CASS COUNTY
GOVERNMENT

Office of the Sheriff

Paul D. Laney, Sheriff

RECEIVED
CASS COUNTY COMMISSION
MAR 27 2017

March 23, 2017

Rick Steen, Portfolio Commissioner
Cass County Commission
Cass County Courthouse
Fargo, ND

Re: Presentation of Public Safety Radio System Analysis and Planning Project Phase 2

Regular Agenda

Chad Peterson, Chairman

Rey Freeman Communications Consulting has completed phase two of the Public Safety Radio System Analysis for Cass County Government. The attached document includes ARMER technical specifications to include the trunked radio system, system technology, tower sites, radio signal coverage and other work details required for the completion of the project.

We would request the opportunity to present information regarding the system, and answer any questions you may have at that time.

Move to authorize the Cass County Commission approve phase two (2) of the Public Safety Radio System Project.

Should you have any questions, please contact our office.

Respectfully,

Captain Michele D. Harmon
Administration/Court Services Division

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Cass County and City of Fargo, North Dakota
Public Safety 800 MHz Radio System Planning

March 27, 2017

To: Cass County ND Board of Supervisors

From: Rey Freeman, RFCC Consulting

Subject: Summary of Cass County/Fargo ND 800 MHz Radio Planning Documents

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Dear Cass County Board Members:

Cass County North Dakota, the cities of Fargo and West Fargo, and other agencies within the county have together initiated a process to conduct a review of their existing public safety radio systems, and develop a plan for replacement of these systems. The systems now being used are VHF, with equipment that is 10 or more years old, and in need of eventual replacement. These VHF systems also do not provide the coverage and capacity needed for the Fargo metropolitan area, nor the large geographical area of Cass County. A summary of the existing VHF radio systems, operations and issues were contained in the Phase 1 report provided to the customer group.

Moving forward, we have prepared a Phase 2 radio system plan which establishes an 800 MHz Trunked Radio System as the primary option being considered for the new system, to be shared by all public safety and public services agencies within the county.

A key option within the plan is the possibility of connecting this new 800 MHz subnetwork to the State of Minnesota ARMER radio network. If this option were available, it would greatly enhance the operational capabilities of the new network, as Clay County/Moorhead MN are now converting from VHF to the 800 MHz ARMER network. There are some potential financial benefits to Cass County/Fargo as well, as an ARMER connection would allow a new Cass County/Fargo 800 MHz subnetwork to operate from the ARMER Zone 6 Master (Controller) Site in Detroit Lakes. The purchase of a similar device would then not be needed by Cass County/Fargo.

Attached to this memo are two documents:

- ☐ RFCC Cass County Fargo ND Phase 2 Radio Plan 3-20-2017
- ☐ Cass Co Fargo ND ARMER Plan 3-24-2017

The Phase 2 plan is self-explanatory, and sets forth the operational benefits, technical details and costs associated with the proposed new 800 MHz radio network.

The ARMER Plan is a document that has been prepared for submission to the State of Minnesota ARMER radio governing committees and agencies, presenting the proposed Cass County/Fargo 800 MHz system plan, and requesting permission to connect to the ARMER system.

It also proposes a cost-sharing formula, whereby Cass County/Fargo would pay a fee to ARMER for shared use of the Zone 6 Master Site in Detroit Lakes.

We are seeking Board Action for approval of the ARMER Plan document, so that we may move ahead with presenting the plan to the Minnesota ARMER groups for their consideration and approval. Please note that approval of the ARMER Plan is NOT an approval or commitment to expend the funding needed for the new system at this time.

Summary: We will be presenting the ARMER Plan to the County Board at your April 3rd meeting in Fargo.

Regards

Rey Freeman

RFCC

Cass County – City of Fargo, North Dakota

ARMER Radio System 800 MHz Participation Plan

April 2017

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ARMER Participation Plan

1. Introduction

Cass County, North Dakota and the public safety entities within Cass County including the cities of Fargo, West Fargo, and all others within the county have developed a plan for the implementation of a new 800 MHz P25 Trunked Radio System to serve the public safety and public service agencies within the Cass County jurisdictional areas. All agencies currently use VHF P25 systems, which were purchased new and installed back in 2006-2007. These VHF systems have been linked together as best possible for local Interoperability between agencies, along with the typical radio channel sharing and cross-programming. This existing VHF system is now becoming dated and reaching the end of the equipment's service life, and the operational needs of the ever-growing Fargo and West Fargo metropolitan areas are now exceeding the VHF system's capabilities. A final critical factor are the plans for Clay County/Moorhead, Minnesota for conversion from VHF to the 800 MHz ARMER system.

