep personal information private

15. Can your agency contribute financially to an upgraded/new system?

N/A

This interview record was sent to Robert Wrzosek for review on November 17, 2020.

Date: November 6, 2020

Agency/Locality: New Castle Volunteer Fire Department

Contact Name: Brent Crush

Interviewed By: Cheryl Giggetts, Rachel Soward, Jeremiah Knowles

Interview Questions

Organization and Responsibilities

1. Please give us a brief overview of your agency.

New Castle Volunteer Fire Department has 3 trucks including a crash truck and a brush truck. They have 5 mobile radios and 24 portables. There are no control stations, pagers, or DVRS.

Current Radio System:

2. How do you use the current radio system? (A general description of your radio system as you perceive it)

The current radio system works better than it has in the past, but they often use their cell phones for best communication.

3. What is your agency's backup communications plan if the current system is not operational?

Their backup communications plan is using the telephone or cell phones.

4. What radio channels are in your radios?

Geromy will provide a list of radio channels.

5. Quantities of subscriber equipment currently in use by your agency:

- | | |
|------------------------|----|
| a. Mobiles | 5 |
| b. Portables | 24 |
| c. Control Stations | 0 |
| d. Pagers | 0 |
| e. Vehicular Repeaters | 0 |

6. Additional quantities of subscriber equipment needed by your agency:

- | | |
|------------------------|---|
| a. Mobiles | 0 |
| b. Portables | 6 |
| c. Control Stations | 0 |
| d. Pagers | 0 |
| e. Vehicular Repeaters | 0 |

Current Communications Environment:

Fire, dispatch, Rescue, talk around, helicopter

7. Who do you communicate with on daily basis? Occasional basis?

They currently communicate mainly with the dispatch center.

8. Can you talk to them on your current radio system? If not, how do you talk with them?

Yes

9. Who do you communicate with outside of your agency and can you use the current radio system for this communication?

They can communicate with Simmonsville VFD Station 5 and John's Creek VFD.

10. Who do you communicate with outside your jurisdiction and can you use the current radio system for this communication?

They can communicate with Roanoke County through dispatch. They can contact Catawba station 4 however, rescue responds more than fire.

Current Communications Issues

11. What are the current communications problems/ issues?

a. Coverage:

- Has your agency experienced radio coverage issues? (geographic areas of the County or in specific buildings)
- Has your agency experienced pager coverage issues? What locations?

b. Interference (from other agencies in the County or from agencies outside of the County)

There is interference close to Montgomery County and with the Sink Creek school buses.

c. Crowding (too many users on a channel) Has your agency experienced delayed access or no access when using radios?

Very rarely

d. Maintenance Issues (radio system or subscriber units) Has your agency experienced issues maintaining your radios or infrastructure? ProComm

- Who performs maintenance on your equipment?
ProComm

12. Has your agency experienced any other technical or operational issues in using the radio system?

No

Future Requirements

13. Who would you like to communicate with in the future to make your job more efficient?

They would like to talk with Botetourt, Oriskany, and Roanoke Counties.

14. What new or expanded features should the new system be capable of incorporating, either purchased initially with the system, or capable of being added in the future? (e.g. intrinsically safe portables, encryption, mobile data terminals, GPS location, Wi-Fi/LTE, Bluetooth, etc.)

New Castle VFD would like notification on the radios to know where incidents are located. They would also like a call in line at dispatch that is recorded, similar to 911 or 5127. Would be beneficial to have a page on their cell phones to push to listen.

15. Your best estimate as to how your department will grow over the next 15 years: (i.e. twice the rate of County growth, etc.)

2025 (5 years) 2% per year

2030 (10 years)

2035 (15 years)

This interview record was sent to Brent Crush for review on November 17, 2020.

Date: November 19, 2020

Agency/Locality: Paint Bank Volunteer Fire Department

Contact Name: Richard Hale, Rick Hale

Interviewed By: Cheryl Giggetts and Jeremiah Knowles

Interview Questions

Organization and Responsibilities

1. Please give us a brief overview of your agency.

Paint Bank Volunteer Fire Department serves the Paint Bank area as well as Rolling Springs, Dunlap, Craig County, Monroe County, WV (75% of calls in Monroe), and Alleghany County. They have Mutual Aid in Monroe WV and Alleghany VA.

The population in Paint Bank is around 200. The Paint Bank VFD currently has 12 volunteers, with 2 fire vehicles and 2 ambulances. There is a mobile radio in each vehicle, with two mobiles in each ambulance.

They have 15 portable radios and 4 pagers and need more radios and pagers; they do not have control stations.

Paint Bank VFD transports to Alleghany County and Giles County, depending on their location. Trauma accidents go to Roanoke Memorial. They use Lifeguard and Healthnet to fly heavy trauma patients.

Paint Bank answers 30 - 60 calls per year. They have had as many as 85 Rescue calls per year. Rescue is BLS only. There are an average of 0-15 Fire calls per year.

Current Radio System:

2. How do you use the current radio system? (A general description of your radio system as you perceive it)

Paint Bank VFD can hear messages from dispatch, they communicate to the station to respond to scene.

3. What is your agency's backup communications plan if the current system is not operational?

If Dispatch calls the Fire Chief at home, he will then call volunteers of the fire department. There is not good cell coverage.

4. What radio channels are in your radios?

Dispatch 1
Dispatch 2
Station 1
Station 1 Work
Station 1 Interop
Station 2
Station 2 Work
Station 3
Station 4
Station 4 Interop
Station 5
Site North
Station Interop
Fire Dept North
Pager
Rescue North
Rescue South

Interop Zone

Station 1
Station 2
Station 3
Fire North
Rescue North
Rescue South
Giles Fire and Rescue
Giles County work
Union Fire Dept. - Monroe WV
Union Rescue Squad - Monroe WV
Sweet Springs tower - Monroe WV
Monroe TAC
Alleghany

Adding Med channel 9 and Med channel 10 for Roanoke in the new ambulance. They also use the Monroe talk around channel.

5. Quantities of subscriber equipment currently in use by your agency:

- a. Mobiles - 6
- b. Portables - 15
- c. Control Stations - 0
- d. Pagers - 4
- e. Vehicular Repeaters - 0

6. Additional quantities of subscriber equipment needed by your agency:

- a. Mobiles - 4

- b. Portables - 15
- c. Control Stations - 1
- d. Pagers - 10
- e. Vehicular Repeaters - 0

Current Communications Environment:

7. Who do you communicate with on daily basis? Occasional basis?

Paint Bank talks to Craig County E911 Dispatch Center frequently as well as Johns Creek VFD, Craig County Rescue Squad, Alleghany County, and Monroe County. They sometimes talk to New Castle Emergency Operations Center, Upper Craig's Creek VFD, Simmonsville VFD, and Giles County.

8. What is your current financial contribution to the radio system/equipment?

Paint Bank VFD have assisted in the purchase of their radios.

Current Communications Issues

9. What are the current communications problems/ issues?

a. Coverage:

- Has your agency experienced radio coverage issues? (geographic areas of the County or in specific buildings)

Paint Bank has coverage issues in West Virginia. There are coverage problems along Route 42 and near Brush Mountain.

Coverage for the Paint Bank area is poor, and they could use a repeater at the station to cover the valley. The Cemetery will allow a tower.

- Has your agency experienced pager coverage issues? What locations?

Coverage outside of the immediate Paint Bank area is poor, especially in West Virginia.

b. Interference (from other agencies in the County or from agencies outside of the County)

Interference is not an issue since they have moved from Low Band.

c. Crowding (too many users on a channel) Has your agency experienced delayed access or no access when using radios?

Only with using the Craig County channels.

d. Maintenance Issues (radio system or subscriber units) Has your agency experienced issues maintaining your radios or infrastructure?

- Who performs maintenance on your equipment?
ProComm

Future Requirements

10. Who would you like to communicate with in the future to make your job more efficient?

Paint Banks believes each station needs its own channel, and a talk around channel. They also believe Dispatch needs its own channel.

11. What new or expanded features should the new system be capable of incorporating, either purchased initially with the system, or capable of being added in the future? (e.g. intrinsically safe portables, encryption, mobile data terminals, GPS location, Wi-Fi/LTE, Bluetooth, etc.)

Paint Bank VFD would like to have mobile data and a big screen in station showing active calls and location. When responding to Allegheny it is difficult to know where you are going. Intrinsically safe portables and Wi-Fi to use notification apps would be helpful.

12. Can your agency contribute financially to an upgraded/new system?

Only if they can obtain grant money

13. Your best estimate as to how your department will grow over the next 15 years: (i.e. twice the rate of County growth, etc.)

Little to no growth anticipated

Additional Comments:

We need to have the current system work the way it was intended to work.

This interview record was sent to Richard Hale for review on December 8, 2020.

Date: November 6, 2020

Agency/Locality: Simmonsville Volunteer Fire Department

Contact Name: Brian Lipes and Brad

Interviewed By: Cheryl Giggetts, Rachel Soward, and Jeremiah Knowles

Interview Questions

Organization and Responsibilities

1. Please give us a brief overview of your agency.

Simmonsville VFD covers the area between New Castle and the Giles County line with about 5-10 miles of overlap. The area includes the valley between Sinking Creek Mountain, and Little Mountain, and over the ridge of Little Mountain, back where the Appalachian Trail crosses near route 42.

Simmonsville VFD was organized in 1976 to help with rescue near Sinking Creek valley, because they are much closer than New Castle and Newport. They have AED on their trucks, and their personnel are trained in basic first aid. They have broaden out beyond fire to rescue. They are responsible for helicopter and extrication. They do not transport but help on scene and they have to be dispatched.

Simmonsville VFD have 17 volunteers, and usually have between 17-20 on the roster. They have one 2005 Pierce Pumper Engine, which is the first vehicle on every call, a 2009 Deep South Pumper Tanker, a 1990 Rescue Brush Truck that carries the rescue tools, crib, etc. They have 2 older brush trucks 1977, 1989.

All 5 vehicles have mobile radios, 5 for officers in their vehicles, Kenwood TK890 (UHF), and they have 25 portables, each member carries a Kenwood TK3312. There are 25 Motorola Minitor 6 pagers.

Brian Lipes writes grants for Simmonsville VFD and turns out gear and the radios.

Current Radio System:

2. How do you use the current radio system? (A general description of your radio system as you perceive it)

Simmonsville VFD has their own work around channel (they have 2 channels), and they are also on the Craig County system. If they leave the area, they have to change channels. They can talk to dispatch from their station, but not to any other station. They prefer everyone have the ability to talk to each other on a few channels. Fire rescue is currently on a separate dispatch channel.

3. What is your agency's backup communications plan if the current system is not operational?

Simmonsville VFD use their cell phones as backup and all volunteers use US cellular.

4. What radio channels are in your radios?

Provided listing

5. What other departments/divisions use the same channel(s)?

Provided listing

6. Quantities of subscriber equipment currently in use by your agency:

- a. Mobiles: 5 in trucks, 5 in officer vehicles, Kenwood TK-890 (UHF) and TK-690H-3 (VHF-FM)
- b. Portables: 25, each member has one, Kenwood TK-3312
- c. Control Stations:
- d. Pagers: 25, Motorola minitor 6
- e. Vehicular Repeaters: None

7. Additional quantities of subscriber equipment needed by your agency:

- a. Mobiles: 0
- b. Portables: 0
- c. Control Stations:
- d. Pagers: no future needs
- e. Vehicular Repeaters: None

Current Communications Environment:

8. Who do you communicate with on daily basis? Occasional basis?

Simmons ville VFD communicates with the Craig County dispatch on a daily basis, and all other volunteer fire departments and they support with mutual aid. They communicate with Giles County 2nd most for mutual aid and Newport Fire and Rescue. They do not have the Sheriff's Office channels programmed in their radios. They are only able to talk with law enforcement if the dispatcher tells law enforcement them to switch to fire channels. They talk with National forest on cell phone or on Dispatch Channel

9. Can you talk to them on your current radio system? If not, how do you talk with them?

It Depends on the incident area. Some areas are dead zones.

10. Who do you communicate with outside of your agency and can you use the current radio system for this communication?

Craig County rescue and Newport rescue also provide support, dependent on where the incident is located. They can sometimes answer a call and Craig County can also dispatch them.

11. Who do you communicate with outside your jurisdiction and can you use the current radio system for this communication?

Montgomery County and Giles County. (Blacksburg, they plan to add their channels into their radios) and Roanoke mutual aid

12. What is your current financial contribution to the radio system/equipment?

The County provides some funding. They write grants and the County helps with matching awarded grants. They finance most of their equipment themselves with fund-raising and donations. They are working with the County to increase the funding percentage on a yearly basis.

Current Communications Issues

13. What are the current communications problems/ issues?

The radio system is old, and they have to rely on cell phones. Currently they have 3G. PemTel can provide highspeed internet but they do not currently use it.

Coverage:

- Has your agency experienced radio coverage issues? (geographic areas of the County or in specific buildings)

There are coverage issues for VFD members who work in Blacksburg and in Christiansburg. They can lose coverage 5 miles down the road and cannot hear dispatch.

Newcastle is a dead area to hear on their radios. Once they are 2 miles into Giles County, the radios get spotty.

- Has your agency experienced pager coverage issues? What locations?

Newcastle is a dead area to hear pagers. Once they are 2 miles into Giles County, the pagers get spotty

- a. Interference (from other agencies in the County or from agencies outside of the County)

None

- b. Crowding (too many users on a channel) Has your agency experienced delayed access or no access when using radios?

Not often but only issues when another fire department is called at the same time.

- c. Maintenance Issues (radio system or subscriber units) Has your agency experienced issues maintaining your radios or infrastructure?

- Who performs maintenance on your equipment? ProComm in Blacksburg

14. Has your agency experienced any other technical or operational issues in using the radio system?

None

Future Requirements

15. What new or expanded features should the new system be capable of incorporating, either purchased initially with the system, or capable of being added in the future? (e.g. intrinsically safe portables, encryption, mobile data terminals, GPS location, Wi-Fi/LTE, Bluetooth, etc.)

- Would benefit from having Bluetooth
- Would like to have tablets in their vehicles (CAD system), so the map shows up on the tablet.
- Would like a UTV vehicle and hope to in the near future. (hopefully via a grant).
- Would like to have one channel for Fire /Rescue, one for dispatch, and then each VFD department have their own channel. Also, one for countywide talk around.
- Would like to use several other towers to extend coverage

- Innovative, scanner to laptop, recorded to cell phones, would like to have this in an APP Countywide, as a backup to pager. CTA recommends PulsePoint APP
- If they had a tower on Brush Mountain it would help coverage immensely, not sure if adding Mt Lake tower would help.
- Would like to be able to see calls on the TV in the Station

16. Can your agency contribute financially to an upgraded/new system?

Very little, Minimal

17. Your best estimate as to how your department will grow over the next 15 years: (i.e. twice the rate of County growth, etc.)

2025 (5 years) 2% - 5%

2030 (10 years) 5%

2035 (15 years) 10%

Farms are being developed into single family homes

Additional Comments:

Concerns about volunteers and the smaller departments surviving. It is difficult to bring in younger people.

This Interview Record was reviewed and returned to CTA by Brian Lipes on December 2, 2020.

Date: November 9, 2020

Agency/Locality: Upper Craig's Creek VFD Station 5

Contact Name: Shawn Matheney and Jake Waller, Hunter

Interviewed By: Rachel Soward and Sylvia Newman

Interview Questions

Organization and Responsibilities

1. Please give us a brief overview of your agency.

Upper Craig's Creek VFD Station 5 has 10-12 active volunteers consisting of admin and fire personnel. There are 2 towers/repeaters North and South and 1 on top of Pott's Mountain site.

They have 3 vehicles (1 brush truck, 1 tanker, and 1 engine. They are expecting three new vehicles in the near future. They have radios in the trucks. Some are Kenwood and some ICOM. They have about 10 portable radios.

Current Radio System:

2. How do you use the current radio system? (A general description of your radio system as you perceive it)

They generally answer about 20-25 calls a year and mostly respond to car wrecks and forest fires. They provide mutual aid along the Craig County line and out to Route 460 and run calls from the County line to Montgomery County.

3. What is your agency's backup communications plan if the current system is not operational?

They use their cell phones as their backup communications plan.

4. What radio channels are in your radios?

Geromy will supply list of radio channels

5. What other departments/divisions use the same channel(s)?

The County Volunteer Fire Departments

6. Quantities of subscriber equipment currently in use by your agency:

- a. Mobiles 3
- b. Portables 10
- c. Control Stations
- d. Pagers
- e. Vehicular Repeaters

7. Additional quantities of subscriber equipment needed by your agency:

- a. Mobiles 4

- b. Portables 15
- c. Control Stations
- d. Pagers
- e. Vehicular Repeaters

Current Communications Environment:

8. Who do you communicate with on daily basis? Occasional basis?

They communicate with Dispatch and often use cell phones for dispatch and the department members.
US cellular works pretty well throughout the County.
May occasionally need to talk to Roanoke and Montgomery County

Current Communications Issues

9. What are the current communications problems/ issues?

They sometimes get toned out by dispatch and when trying to communicate with station 4.
Communicating between members is sometimes an issue.

a. Coverage:

- Has your agency experienced radio coverage issues? (geographic areas of the County or in specific buildings)
- Has your agency experienced pager coverage issues? What locations?

b. Interference (from other agencies in the County or from agencies outside of the County)

Montgomery County's two departments causes interference and comes across the channel a lot.
Alleghany County also causes interference.

c. Crowding (too many users on a channel) Has your agency experienced delayed access or no access when using radios?

No

d. people who need communications and are not on the current system

No

e. Maintenance Issues (radio system or subscriber units) Has your agency experienced issues maintaining your radios or infrastructure?

- Who performs maintenance on your equipment?

ProCom sometimes can fix the radios.

10. Has your agency experienced any other technical or operational issues in using the radio system?

No, Geromy takes care of technical issues if it comes about.

Future Requirements

11. What new or expanded features should the new system be capable of incorporating, either purchased initially with the system, or capable of being added in the future? (e.g. intrinsically safe portables, encryption, mobile data terminals, GPS location, Wi-Fi/LTE, Bluetooth, etc.)

CAD location
Cell phone apps
Bluetooth
Would like less channel changing
Station TAC channels
Intrinsically safe portables

12. What functions are currently performed by other communications means, such as cell phones, tablets, pagers could or should be assumed by the new system? (Any functionality is critical not to lose with a new system)

Good to have a separate channel to just talk to our members

This interview record was sent to Shawn Matheney for review on November 17, 2020.

Appendix C Frequency Analysis

License Holder	FCC Call Sign	Frequency	Type	ERP	Location
Craig County	WQAW220	37.08	FB2	105	Forestry Road 177-1
Craig County	WQAW220	39.48	MO	100	Area of Operation
Craig County	WQAW220	39.48	FB	200	State RT 311
Craig County	WQAW220	39.5	MO	100	Area of Operation
Craig County	WQAW220	39.5	FB	200	State RT 311
Craig County	WQAW220	39.52	FB2	300	Forestry Road 177-1
Craig County	WQAW220	39.54	MO	100	Area of Operation
Craig County	WQAW220	39.54	FB	200	State RT 311
Craig County	WQAW220	39.6	MO	100	Area of Operation
Craig County	WQSA703	151.535	FB2	7.5	Top of POTTS MTN
Craig County	WQSA703	151.535	MO	45	Top of POTTS MTN
Craig County	WQTA668	151.5875	MO	5	Area of Operation
Craig County	WQTA668	151.9625	MO	5	Area of Operation
Craig County	WQTA668	152.3225	MO	5	Area of Operation
Craig County	WQTA668	152.9825	MO	5	Area of Operation
Craig County	WQTA668	154.4825	MO	5	Area of Operation
Craig County	WQAW220	155.67	MO	2.5	Area of Operation
Craig County	WQAW220	155.67	MO3	100	Area of Operation
Craig County	WQTA668	157.5825	MO	5	Area of Operation
Craig County	WQTA668	158.3925	MO	5	Area of Operation
Craig County	WQSA703	158.43	MO	45	Top of POTTS MTN
Craig County	WQTA668	159.5025	MO	5	Area of Operation
Craig County	WQTA668	159.7125	MO	5	Area of Operation
Craig County	WQTA668	160.1025	MO	5	Area of Operation
Craig County	WQTA668	160.17	MO	5	Area of Operation
Craig County	WQTA668	160.2	MO	5	Area of Operation
Craig County	WQTA668	173.225	MO	5	Area of Operation
Craig County	WQTA668	173.275	MO	5	Area of Operation
Craig County	WQTA668	173.325	MO	5	Area of Operation
Craig County	WQTA668	173.35	MO	5	Area of Operation
Craig County	WQTA668	173.375	MO	5	Area of Operation
Craig County	WQKP962	451.675	MO	45	Area of Operation
Craig County	WQKP962	451.675	FB2	24	Sinking Creek Mtn
Craig County	WQKQ203	451.725	FB2	35	Forestry Road 177
Craig County	WQKP962	451.775	MO	45	Area of Operation
Craig County	WQKP962	451.775	MO	45	Area of Operation
Craig County	WQKP962	451.775	FB2	24	Sinking Creek Mtn
New Castle Vol Fire Dept	WQNH967	451.7875	FB2	150	Water Tank on Awah Lane
New Castle Vol Fire Dept	WQNH967	451.7875	MO	45	Area of Operation