Cass County operations are unique in that the county is located on the state border with Minnesota, and all 911 dispatch operations are handled by the Red River Regional Dispatch Center (RRRDC). The RRRDC is an independent local government agency that provides 911 call answering and dispatching services for Minnesota agencies (Clay County, City of Moorhead, and other cities in the county) and North Dakota agencies (Cass County, City of Fargo, and other cities in the county). The RRRDC facility is located in the city of Fargo, and operates under contract to both the Minnesota and North Dakota agencies. This ARMER plan is being presented by and for Cass County, but the RRRDC is currently an ARMER user through Clay County's plan.

A detailed implementation plan has been developed for Cass County, and the details of that plan are incorporated into this ARMER system application. A copy of the Cass County/Fargo 800 MHz Phase 2 plan is also attached to this document for reference purposes.

The key factor for consideration within this project is whether the State of Minnesota ARMER organization would consider allowing Cass County to connect to and utilize the ARMER Zone 6 Master Site (MSO) in Detroit Lakes for the operation of a new Cass County 800 MHz P25 subnetwork. It is the purpose of this document to present the technical, operational and financial parameters and factors associated with this concept. Note that this proposal would not use any ARMER 800 MHz tower site RF channels, as Cass County/Fargo would be providing a separate 800 MHz subnetwork with RF tower sites and associated infrastructure.

2. Client and Project Overview

Cass County, and the cities within the county plan to implement a 9-site 800 MHz P25 Trunked Radio System, to serve all public safety and public service operations within the Cass County, Fargo, West Fargo, and associated metropolitan and rural areas of the county.

Cass County is located in the southwest area of North Dakota, and borders Minnesota. The county has a total land area of 1,768 square miles, with a population of approximately 150,000 (2010 census data). The county seat is located in Fargo. The county is generally considered "rural", with the exception of the Fargo and West Fargo metropolitan areas. The population of the Fargo and West Fargo areas was 145,000 per 2010 census data, with continued significant growth in recent years, estimated to be 172,000 at the end of 2016. Fargo and West Fargo are the most populated area in North Dakota, with continued growth expected due to a strong economy in the region.

Cass County is bordered by seven other counties: Clay and Norman, Minnesota (east); Traill and Steele (north and northwest); Barnes (west); and Ranson and Richland (southwest and south). The heavily-traveled Interstate 94 highway corridor runs through the entire east-west length of the county, and Interstate 29 runs the entire north-south distance of the county. These two highways intersect in Fargo, with significant traffic implications.

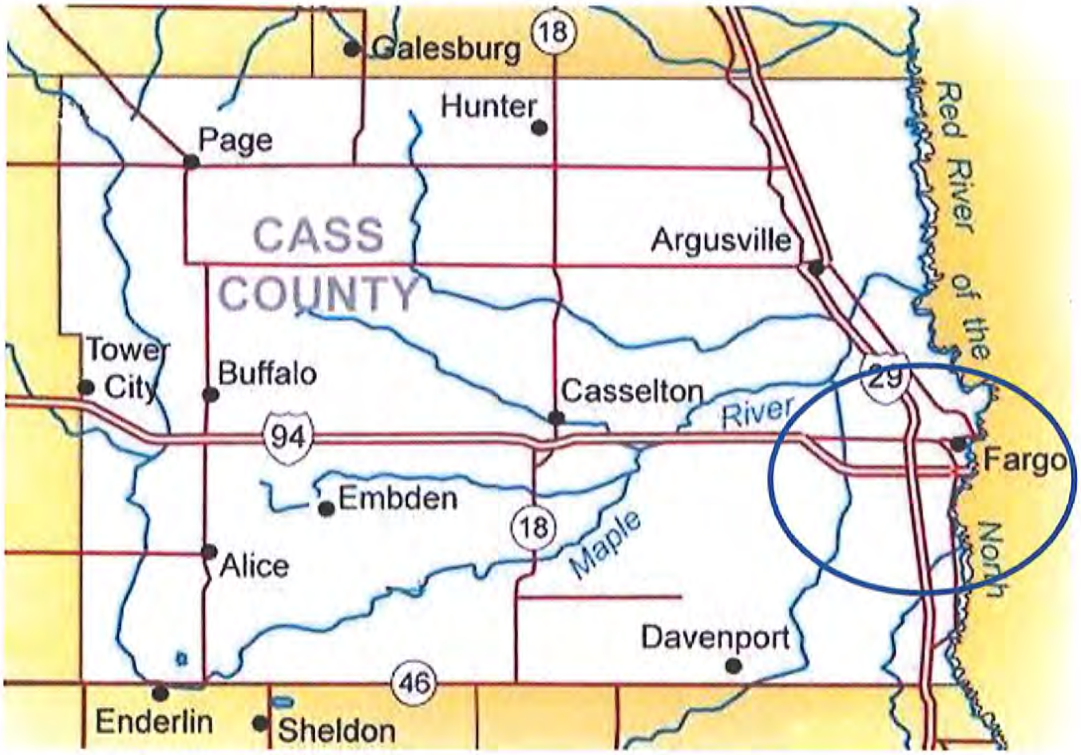
A. Agency Summary and Jurisdictional Coverage of New System