Craig County, Virginia
Radio System Assessment

License Holder	FCC Call Sign	Frequency	Type	ERP	Location
Craig County	WQAW220	37.08	FB2	105	Forestry Road 177-1
Craig County	WQAW220	39.48	MO	100	Area of Operation
Craig County	WQAW220	39.48	FB	200	State RT 311
Craig County	WQAW220	39.5	MO	100	Area of Operation
Craig County	WQAW220	39.5	FB	200	State RT 311
Craig County	WQAW220	39.52	FB2	300	Forestry Road 177-1
Craig County	WQAW220	39.54	MO	100	Area of Operation
Craig County	WQAW220	39.54	FB	200	State RT 311
Craig County	WQAW220	39.6	MO	100	Area of Operation
Craig County	WQSA703	151.535	FB2	7.5	Top of POTTS MTN
Craig County	WQSA703	151.535	MO	45	Top of POTTS MTN
Craig County	WQTA668	151.5875	MO	5	Area of Operation
Craig County	WQTA668	151.9625	MO	5	Area of Operation
Craig County	WQTA668	152.3225	MO	5	Area of Operation
Craig County	WQTA668	152.9825	MO	5	Area of Operation
Craig County	WQTA668	154.4825	MO	5	Area of Operation
Craig County	WQAW220	155.67	MO	2.5	Area of Operation
Craig County	WQAW220	155.67	MO3	100	Area of Operation
Craig County	WQTA668	157.5825	MO	5	Area of Operation
Craig County	WQTA668	158.3925	MO	5	Area of Operation
Craig County	WQSA703	158.43	MO	45	Top of POTTS MTN
Craig County	WQTA668	159.5025	MO	5	Area of Operation
Craig County	WQTA668	159.7125	MO	5	Area of Operation
Craig County	WQTA668	160.1025	MO	5	Area of Operation
Craig County	WQTA668	160.17	MO	5	Area of Operation
Craig County	WQTA668	160.2	MO	5	Area of Operation
Craig County	WQTA668	173.225	MO	5	Area of Operation
Craig County	WQTA668	173.275	MO	5	Area of Operation
Craig County	WQTA668	173.325	MO	5	Area of Operation
Craig County	WQTA668	173.35	MO	5	Area of Operation
Craig County	WQTA668	173.375	MO	5	Area of Operation
Craig County	WQKP962	451.675	MO	45	Area of Operation
Craig County	WQKP962	451.675	FB2	24	Sinking Creek Mtn
Craig County	WQKQ203	451.725	FB2	35	Forestry Road 177
Craig County	WQKP962	451.775	MO	45	Area of Operation
Craig County	WQKP962	451.775	MO	45	Area of Operation
Craig County	WQKP962	451.775	FB2	24	Sinking Creek Mtn
New Castle Vol Fire Dept	WQNH967	451.7875	FB2	150	Water Tank on Awah Lane
New Castle Vol Fire Dept	WQNH967	451.7875	MO	45	Area of Operation

Craig County, Virginia
Radio System Assessment

License Holder	FCC Call Sign	Frequency	Type	ERP	Location
Craig County	WQKQ203	451.925	MO	45	Area of Operation
Craig County	WQKQ203	451.925	FB2	35	Forestry Road 177
Craig County	WQKQ203	452.225	MO	45	Area of Operation
Craig County	WQKQ203	452.225	FB2	35	Forestry Road 177
New Castle Vol Fire Dept	WQNH967	452.85	FB2	150	Water Tank on Awah Lane
New Castle Vol Fire Dept	WQNH967	452.85	MO	45	Area of Operation
Craig County	WQKP962	452.975	MO	45	Area of Operation
Craig County	WQKP962	452.975	FB2	24	Sinking Creek Mtn
Craig County	WQKP962	456.675	MO	45	Area of Operation
Craig County	WQKQ203	456.725	MO	45	Area of Operation
Craig County	WQKQ203	456.725	MO	45	Area of Operation
Craig County	WQKP962	456.775	MO	45	Area of Operation
New Castle Vol Fire Dept	WQNH967	456.7875	MO	45	Area of Operation
New Castle Vol Fire Dept	WQNH967	456.7875	FX1	45	Area of Operation
Craig County	WQKQ203	456.925	MO	45	Area of Operation
Craig County	WQKQ203	457.225	MO	45	Area of Operation
New Castle Vol Fire Dept	WQNH967	457.85	MO	45	Area of Operation
New Castle Vol Fire Dept	WQNH967	457.85	FX1	45	Area of Operation
Craig County	WQKP962	457.975	MO	45	Area of Operation
Craig County	WQHG869	461.375	FB2	35	25329 Craigs Creek Rd
Craig County	WQHG869	461.375	MO	5	Area of Operation
Craig County	WQKQ203	463.2125	MO	25	Area of Operation
Craig County	WQKQ203	463.2125	FB2	60	Forestry Road 177
Craig County	WQHG869	463.2625	MO	25	Area of Operation
Craig County	WQHG869	463.2625	FB2	20	Forestry Road 177
Craig County	WQHG869	463.2875	MO	25	Area of Operation
Craig County	WQHG869	463.2875	FB2	20	Forestry Road 177
Craig County	WQHG869	463.3125	MO	25	Area of Operation
Craig County	WQHG869	463.3125	FB2	20	Forestry Road 177
Craig County	WQHG869	463.3375	MO	25	Area of Operation
Craig County	WQHG869	463.3375	FB2	20	Forestry Road 177
Craig County	WQKQ203	463.4125	MO	25	Area of Operation
Craig County	WQKQ203	463.4125	FB2	60	Forestry Road 177
Craig County	WQKP962	463.6875	MO	45	Area of Operation
Craig County	WQKP962	463.6875	FB2	24	Sinking Creek Mtn
Craig County	WQHG869	463.7125	FB2	24	Sinking Creek Mtn
Craig County	WQKP962	463.7125	MO	45	Area of Operation
Craig County	WQKP962	463.7125	MO	45	Area of Operation
Craig County	WQKP962	463.7125	FB2	50	Simmons ville
Craig County	WQHG869	466.375	MO	5	Area of Operation
Craig County	WQKQ203	468.2125	MO	25	Area of Operation
Craig County	WQKQ203	468.2125	FX1	25	Area of Operation
Craig County	WQHG869	468.2625	MO	25	Area of Operation
Craig County	WQHG869	468.2625	FX1	25	Area of Operation
Craig County	WQHG869	468.2875	MO	25	Area of Operation

Craig County, Virginia
Radio System Assessment

License Holder	FCC Call Sign	Frequency	Type	ERP	Location
Craig County	WQHG869	468.2875	FX1	25	Area of Operation
Craig County	WQHG869	468.3125	MO	25	Area of Operation
Craig County	WQHG869	468.3375	MO	25	Area of Operation
Craig County	WQHG869	468.3375	FX1	25	Area of Operation
Craig County	WQHG869	468.3375	FX1	25	Area of Operation
Craig County	WQKQ203	468.4125	MO	25	Area of Operation
Craig County	WQKQ203	468.4125	FX1	25	Area of Operation
Craig County	WQKP962	468.6875	MO	45	Area of Operation
Craig County	WQKP962	468.6875	FX1	45	Area of Operation
Craig County	WQKP962	468.7125	MO	45	Area of Operation
Craig County	WQKP962	468.7125	MO	45	Area of Operation
Craig County	WQKP962	468.7125	FX1	20	Area of Operation
Simmons ville Vol Fire Dept	WQKK426	451.8875	FB2	70	Fire Dept BLDG on SR42 Near Simmons ville
Simmons ville Vol Fire Dept	WQKK426	451.8875	MO	35	Area of Operation
Simmons ville Vol Fire Dept	WQKK426	456.8875	MO	35	Area of Operation
Simmons ville Vol Fire Dept	WQKK426	456.8875	FX1	35	Area of Operation
Simmons ville Vol Fire Dept	WQJY291	462.3125	MO	5	Area of Operation
Simmons ville Vol Fire Dept	WQJY291	467.3125	MO	5	Area of Operation

Appendix D Coverage Maps

Craig County Existing Sheriff's UHF Mobile Talk-In

Craig County Existing Sheriff's VHF Low-Band Mobile Talk-Out

Craig County Existing Fire Rescue UHF Mobile Talk-In

Craig County Existing Fire Rescue UHF Mobile Talk-Out

Craig County Existing Fire Rescue UHF Portable Outdoor Talk-In

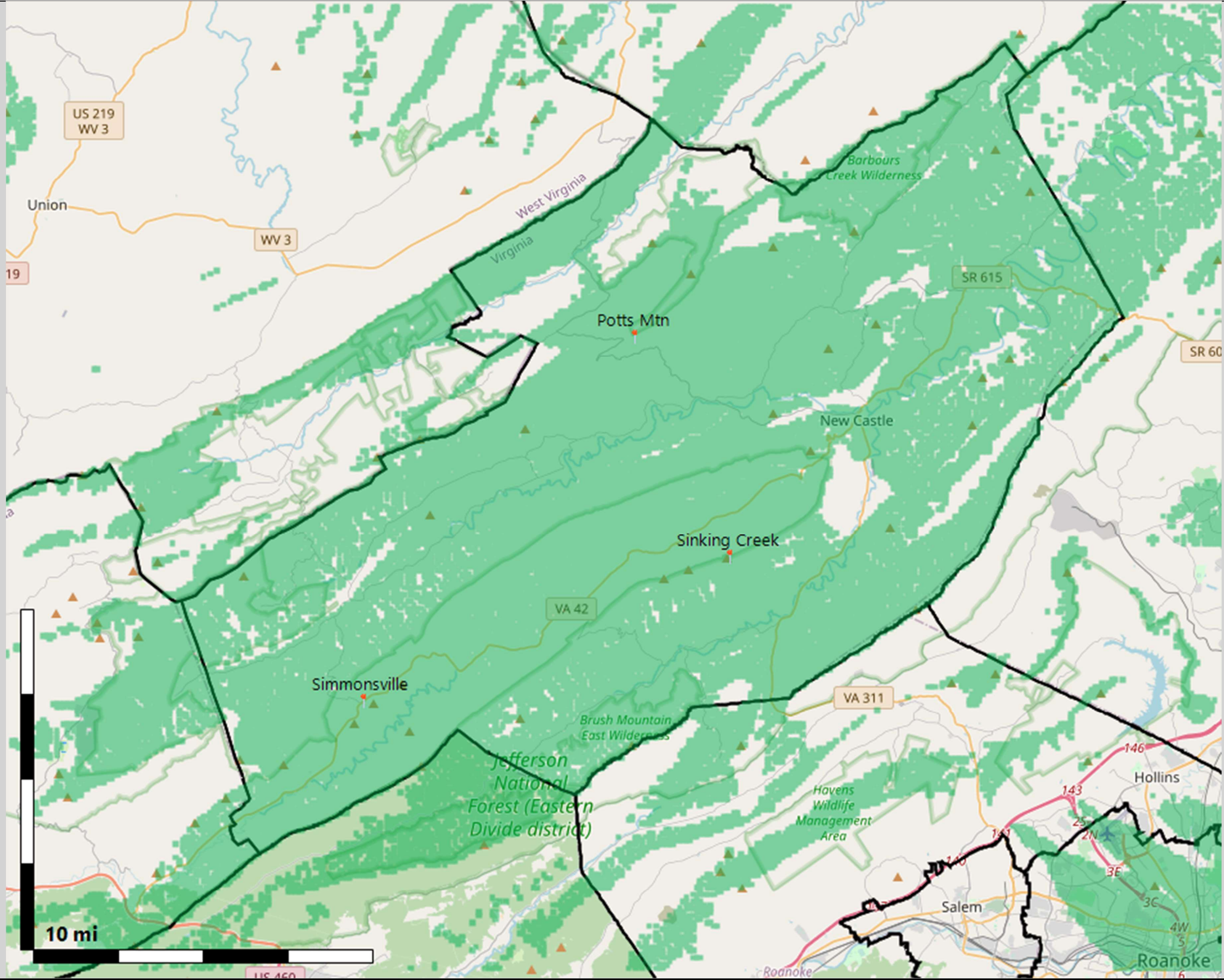
Craig County Existing Fire Rescue UHF Portable Outdoor Talk-Out

Craig County Future UHF P25C Mobile Talk-in Predicted Coverage

Craig County Future UHF P25C Mobile Talk-out Predicted Coverage

Craig County Future UHF P25C Portable Outdoor Predicted Coverage

Craig County Existing Sheriff's UHF Mobile Talk-in Predicted Coverage
Terrain Analysis Package (TAP): www.softwright.com



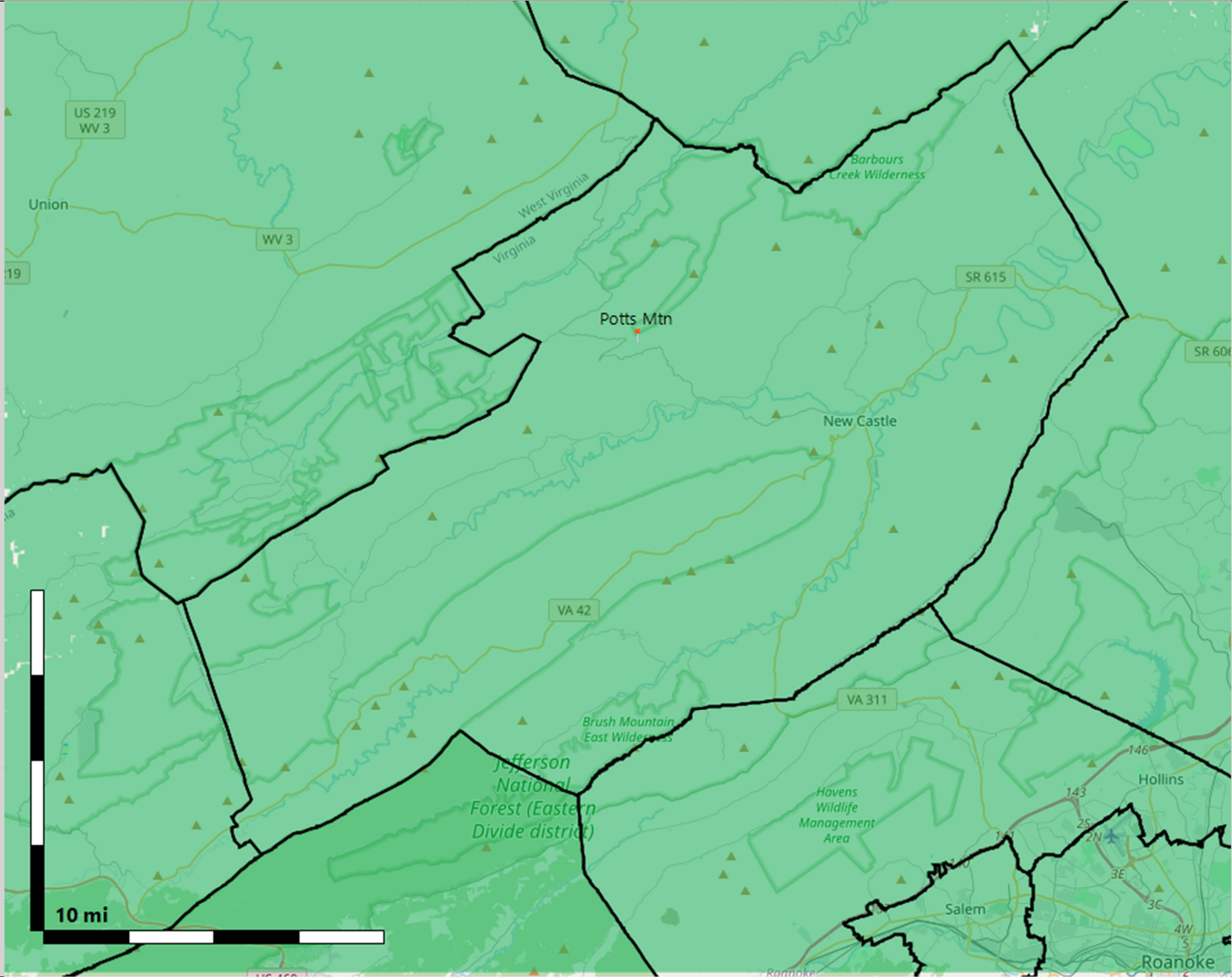
**Craig County Sheriff's
Existing UHF Predicted
Mobile Talk-In Coverage**

Tile Size: 0.1 mi x 0.1 mi
Propagation Model: Longley Rice 90/90
DAQ:3.0
Transmission Type: Analog 12.5 kHz
Minimum Required Signal Level: -98.47 dBm
Coverage Type: Talk-In

Sites:
Potts Mountain
Simmonsville
Sinking Creek

Coverage is based on a TK890 mobile radio,
with a Unity gain antenna mounted on the
roof of a vehicle.

Coverage displayed is based on predictive
statistical modeling utilizing information from
FCC regulations and USGS geographical data.
Users in the field will experience variable
coverage conditions due to multi-path fading,
interference, and other random effects, which
will be further degraded based upon the age
of the equipment in use.



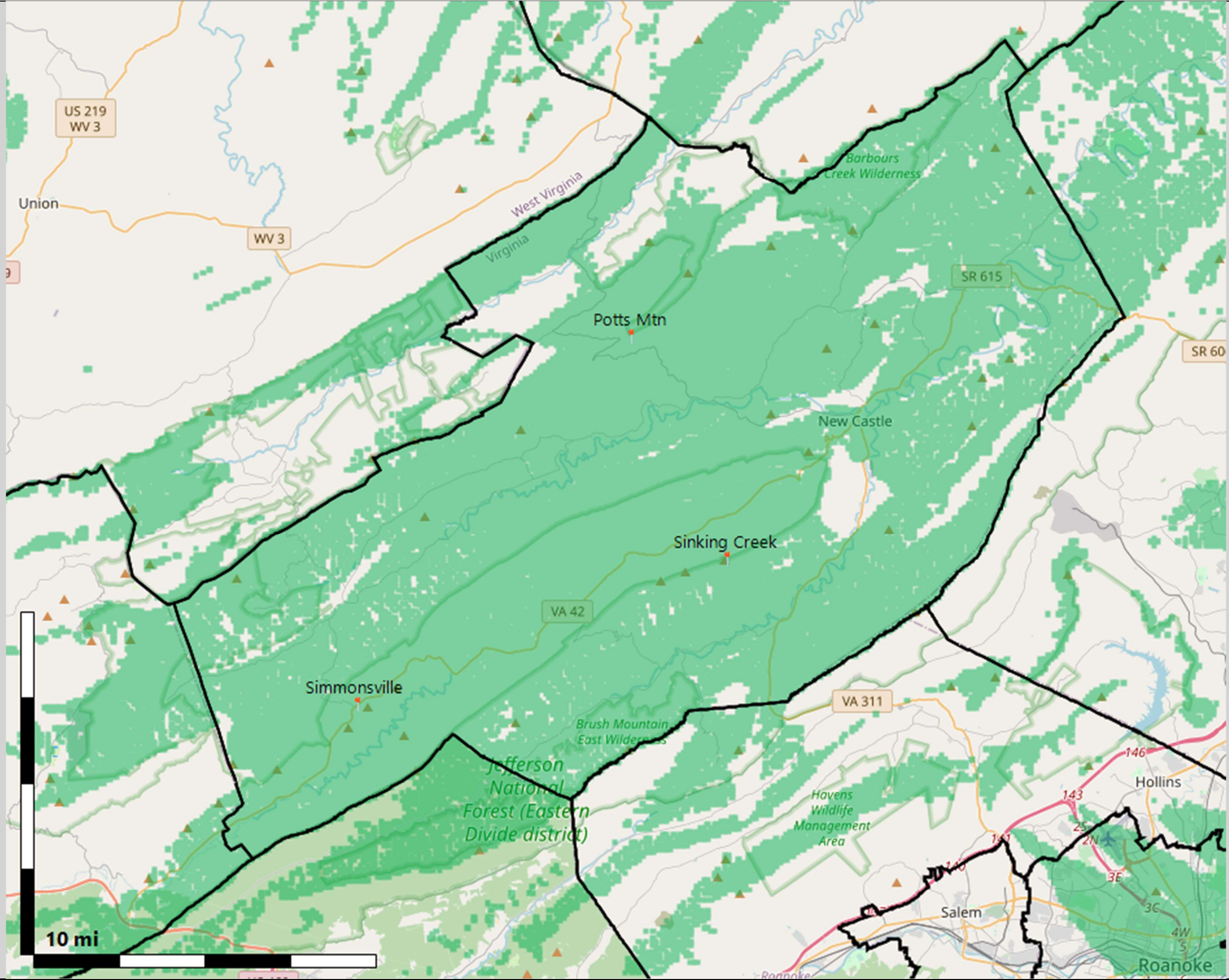
**Craig County Sheriff's
Existing VHF Low-Band Predicted
Mobile Talk-Out Coverage**

Tile Size: 0.1 mi x 0.1 mi
Propagation Model: Longley Rice 90/90
DAQ:3.0
Transmission Type: Analog 12.5 kHz
Minimum Required Signal Level: -95.61 dBm
Coverage Type: Talk-out

Sites:
Potts Mountain

Coverage is based on a TK890 mobile radio, with a Unity gain antenna mounted on the roof of a vehicle.

Coverage displayed is based on predictive statistical modeling utilizing information from FCC regulations and USGS geographical data. Users in the field will experience variable coverage conditions due to multi-path fading, interference, and other random effects, which will be further degraded based upon the age of the equipment in use.