The new 800 MHz P25 Trunked System is intended to provide integrated radio service for all public safety and public service entities within Cass County, North Dakota. Those agencies include:

Law Agencies (4)	Fire/EMS Agencies (17)	Fire/EMS Agencies
Cass County Sheriff	Argusville Fire Prot. District	Harwood Area Fire & Rescue
Fargo Police Department	Arthur Volunteer Fire Dept.	Hunter Fire Prot. District
West Fargo Police Dept.	Buffalo Fire Dept.	Kindred Fire Prot. District
NDSU Police Department	Casselton Fire Dept.	Leonard Fire Prot. District
	Davenport Fire Dept.	Mapleton Fire Dept.
	Erie Rural Fire Dept.	Page Fire Dept.
	Fargo Fire Dept.	Tower City Rural Fire Dept.
	Fargo Moorhead Ambulance	West Fargo Fire Dept.
	Grandin Fire Dept.	
Public Works and School Agencies (4)		
Fargo Public Works	West Fargo Public Works	Fargo Area Schools
Fargo Utilities	Cass County Highway Dept.	West Fargo Schools

All agencies are dispatched by the RRRDC in Fargo. There exists a high level of interoperability between all agencies within Cass County, as well as "across the river" with Clay County, Moorhead, Norman County and other agencies in Minnesota. The southwest area of Cass County also borders the northwest area of the Central ARMER Region of Minnesota. The new

800 MHz Trunked Radio System will be utilized by all agencies listed above. Shown below is a map of the Cass County and Fargo area:



The primary points of contact for this project and plan are:

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B. Existing VHF Radio Systems in Cass County/Fargo

Within Cass County, Fargo and West Fargo the existing VHF radio system utilizes numerous P25 repeater systems for the individual agencies:

- 2 repeaters for Fargo Police
- 2 repeaters for Fargo Fire
- 1 repeater for Fargo Metro Ops
  (the above are a multi-site Simulcast network in Fargo)
- 2 repeaters for Fargo Public Works
- 1 repeater for West Fargo Police
- 1 repeater for West Fargo Fire
- 2 repeaters for Cass County Sheriff
- 1 repeater for Cass County Fire and Local Government
- 1 repeater for Cass County Highway
- ...along with other analog repeaters for local operations

These repeaters, voting receivers and base stations are located at 14 different site locations throughout the operating area. The sites are connected through a combination of microwave radio, city-owned fiber optic cabling, and leased telco circuits.

The existing systems are fairly complex, some using Simulcast technology, Voting receivers, Multicast, and other technologies. Most of the repeater and base stations are Motorola Quantar. The majority of the system equipment was purchased and installed in 2006-2007, and is now approaching the end of its service life, and/or support from the manufacturer as the products have been discontinued for several years. A large number of VHF radio frequencies and FCC licenses are also needed for the operation of these systems.

All public safety agencies are receive primary dispatch services through the RRRDC 911 center in Fargo. The RRRDC has recently installed new Motorola MCC7500 radio dispatch consoles, and is connected to ARMER via microwave link through the Moorhead ARMER tower site.

C. 800 MHz Radio System Summary – Cass County, North Dakota

The implementation of an 800 MHz Trunked Radio System has been determined to be the best technology solution to meet the operational needs of the agencies within Cass County. As outlined in the previous section, numerous VHF systems are now used to provide radio communications for the many agencies in the area. The growing operational needs of the county and city agencies are no longer met by the existing VHF systems. The key performance factors to be addressed within the radio system are:

- Coverage: The system needs to have enough tower sites, designed and/or tall enough, to provide the required level of coverage for the local agencies service area. Statewide systems

are often designed with a basic level of coverage, and additional sites can be added by local agencies if more coverage is needed.

An important use of the tower sites in the system is the ability of radio users to "roam" automatically between tower sites as needed. The system uses the measured signal strength of the radios to direct the radios to the best tower site. The mobile and portable radios are constantly measuring the signal strength from the tower site, and will automatically switch to a different tower site with a better signal. This includes other tower sites that may be outside the county boundaries.

- ☐ Capacity: The system should provide enough "channel" capacity to support all agencies using the system and tower sites. In a Trunked System, capacity is greatly expanded over conventional systems through the dynamic assignment of frequencies for use as talk paths (Talk Groups or Channels) for agencies using the system. The system also needs to provide easy to use Interoperability between neighboring agencies.
- ☐ Reliability: A system should utilize a high level of equipment and technology to minimize the possibility of equipment or system failure, in conjunction with meeting user coverage requirements. This includes multiple tower sites, connectivity paths, backup AC power and generators at tower sites, alarm systems, lightning and grounding protection, and other critical elements.
- ☐ Redundancy: The system should be designed with enough overlap between sites, along with backup systems, to ensure that the failure of any one site, repeater, or link results in a loss of system access for user agencies.

A properly designed 800 MHz P25 Trunked Radio System will meet the operational performance needs of the Cass County, Fargo, West Fargo and associated agencies identified in this plan.

Another critical factor in this decision are the plans for Clay County and Moorhead, Minnesota agencies to convert from VHF radio systems to the Minnesota ARMER system later in 2017. Clay County completed and approved an ARMER Plan in 2015, and is moving forward with the implementation of 800 MHz ARMER. As noted previously, the Cass County ND and Clay County MN agencies work seamlessly together on a daily basis for public safety operations, and having a common radio system in place for all agencies is key to the success of operations.

1. **800 MHz System Design:** A new 800 MHz system design has been developed utilizing 9 tower and water tower sites throughout the Cass County and Fargo/West Fargo area. This system will also use a combination of Simulcast and Multicast/ASR sites for effective coverage, capacity and cost:
   - ☐ **Fargo area: 4-site, 10 channel Simulcast system**
     1. Downtown water tower (new Prime site)
     2. 45th Street water tower

3. 32nd Avenue water tower (new site)
4. 64th Avenue water tower

☐ **Cass County area: 5-site, 5-channel Multicast/ASR system**

1. Amenia tower
2. US Customs and Border Patrol tower
3. Buffalo tower (new)
4. Kindred tower
5. Alice tower (new)

The proposed radio system will reuse several existing tower and water tower sites where possible to reduce the cost of new sites. Maps of the site locations are provided in Section 2 of this ARMER plan.

Connectivity between the sites will use a combination of microwave radio, city-owned fiber optic cabling, and leased circuits as needed.

A budgetary proposal has been received from Motorola for the new radio system.

A key factor in the overall design of the new 800 MHz network is the decision whether a Master Site/Zone Controller will need to be purchased by Cass County for operation of the new system, or whether ARMER will allow this new system to operate as a subnetwork on the ARMER network through the Zone 6 Master Site located in Detroit Lakes, MN.

2. **800 MHz Frequencies/Channels:** The proposed system will require a total of 35 new 800 MHz channels for operation of the network.
   - ☐ 10 for Fargo/West Fargo Simulcast
   - ☐ 25 for Cass County ASR sites (5 sites x 5 channels each)

   A group of 14 existing 800 MHz channels are available to Cass County for use with the proposed network. Additional 800 MHz channels are available from the Public Safety and NPSPAC pools for the project.

3. **Talk Groups and Fleetmap:** The planning work conducted for a new 800 MHz radio system has established a Fleetmap with a total of 82 Talk Groups for use within the system. Refer to Section 2.B. of this ARMER plan for more details about the proposed Fleetmap.

4. **Mobile and Portable Subscriber Radios:** The radio system user agencies within Cass County are planning for a total of approximately 1,650 radios for use within the network. A detailed breakout of these radios is provided in Section 2.

More detailed technical radio system information is provided in Section 2. of this ARMER plan.

D. ARMER System Application – Cass County, North Dakota

Cass County North Dakota, the City of Fargo, and the municipal governmental agencies within the county are presenting this ARMER Participation Plan and Radio System Plan for consideration by the various committees and governing agencies of the ARMER radio system network. The county and its agencies desire to be "Full Participants" in the ARMER system, and will migrate all primary voice communications services to the network, once fully implemented.