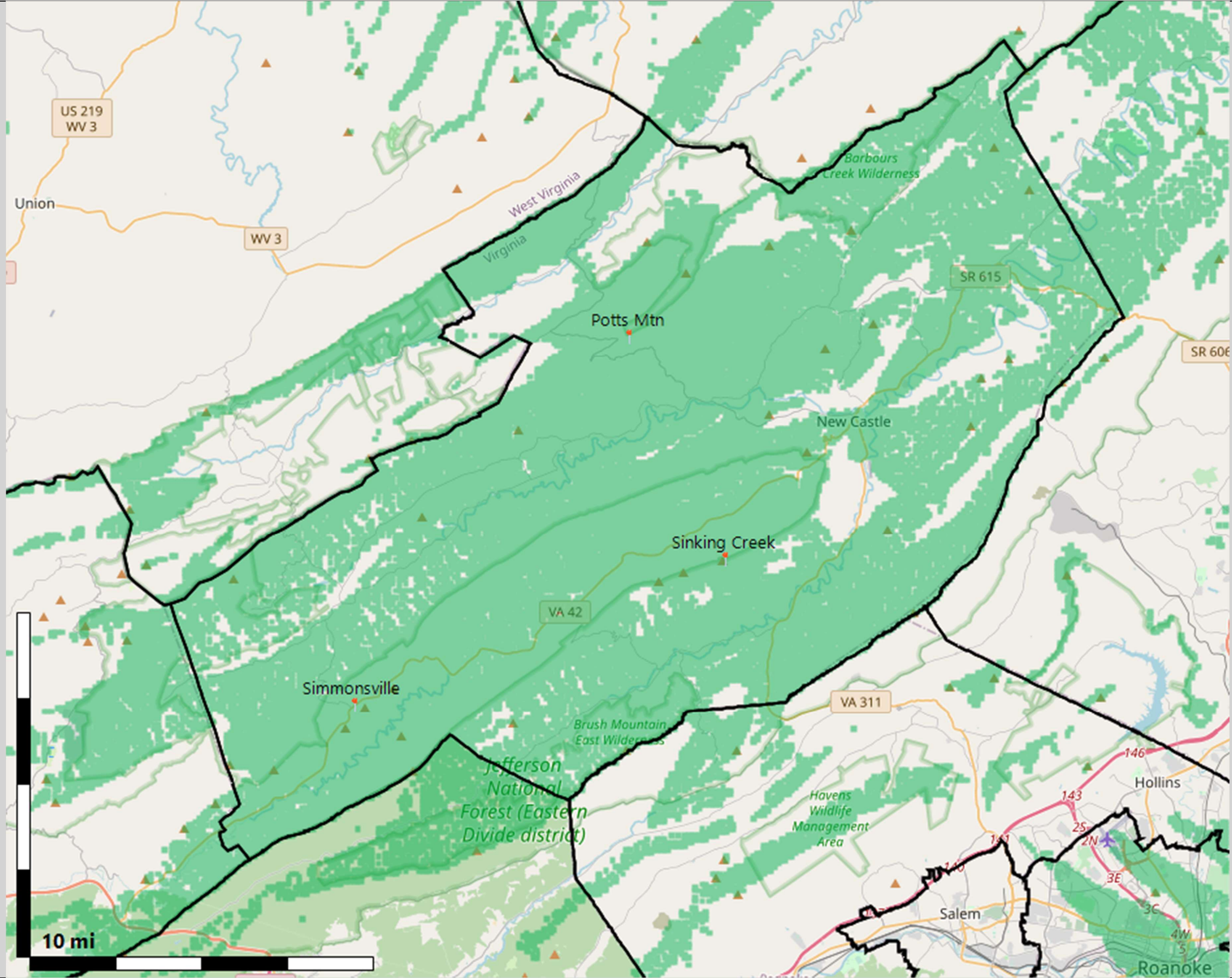
**Craig County Fire Rescue
Existing UHF Predicted
Mobile Talk-In Coverage**

Tile Size: 0.1 mi x 0.1 mi
Propagation Model: Longley Rice 90/90
DAQ:3.0
Transmission Type: Analog 12.5 kHz
Minimum Required Signal Level: -98.47 dBm
Coverage Type: Talk-In

Sites:
Potts Mountain
Simmonsville
Sinking Creek

Coverage is based on a TK890 mobile radio,
with a Unity gain antenna mounted on the
roof of a vehicle.

Coverage displayed is based on predictive
statistical modeling utilizing information from
FCC regulations and USGS geographical data.
Users in the field will experience variable
coverage conditions due to multi-path fading,
interference, and other random effects,
which will be further degraded based upon
the age of the equipment in use.



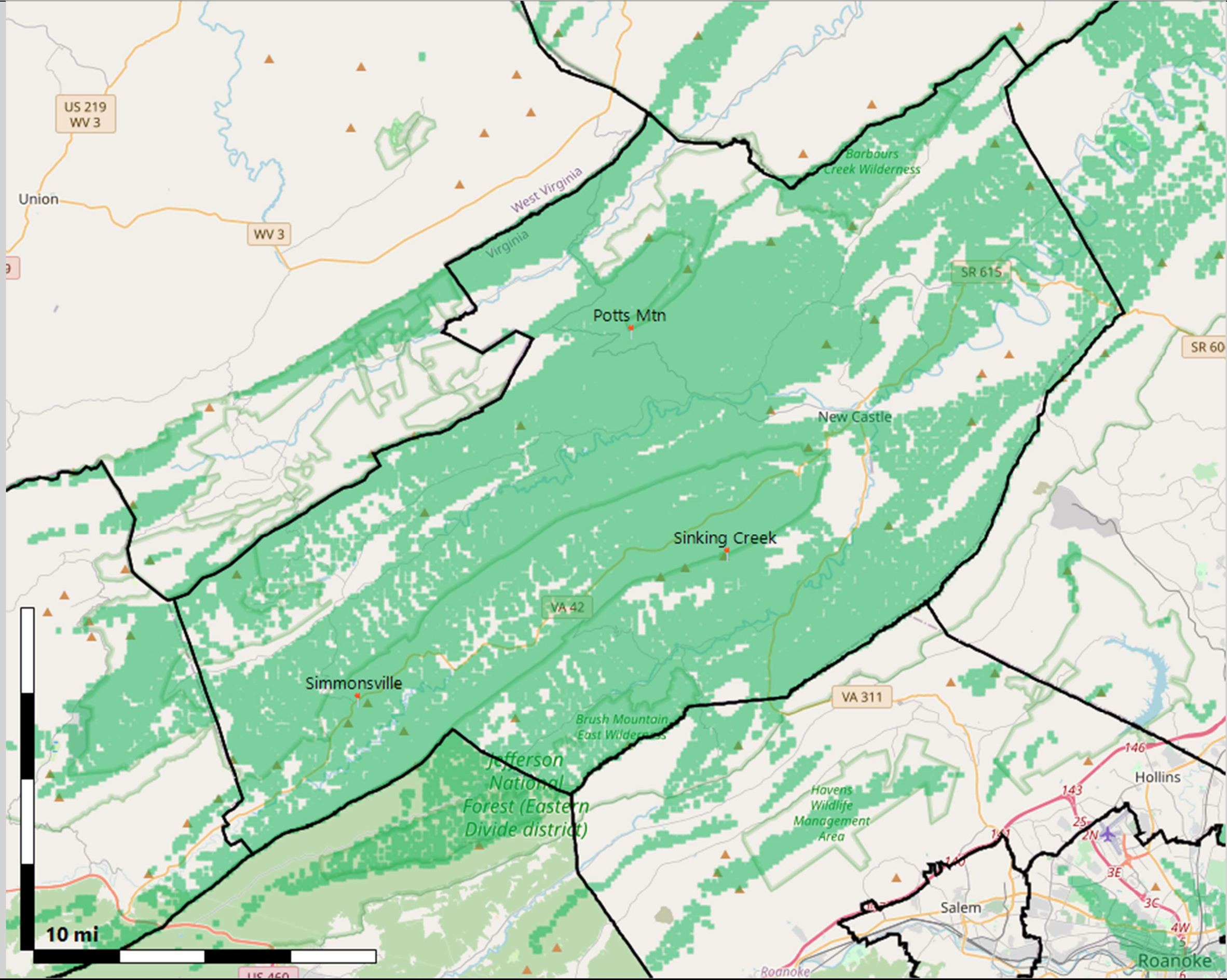
**Craig County Fire Rescue
Existing UHF Predicted
Mobile Talk-Out Coverage**

Tile Size: 0.1 mi x 0.1 mi
Propagation Model: Longley Rice 90/90
DAQ:3.0
Transmission Type: Analog 12.5 kHz
Minimum Required Signal Level: -101.4 dBm
Coverage Type: Talk-out

Sites:
Potts Mountain
Simmonsville
Sinking Creek

Coverage is based on a TK890 mobile radio,
with a Unity gain antenna mounted on the
roof of a vehicle.

Coverage displayed is based on predictive
statistical modeling utilizing information from
FCC regulations and USGS geographical
data. Users in the field will experience
variable coverage conditions due to multi-
path fading, interference, and other random
effects, which will be further degraded based
upon the age of the equipment in use.



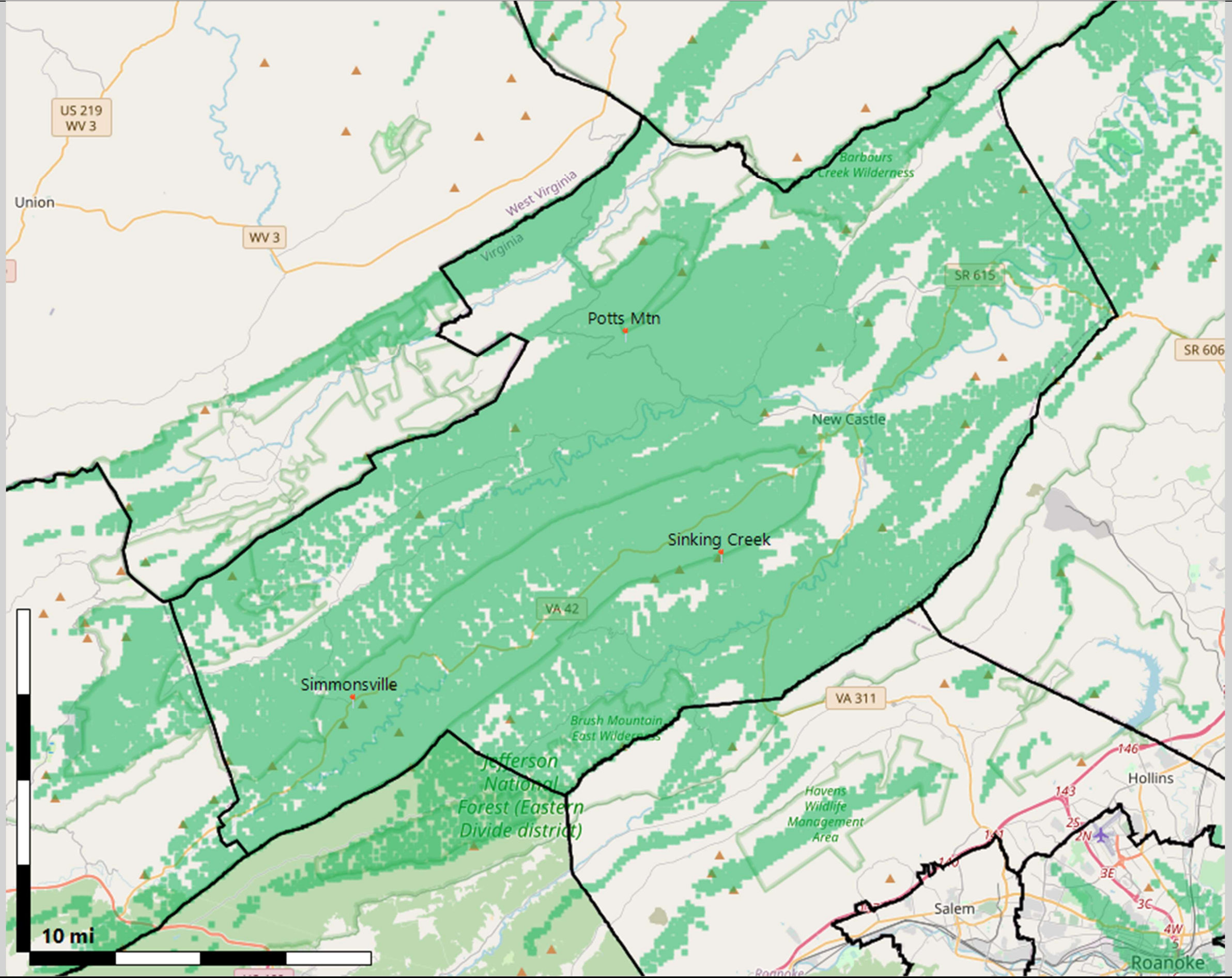
**Craig County Fire Rescue
Existing UHF Predicted
Portable Outdoor Talk-In Coverage**

Tile Size: 0.1 mi x 0.1 mi
Propagation Model: Longley Rice 90/90
DAQ:3.0
Transmission Type: Analog 12.5 kHz
Minimum Required Signal Level: -98.47 dBm
Coverage Type: Talk-In

Sites:
Potts Mountain
Simmonsville
Sinking Creek

Coverage is based on TK3312 portable radio outdoor, mounted at hip level.

Coverage displayed is based on predictive statistical modeling utilizing information from FCC regulations and USGS geographical data. Users in the field will experience variable coverage conditions due to multi-path fading, interference, and other random effects, which will be further degraded based upon the age of the equipment in use.



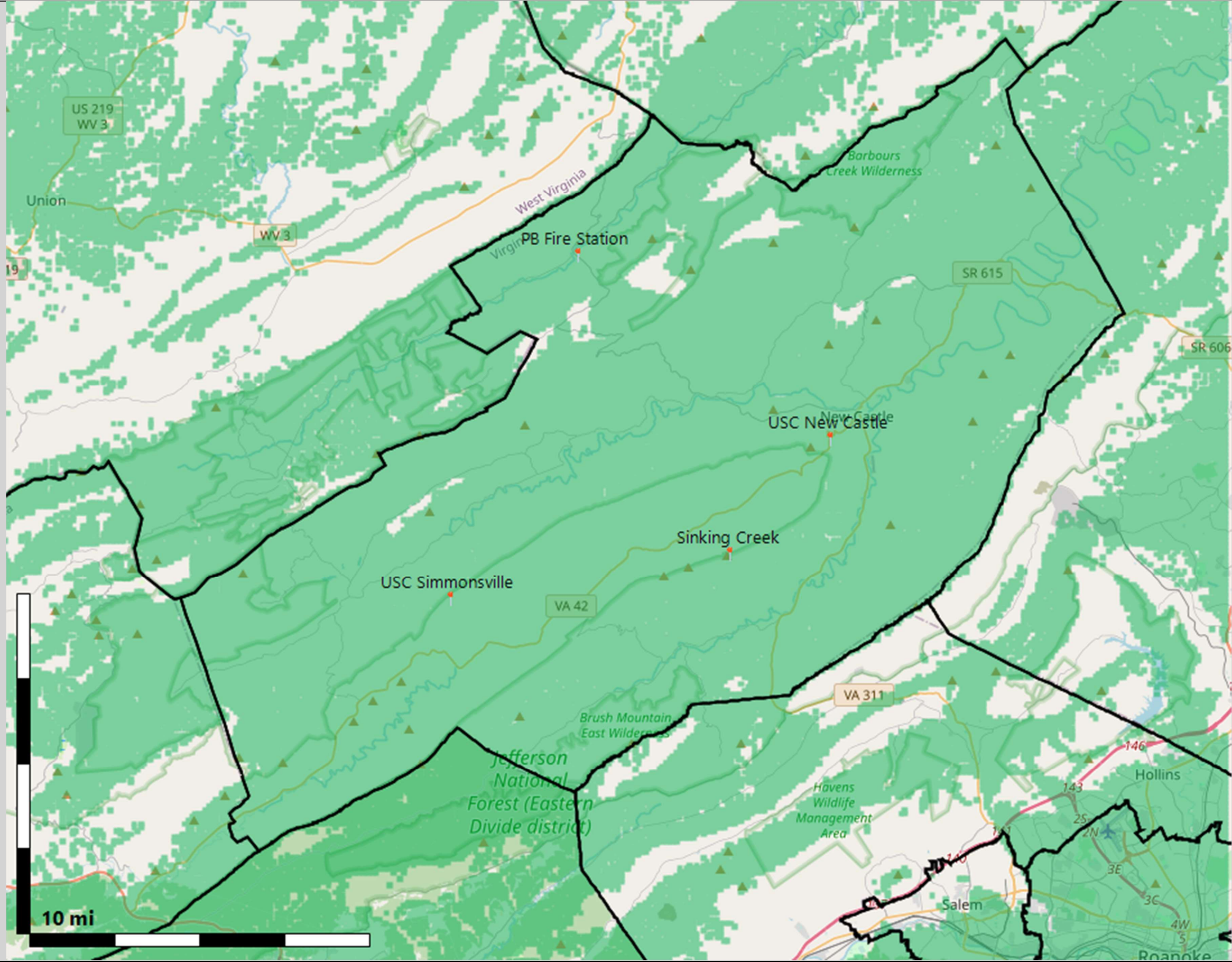
**Craig County Fire Rescue
Existing UHF Predicted
Portable Outdoor Talk-Out Coverage**

Tile Size: 0.1 mi x 0.1 mi
Propagation Model: Longley Rice 90/90
DAQ:3.0
Transmission Type: Analog 12.5 kHz
Minimum Required Signal Level: -90.95 dBm
Coverage Type: Talk-out

Sites:
Potts Mountain
Simmonsville
Sinking Creek

Coverage is based on TK3312 portable radio outdoor, mounted at hip level.

Coverage displayed is based on predictive statistical modeling utilizing information from FCC regulations and USGS geographical data. Users in the field will experience variable coverage conditions due to multi-path fading, interference, and other random effects, which will be further degraded based upon the age of the equipment in use.



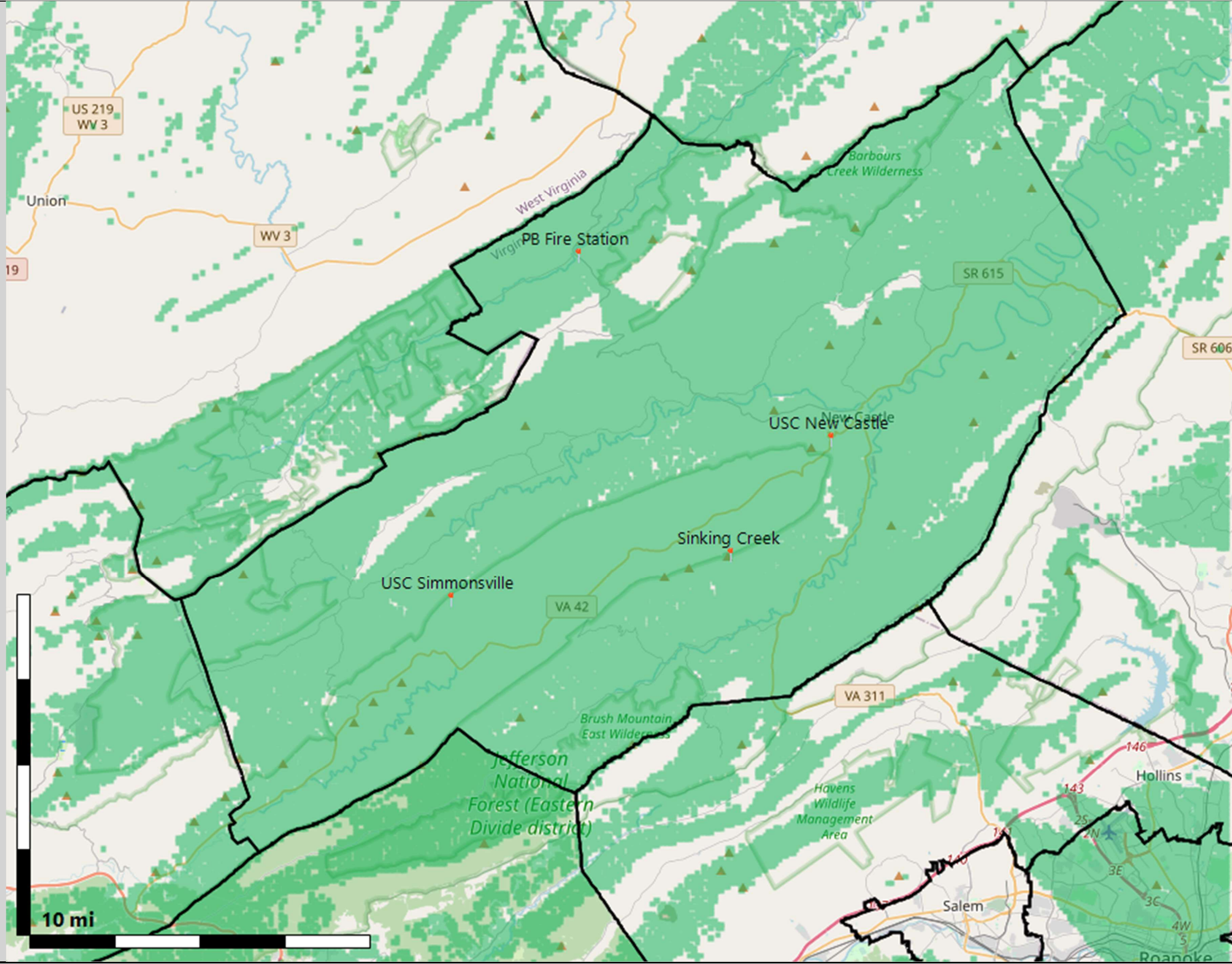
**Craig County Future
UHF P25C Mobile
Talk-in Predicted Coverage**

Tile Size: 0.1 mi x 0.1 mi
Propagation Model: Longley Rice 90/90
DAQ:3.4
Transmission Type: P25 Conventional 12.5 kHz
Minimum Required Signal Level: -116.83 dBm
Coverage Type: Talk-In

- Sites:**
Paint Bank Fire Station
Sinking Creek
U.S. Cellular New Castle
U.S. Cellular Simmonsville

Coverage is based on a P25 Conventional mobile radio, with a Unity gain antenna mounted on the roof of a vehicle.