Cass County, Fargo, West Fargo and associated agencies recognize that as entities located outside of the geographical borders of Minnesota, it may be outside the scope or charter of the ARMER system to be utilized in this manner. However, we propose that the Cass County/Fargo operations, in conjunction with Clay County/Moorhead, Minnesota and the RRRDC 911 dispatch center all functioning as a cohesive and interoperable group, it is the best interest of all agencies to communicate through a common radio system platform.

The request by Cass County/Fargo is for access to and use of the ARMER Zone 6 Master Site in Detroit Lakes, MN. Please note that this request for ARMER system access is only for use of the core ARMER network, and not for access to or use of the 800 MHz tower sites or radio channels, as Cass County/Fargo plans to implement a fully independent 800 MHz P25 subnetwork with 9 sites in the Cass County/Fargo geographical area.

Cass County/Fargo requests that this application and plan be reviewed and approved by the following agencies:

- ☐ Northwest Minnesota Regional Advisory Committee (NW RAC)
- ☐ Central Minnesota Regional Advisory Committee (CM RAC)
- ☐ Northwest Minnesota Regional Radio Board (NW RRB)
- ☐ State of Minnesota Radio Board Operations and Technical Committee (OTC)
- ☐ State of Minnesota Emergency Communications Board (SECB)

Cass County's plan – though an independent 800 MHz subnetwork – has been developed based on the requirements and operational standards established for participation in and use of the ARMER radio system. The county desires to contract as required with ARMER, the Northwest Regional Radio Board and the State of Minnesota Department of Transportation (Mn/DOT) for use of the ARMER system if approved.

The specific justifications and technical considerations for use of the Zone 6 Master Site by Cass County/Fargo are presented in the next Section (1.E.) of this plan.

E. Operational and Technical Review, and Justification for Use of the ARMER Backbone by Cass County North Dakota

The new 800 MHz 9-site Trunked Radio System being planned for Cass County requires the implementation of a Master Site/Zone Controller for operation and management of the new system. There are two primary options to accomplish this for Cass County:

- Purchase and install a new Master Site from Motorola, which would be housed in Fargo at a new site to be developed for the project
- Connect the new subnetwork to the State of Minnesota ARMER Zone 6 Master Site in Detroit Lakes

Cass County North Dakota, along with the city of Fargo, West Fargo, and all other public safety entities within the county are requesting and proposing the use of the existing ARMER Zone 6 Master Site for use with their planned 800 MHz 9-site subnetwork.

When considering this option, there are operational, technical and financial issues and parameters to be reviewed. We believe there is a strong case for ARMER to consider allowing Cass County access to and use of the Zone 6 Master Site.

1. **Operational Considerations**: We believe it is in this area that significant benefits are to be realized for all entities involved in public safety operations in the area.
   - Clay County Minnesota, the city of Moorhead and all other public safety agencies in Clay County will be converting from VHF radio operations to the 800 MHz ARMER system in the near future, potentially in later 2017. This transition will cause some amount of disruption to the radio interoperability that now exists with all local agencies operating on VHF systems and channels. To address this issue on a short-term basis, cross-band patch capabilities have been implemented within the RRRDC to allow interoperability between the agencies and VHF/800 MHz radio spectrum.

     But ultimately, it is highly beneficial for all agencies to be operating within the same radio frequency spectrum and common radio network when possible.
   - The RRRDC 911 dispatch center in Fargo, which provides 911 and radio dispatching services for all agencies in both Cass and Clay counties, has recently installed new Motorola MCC7500 radio consoles, which replaced older Centracom equipment. These new consoles are now connected into the ARMER system Zone 6 Master Site via microwave radio link into the Moorhead ARMER tower site. Once Clay County and Moorhead operations convert to ARMER, the console system will be operating on both the existing Cass County VHF system (via CCGW's) and the ARMER system for Clay County (via network link into ARMER).

- ***It is not possible to directly connect (network level) an MCC7500 console system to more than one Trunked radio system. As such, if Cass County/Fargo is required to purchase and implement an independent Master Site for their new 800 MHz Trunked system, there cannot be direct connectivity from the RRRDC into both systems. A choice will need to be made which of the two networks would be accessed via RF control stations.***

- ISSI: If Cass County/Fargo is required to purchase and implement an independent Master Site for their new 800 MHz Trunked system, it may be possible to implement an ISSI connection between the new system and ARMER. This has been done for connectivity and interoperability in other areas of Minnesota, including access into the State of Wisconsin WISCOM network for agencies and operations in the Duluth area.

  However, there is a cost to implement this option (~$50k to $100k), and ISSI does not necessarily provide full functionality and seamless operation. There are limits to the number of talk groups (10) that are allowed between the systems, along with radio ID's. Additional talk groups are $50K per group of 10.

- Allowing the Cass County/Fargo 800 MHz subnetwork to operate from the ARMER Zone 6 Master Site will promote communications interoperability with other Minnesota agencies as well, including State Patrol, Norman County MN, and potentially others. Minnesota-based radio users would be allowed to roam into the Cass County/Fargo subnetwork for interoperability with local users, and other use as would be established through operational agreements.

  The proposed Cass County 800 MHz system would also provide good coverage in the far western area of Norman County, where ARMER coverage is somewhat limited. It may be possible to establish radio site roaming permissions to allow Norman County radios to use the Cass County site(s) if ARMER coverage is not available in certain areas.

  The proposed Cass County 800 MHz system is expected to provide a good coverage footprint well into the Clay County area of Minnesota. Cass County/Fargo units roaming into Minnesota would be programmed to remain affiliated with the Cass County network and not require access to or use of the local ARMER tower site RF channel resources.

Ultimately, it is of great benefit to all agencies on both sides of the river if the Cass County/Fargo 800 MHz radio system were to be allowed to operate from the ARMER Zone 6 Master Site, and on a common radio system platform.

2. **Technical Factors:** The factors that determine whether or not the Cass County/Fargo 800 MHz subnetwork can effectively operate from the ARMER Zone 6 Master Site, and the potential impact to the system, are rather straightforward and easy to accomplish.

   - ☐ Availability: The Zone 6 Master Site in Detroit Lakes is the least-utilized of the six Master Sites now implemented within the ARMER network (based on input from MnDOT operations), as discussed in the next topic points. See also the data table provided below.

   - ☐ Site Capacity: Each Master Site within the ARMER network is capable of supporting a total of 100 tower sites. The Zone 6 Master Site is currently supporting 59 tower sites in the Northwest Region of Minnesota. The proposed Cass County/Fargo subnetwork would add a total of 6 sites to the Zone 6 controller (1 Simulcast group, and 5 ASR's). This reflects a 10% increase of site usage for Zone 6. The addition of the Cass County sites would function exactly the same as any other group of sites connected to an ARMER Master Site.

     Based on the information obtained for this plan, there are currently no plans for the addition of any new tower sites in the Northwest Region of the state.

   - ☐ Console connections and CCGW's: Each Master Site is capable of supporting a maximum of 50 MCC7500 console connections. There are currently a total of six consoles connected to the Zone 6 Master Site:
     - Becker County
     - Beltrami County
     - Clay County (RRRDC)
     - Hubbard County
     - Polk County
     - Pennington County

     Because Clay County/RRRDC is already connected to Zone 6, no additional console ports or resources would be needed for the Cass County system.

   - ☐ ARMER System ID's: The ARMER system (overall) currently has the capability of supporting 128,000 radio user IDs, with current usage estimated at 92,000. The proposed Cass County system is estimated to add 1,650 radio IDs, and a long-term total of 2,000 included in this ARMER plan. This calculates to a 2% increase system-wide. Motorola advises that the system-wide ID capacity will be increased to 256,000 through a future system software release.

   - ☐ Talk Groups: The ARMER system (overall) has the capacity for 8,000 Talk Groups, with current usage estimated at 4,000. The proposed Cass County system would add 85 talk groups to the ARMER system, for a calculated increase of 2% over current use.

- Call Count/PTT's and Airtime: An important metric within the ARMER system is the number of calls or PTTs (Push-To-Talk) events generated by the radio users of the ARMER system, along with the total amount of airtime from these call events. This is used to track the level of traffic within a specific tower site or group of sites by all users, within a Zone or Region, or from a specific user agency. While the maximum number of calls or airtime for a Master Site is not known, the limiting factor is usually the number of 800 MHz RF channels at the tower sites associated with the Zone.

  This becomes an easy tool to use for tracking the amount of traffic that a Cass County/Fargo subnetwork would generate within Zone 6.

Shown below is a table which summarizes the above data for the Zone 6 Master Site or ARMER system overall:

Parameter	Capacity	Current Use (est or avg)	Est. Cass Co. Use	Est. Cass Co. Use %	Remaining Capacity
System ID's (Note 1)	128,000	92,000	2,000	2%	34,000
Zone 6 Tower Sites	100	59	6	10%	35
Talk Groups (Note 2)	8,000	4,000	82	2%	3,920
Z6 Call Count/PTTs (3)	NA	2.4M	265K	11%	NA
Z6 User Airtime (hours)	NA	5,500	725	13%	NA
Z6 Console ID's (4)	50	6	Included	Included	44

(Note 1): The System ID capacity is planned for expansion to 256,000 through a future software upgrade via Motorola's SUA II program. The numbers shown are system wide, not just for Zone 6.