Coverage displayed is based on predictive statistical modeling utilizing information from FCC regulations and USGS geographical data. Users in the field will experience variable coverage conditions due to multi-path fading, interference, and other random effects, which will be further degraded based upon the age of the equipment in use.



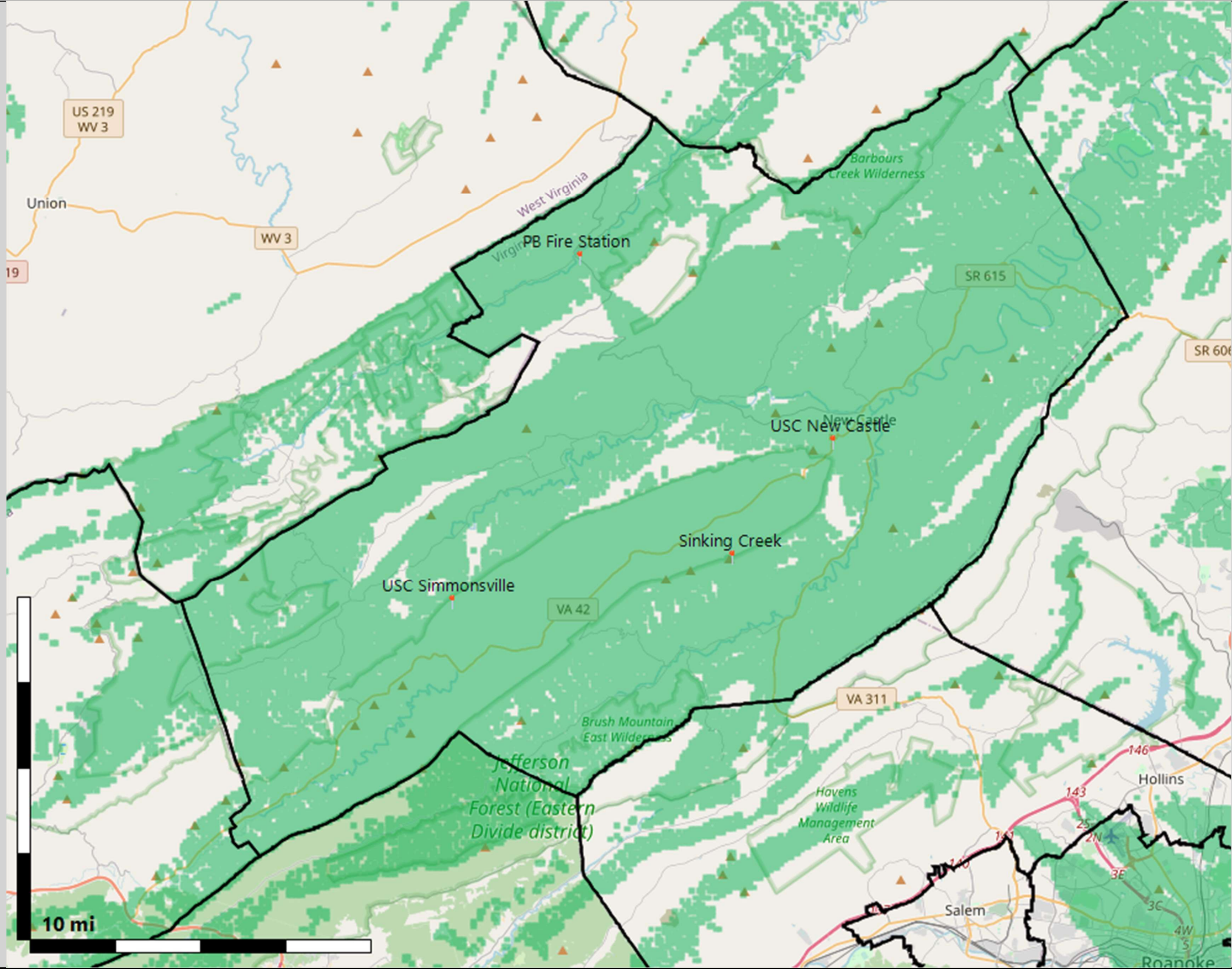
**Craig County Future
UHF P25C Mobile
Talk-Out Predicted Coverage**

Tile Size: 0.1 mi x 0.1 mi
Propagation Model: Longley Rice 90/90
DAQ:3.4
Transmission Type: P25 Conventional 12.5 kHz
Minimum Required Signal Level: -106.87 dBm
Coverage Type: Talk-out

- Sites:**
Paint Bank Fire Station
Sinking Creek
U.S. Cellular New Castle
U.S. Cellular Simmonsville

Coverage is based on a P25 Conventional mobile radio, with a Unity gain antenna mounted on the roof of a vehicle.

Coverage displayed is based on predictive statistical modeling utilizing information from FCC regulations and USGS geographical data. Users in the field will experience variable coverage conditions due to multi-path fading, interference, and other random effects, which will be further degraded based upon the age of the equipment in use.



**Craig County Future
UHF P25C Portable Outdoor
Predicted Coverage**

Tile Size: 0.1 mi x 0.1 mi
Propagation Model: Longley Rice 90/90
DAQ:3.4
Transmission Type: P25 Conventional 12.5 kHz
Minimum Required Signal Level: -99.07/-116.83 dBm
Coverage Type: Talk-out/Talk-in (Balanced)

- Sites:**
- Paint Bank Fire Station
 - Sinking Creek
 - U.S. Cellular New Castle
 - U.S. Cellular Simmonsville

Coverage is based on P25 Conventional portable radio outdoor, mounted at hip level.

Coverage displayed is based on predictive statistical modeling utilizing information from FCC regulations and USGS geographical data. Users in the field will experience variable coverage conditions due to multi-path fading, interference, and other random effects, which will be further degraded based upon the age of the equipment in use.

Appendix E Functional System Attributes

Based on the needs and concerns expressed by radio system users, CTA has developed a list of system attributes for Craig County including Alleghany, Botetourt, Giles, Monroe, Montgomery, and Roanoke Counties. Each of the attributes addressed are essential in a public safety communications system.

E.1 Overview of System Requirements

A Radio System provides two-way communications between dispatchers and mobile and portable radios, and between the mobile and portable radios themselves. Two-way radio communications may include both voice and data traffic.

The Craig County radio service area is defined as the area within the geopolitical boundaries of the County. Radio coverage is required both for mobile radios and portable radios in buildings throughout the service area. This report also addresses communications with radios responding outside the defined service area.

Craig County will require the selected vendor to guarantee radio coverage as part of the implementation contract. Actual verification of coverage should perform direct measurements, not computer predictions. It should be noted that, if the selected vendor feels coverage requirements cannot be met from a desired site, either an alternate site or multiple sites might be proposed. In any event, should the coverage not meet the specified requirements, the vendor should be required to correct it at no additional cost.

This list of system attributes has been used as a starting point to develop the system design alternatives, which in turn was used as a basis for developing budgetary estimates obtained from an average of system list prices submitted by vendors. This is a feasibility study addressing the proposed alternatives: the intent is not to have a fully designed system at this point, but only to make sure that each system design concept is generally feasible, operationally appropriate, and economically sensible for Craig County.

E.2 Target System Attributes

This section describes the target system attributes (overall functional requirements) for a replaced Radio Communications System for Craig County. These attributes were developed from meetings with the County and rated by the agencies. The ratings are summarized in Table 4-1. The specific attributes are defined as follows:

E.2.1 Coverage

The system shall provide a signal availability of 95 percent to/from all (a) mobile radios, (b) outdoor and (c) in-building portables and with coverage evenly distributed over the service area for all operational functions. The goal is to provide coverage with no dead spots.

E.2.2 Dispatch Operational Concept

The system shall support dispatch operations from the Sheriff's Office. Normal operations shall be conducted from a centralized dispatch location, where access to all talk-groups and agencies shall be provided by use of computer-controlled consoles. The growth capability shall be provided by expansion of the computer database,

and by the installation of additional dispatch consoles. The system will also support the capability of a backup communications center environment.

E.2.3 Flexibility in Channel / Talk group Structure

The system shall provide the ability to shift personnel to support different radio groups depending on workload. Communications must be tied to the individual's work, not to the individual. Emergency contingency plans should be aided, not constrained, by the communications system.

E.2.4 Survivability

The system shall be designed to survive in severe weather or emergency conditions. If dispatch points are shifted from their primary to a backup location, radio control shall be available at the backup location to the same degree it was available at primary dispatch.

E.2.5 Redundant System Equipment

The system shall have the capability for redundant system equipment, to keep the system operational in the case of catastrophic failure of the system equipment.

E.2.6 Capacity / Frequency

The system shall have enough channels or talk groups to relieve the over-crowding problems that now exist (users having to wait for busy channels to clear). The system shall provide sufficient capacity so that the current routine, peak, and emergency overcrowding conditions will be alleviated.

- Frequency Capacity: Availability of necessary frequencies to meet system capacity.
- Routine Capacity: Alleviate crowded conditions with various channels at various times. This is true for both voice *and data*, and may include shifting some voice to digital, and increasing digital throughput.
- Peak and Emergency Capacity: Provide reserve for peak and emergency situations. The system shall allow priority calls for critical users when the system approaches full loading.
- Growth capacity: To the year 2035 (Voice and data).
- Goal: Radio system to handle routine traffic at 30 percent capacity, peak traffic at 60 to 95 percent capacity, and emergency traffic through prioritized radio usage.

E.2.7 Infrastructure Scalability

The system shall be capable of future expansion of both the channels and the number of sites. System design shall incorporate expansion to the level of usage predicted for the next 15 years with only the addition of subscribers (mobile and portable radios). No replacement of fixed equipment shall be required.

The proposed system shall be capable of advanced to digital technology applications as described above.

E.2.8 Interoperability

The system shall provide portable-to-portable, vehicle-to-vehicle, and vehicle-to/from-portable communications.

Emergency: Allow responders from other agencies and the surrounding area to talk together during an emergency when they are a common team.

Provide the ability to move anywhere in the coverage area and communicate using the same radio with the same access protocol, and without needing to know where the calling or called unit is located.

E.2.9 No Interference

The system shall eliminate and prevent inter-site (co-channel) and skip (other users and foreign) interference.