(Note 2): The Talk Group Capacity is system wide, not just for Zone 6.

(Note 3): The numbers shown are per month. The Cass County/Fargo estimates are based on existing traffic levels from similar subnetworks such as Duluth, St. Cloud and Olmsted.

(Note 4): The RRRDC consoles are already connected to the Zone 6/DL site. No further port use or expansion would be needed.

As shown, there exists significant available capacity within the Zone 6 Detroit Lakes Master Site and the ARMER system for future use and expansion. At this time, there are no additional tower sites planned in the Northwest/Zone 6 Region, but significant capacity remains available for future expansion within the Region.

- Connectivity: It would be very easy to establish connectivity between a new 800 MHz subnetwork in the Cass County area and the Zone 6 Master Site. This same type of connectivity was installed between the RRRDC in Fargo and the Moorhead ARMER tower site using microwave radio. The Moorhead site has dual routing microwave paths to Detroit Lakes for reliability. A new microwave radio link would be

implemented from the new Prime Site in Fargo to the Moorhead site. Additional capacity between Moorhead and Detroit Lakes would be funded by Cass County if necessary to ensure the required system transport capacity.

3. **Financial Considerations:** A Master Site/Zone Controller is an expensive piece of equipment to purchase and maintain. The cost to purchase and install an M1 Master Site for the proposed Cass County/Fargo 800 MHz is estimated at $1.5 million, along with an estimated annual maintenance cost of $83,000 per year. Based on data obtained for this plan, the State of Minnesota spends an estimated $233,000 per year to maintain the Zone 6 Master Site in Detroit Lakes. The difference in cost between the two is that ARMER system uses a larger M3 Master Site, vs. an M1 Master Site proposed for Cass County.

   We believe it could be beneficial to all parties involved for some type of cost sharing plan to be implemented in conjunction with this ARMER plan.

   - ☐ Cass County/Fargo: The obvious benefit to Cass County/Fargo and associated agencies if ARMER Zone 6 connectivity were allowed is the elimination of the need to purchase a Master Site for their new system (~ $1.5 million). Also eliminated would be the need for $83,000 in annual maintenance fees.
   - ☐ ARMER: It could be argued that there is potentially no direct incremental cost to ARMER for the proposed Cass County 800 MHz subnetwork's use of the Zone 6 Master Site, as no new hardware or software expansion would be needed to accommodate the Cass County/Fargo 800 MHz subnetwork. Any fees paid to ARMER by Cass County/Fargo could be used to offset existing maintenance costs.

   Cass County is proposing and prepared to pay ARMER a fee for the use of the Zone 6 Master Site. But how should a usage fee be determined? The suggested approach might be calculate the percentage of the overall use of the Zone 6 Master Site by the Cass County/Fargo subnetwork, and apply this percentage to the annual costs associated with the Zone 6 Master Site. An example of that model might be as follows:

1	Annual Operating and Maintenance Costs for Zone 6 Master Site (Motorola SUA-II Service Contract)	$156,000
2	Motorola ST Technical Services (% of system total)	$ 27,200
3	Other MnDOT Zone 6 Maintenance and Operating Costs (est.)	$ 50,000
4	Total Estimated Yearly ARMER Zone 6 Maintenance Costs	$233,200
5	Cass County/Fargo Zone 6 Site Usage (estimated, from previous table)	13%
6	$233,200 x 13% = (Cass County/Fargo Annual Usage Fee)	$ 30,316

In the above example, Cass County/Fargo uses 10% of the overall Zone 6 tower site capacity (based on 6 sites of a total of 65 being used). However, as shown in the table on the

previous page, the Cass County/Fargo subnetwork is projected to use 13% of the traffic capacity in Zone 6, so this higher number would be used to calculate the resulting cost sharing. This usage can easily be tracked, and adjustments made if the traffic levels are significantly higher or lower than the estimated numbers.

Cass County/Fargo also proposes to pay a one-time "Connection Fee" of $195,000 for use of the Zone 6 Master Site. This number is based on a Master Site cost of $1.5M x 13% (usage) = $195,000.

Cass County/Fargo is open to a discussion regarding other operational usage parameters or criteria that could be used to calculate their use of the Zone 6 Master Site, and establish an equitable fee to be paid to ARMER for the use of this valuable resource.