E.2.10 Maintainability

The radio system shall be designed for a mean-time-to-repair of no more than four hours.

E.2.11 Reliability

The radio system and equipment must be designed such that single-mode failures do not perceptibly impact the routine operations of the system. Current radios, which are generally aged and becoming unreliable, shall be replaced by reliable new equipment.

The following requirements shall apply to failure conditions:

- Channel failure: no operating impact due to failed voice or data channel.
- Primary power failure: UPS backup shall be supplied for all computer/control equipment, and generator backup for the radio equipment.
- Console failures:
 - Console terminal failure: use reserve console.
 - Console common equipment failure: dispatchers operate backup console.
 - Communications Center failure: Revert to designated backup.
- Connectivity: designed to a 99.999% availability per-microwave hop; loop configuration is preferred and if not possible monitored hot-standby is required.

E.2.12 System Operational Transparency

The radio system shall transmit/receive from multiple sites, with switching operations transparent to the radio user. System operation shall be logical, with the focus on who the user wants to call rather than where they are located.

E.2.13 Emergency Access

The system shall provide universal emergency access throughout the defined service area. Emergency calls shall have the highest priority and shall be given exclusive use of the channel during the duration of an emergency situation. Routine radio traffic shall be allowed to continue uninterrupted on other channels.

E.2.14 Encryption (selected units only)

To prevent unauthorized release of confidential information, the system shall provide encrypted communications for security and other required personnel. Encryption shall be Advanced Encryption Standard (AES).

E.2.15 Security (Physical and Software)

Beyond encryption, security physical items include locks, fences, outdoor and indoor lights, cameras, bullet-proof doors, fuel tanks, windows, etc. Software security issues will include firewall, defenses for antivirus, malware, intrusion, etc.

E.2.16 Initial Cost

The initial cost is a prime concern in the evaluation of the proposed alternatives. Trade-offs between cost and capability will be examined and presented in this report.

E.2.17 Long Term Cost

Long term cost is also a prime concern in the evaluation of the proposed alternatives. Long term costs associated with leasing and ownership of the systems will be examined in this report.

E.2.18 Cost Effectiveness

As much as possible, system procurement and implementation shall occur on a phased basis, intending to stagger costs over several years. The radio system shall be designed to meet operational needs while remaining within your fiscal constraints. High, mid- and low-tier radio equipment with decreasing levels of feature sets matched to the particular using group shall be provided. Where practical re-use of existing equipment is desired.

E.2.19 Competitive Procurement

The system and equipment should be procured using a competitive, open, non-restrictive, functional specifications process. Contract award should be based on the most cost-effective proposal meeting your operational and functional requirements.

E.2.20 Commonality of Infrastructure Equipment

A single vendor shall install and supply all required infrastructure equipment. Goal: minimize spare parts inventory and requirement for training on multiple system equipment.

E.2.21 Alarms & Monitoring

The system shall be equipped with an alarm and monitoring capability that will provide real time notifications and a detailed history log.

E.2.22 Training

System vendor shall provide formal training for supervisors, dispatchers, field users, and maintenance technicians.

E.2.23 Console Features

All consoles shall be public-safety grade with keyboard, mouse, trackball, and/or touch-screen operation, to include the following features:

- Capability for paging
- Ability to support computer-aided dispatch (CAD)
- Audible/visual cues for acknowledgment of calls transmitted
- Audible/visual cues to announce incoming emergency calls
- Head set with microphone
- Foot pedal transmit button
- Cross-patching to the County telephone system
- Fiber or microwave link to the base station repeaters

There should be limited/controlled personnel access to console area to reduce distractions around dispatchers.

E.2.24 Additional Subscriber Features

- Unit identification on each radio
- Call alert, select call, or paging from dispatch
- Audible tones to acknowledge successful/failed calls during push-to-talk
- Priority break-in for dispatchers to relay emergency information if users are on a talk-around channel
- Remote enable/disable
- GPS Location
- Wi-Fi
- Bluetooth
- Over-The-Air Programming (OTAP)
- Over-The-Air Rekeying (OTAR)
- Text Messaging

These attributes are optional and can be added if needed. They are not included in the ranking of attributes table.

Appendix F – Hall Road Site Alternative

During CTA's needs assessment, Craig County stakeholders identified Hall Road as a potential alternate site in place of the existing Sinking Creek tower site. Site access to Sinking Creek is difficult in good weather conditions with a 4-wheel drive, and there are times when the site is not accessible during severe weather. We investigated the Hall Road site due to the difficulty in reaching the Sinking Creek site for maintenance, and the poor condition of the site access road.

The proposed Hall Road site is located just off Hall Road, approximately 5 miles Southwest of the existing Sinking Creek site. There is a small 60 ft mast currently used by the Federal Department of Forestry. There is no existing commercial power at the site, which can be a significant cost. Approval for new towers on Forestry land is often denied and when successful can take 6-12 months or longer to navigate the process.

CTA determined the coverage provided by the potential Hall Road site is similar to the coverage provided by the existing Sinking Creek site. A coverage map for mobile coverage using the Hall Road site is shown below.

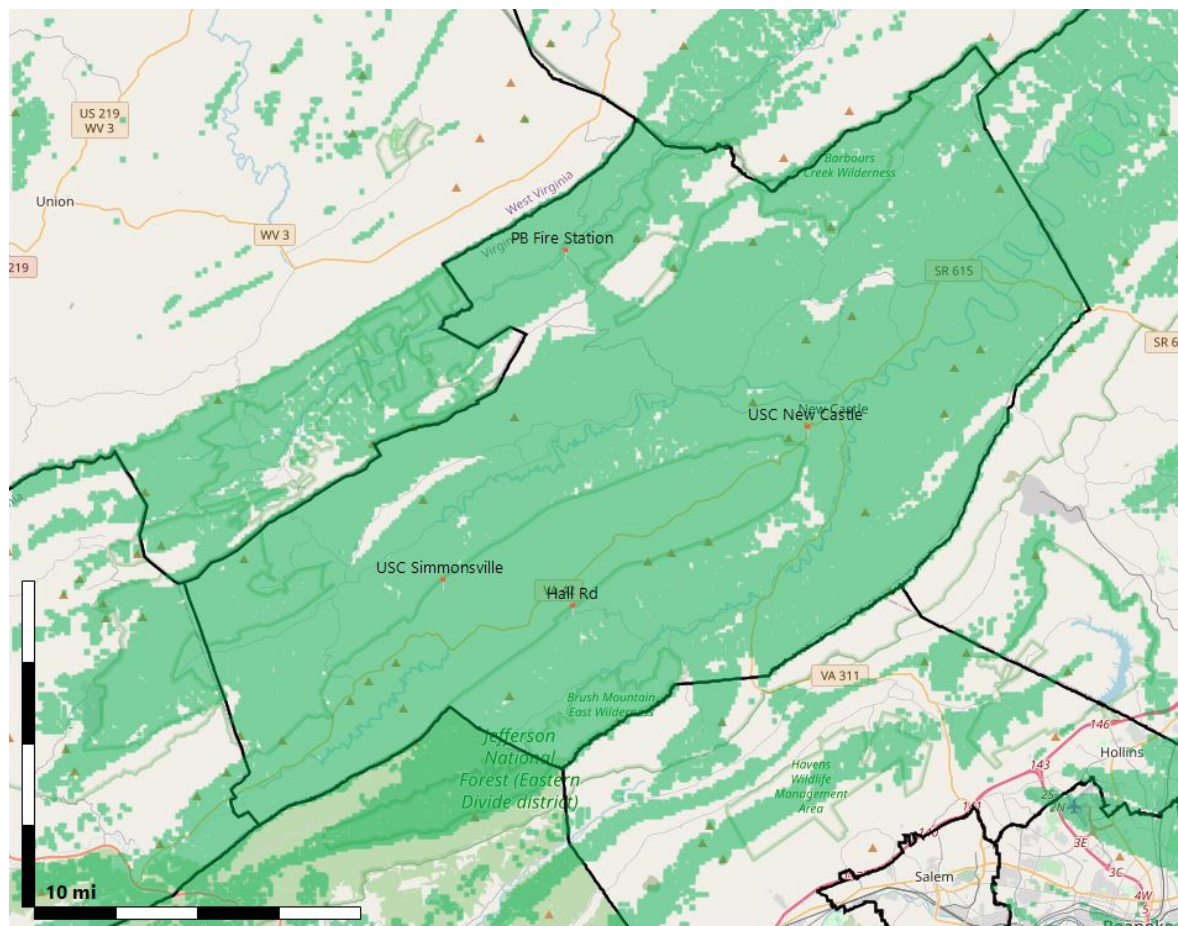


Figure F-1 Mobile Coverage Using Hall Road Site

Craig County, Virginia
Radio System Assessment

The following is an opinion of probable cost which shows the cost of the system using Hall Road in place of Sinking Creek. It should be noted there is not a significant difference in the estimated costs between the two sites.

Craig County, VA
UHF P25 Conventional Simulcast Radio System (4 sites, 5 channels)
Removed Sinking Creek, Added Hall Road

Cost Elements	List Estimate	Negotiated Estimate	Competitive Estimate	MULTI-VENDOR ESTIMATE
RADIO INFRASTRUCTURE	\$ 1,155,700	\$ 1,155,700	\$ 1,155,700	\$ 1,155,700
COMMUNICATIONS CENTER	\$ 325,500	\$ 325,500	\$ 325,500	\$ 325,500
MICROWAVE SYSTEM	\$ 604,900	\$ 604,900	\$ 604,900	\$ 502,100
PHYSICAL FACILITIES	\$ 1,607,400	\$ 1,607,400	\$ 1,607,400	\$ 908,900
SUBSCRIBERS	\$ 1,342,700	\$ 1,033,900	\$ 966,700	\$ 939,900
VENDOR SERVICES	\$ 738,700	\$ 738,700	\$ 738,700	\$ 543,400
DISCOUNT	\$ -	\$ (904,000)	\$ (1,581,900)	\$ (1,059,700)
SPARES - SUBSCRIBERS	\$ 25,600	\$ 19,700	\$ 18,400	\$ 11,800
SPARES - FIXED NETWORK	\$ 87,600	\$ 87,600	\$ 87,600	\$ 65,700
CONSULTING	\$ 225,000	\$ 225,000	\$ 225,000	\$ 337,500
CONTINGENCY (5%)	\$ 294,400	\$ 233,500	\$ 196,200	\$ 169,700
RADIO SYSTEM TOTAL	\$ 6,407,500	\$ 5,127,900	\$ 4,344,200	\$ 3,900,500
MAINTENANCE (After 1 year warranty)	\$ 141,100	\$ 141,100	\$ 141,100	\$ 105,800

In conclusion, due to the probable project delays Craig County may encounter and the insignificant difference in coverage or costs it is CTA's opinion Hall Road is not a best fit alternative. If, however, the existing Sinking Creek site become unusable, Craig County should reconsider the Hall Road.