Another important element to these calculations, usage considerations and cost determination is to establish an understanding and written agreement that if – at some point in the future – the Zone 6 Master Site approaches operational capacity, and requires expansion (with associated costs), Cass County/Fargo will be responsible for funding whatever changes are needed to that element of the system.

Further, Cass County/Fargo would be required (by written agreement) to do the following:

- ☐ Maintain their 800 MHz Trunked Radio subnetwork at the same software levels being used by the ARMER system
- ☐ Provide funding for future maintenance and software upgrades associated with Zone 6 Master Site operations, based on whatever usage formula is established with ARMER

There are numerous other technical considerations to be addressed, such as Tower Site permissions for Cass County/Fargo radios, which would be set to keep Cass County/Fargo agency radios affiliated with their home network, unless roaming into Clay County, when working with other agencies in that service area. However, the proposed Cass County/Fargo 800 MHz system would provide a significant coverage footprint into Clay County and Moorhead areas, and as a result Cass County/Fargo radios could remain on the Cass/Fargo system without using ARMER 800 MHz RF tower site capacity.

4. **Other Options and Considerations**: The reader might be questioning whether there has been any discussion about or consideration for the proposed Cass County 800 MHz system being connected to a future State of North Dakota (SIRN 20/20) radio network. A significant effort has been underway for the past few years within the state, trying to move forward with the funding and implementation of a new public safety radio system in North Dakota. A full radio assessment and planning effort was conducted in 2016 (Televate consultants), whereby a full technical plan and cost analysis was established for the new system.

The planned system is to implement a P25 Trunked System, using VHF frequencies in the rural areas of the state, and 800 MHz operation in the metropolitan areas (Bismarck, Fargo, Grand Forks, etc.). However, at this time the current funding sources for SIRN 20/20 are uncertain, with no defined sources identified or established. Any possible funding sources currently being debated by the 2017 North Dakota legislature are not directed toward local RF infrastructure or subscriber needs within SIRN 20/20. With the uncertainty and lack of project timelines, this option cannot currently be effectively reviewed or considered.

It should be noted that IF the SIRN 20/20 system were to become available, connectivity to the ARMER system would still provide significant operational benefits to Cass County/Fargo agencies, because of the high level of interoperability needed between Cass County and Clay County agencies.

Summary: The Cass County and Fargo project team appreciate the collective ARMER administration's willingness to consider the option of allowing connectivity and operation of a new Cass County/Fargo 800 MHz subnetwork from the ARMER Zone 6 Master Site. We believe there are significant operational and financial benefits to be provided to all participants with the implementation of this system configuration. The county again recognizes that this is a somewhat unusual request, but believes that the unique operational situation of the Cass County, Clay County and RRRDC entities open the door to such an opportunity.

In preparation for the presentation of this plan to the user groups and committees who will review and consider this request, there have been some prior discussions and presentations of the concept to various groups within the ARMER administration, allowing for consideration of the plan and seeking feedback on the concept. This includes the following groups:

- ☐ ARMER Executive Steering Committee
- ☐ ARMER SECB Finance Committee
- ☐ State of Minnesota ECN staff
- ☐ MnDOT
- ☐ Northwest Minnesota RAC and ECB

In general, the responses received from these groups was overwhelmingly positive and supportive, with an understanding that Cass County/Fargo be willing to fund any and all costs associated with the technical needs, as well as establish specific requirements for future upgrades and operational requirements needed for proper and effective shared system usage.

3. 800 MHz System and ARMER Technical Plans

A. System Design

A detailed and complete radio system implementation plan was developed for the proposed Cass County/Fargo 800 MHz subnetwork, which incorporated the following primary factors:

- ☐ System infrastructure and equipment plans
- ☐ Tower site planning
- ☐ Tower site and Public Safety Answering Point (PSAP) equipment and connectivity
- ☐ 800 MHz RF channel and loading requirements
- ☐ 800 MHz talk group requirements
- ☐ Quantity of end user radios

Specific details of how these system parameters have been addressed are provided in this section of the document. Refer also to the attached Cass County/Fargo Phase 2 Radio System planning document for more detail.

1. System Infrastructure and Tower Site Planning

The 800 MHz subnetwork being planned by Cass County/Fargo includes a total of nine (9) tower sites, as follows:

- 4-site Simulcast system for the Fargo and West Fargo areas, with 10 RF channels
- 5-site ASR system for the Cass County areas, with 5 RF channels per site

The 4-site Simulcast system will provide improved in-building portable radio coverage within the urban and suburban Fargo and West Fargo city areas; the 5-site ASR will provide wide-area coverage throughout Cass County. The following tower sites are planned for the new network:

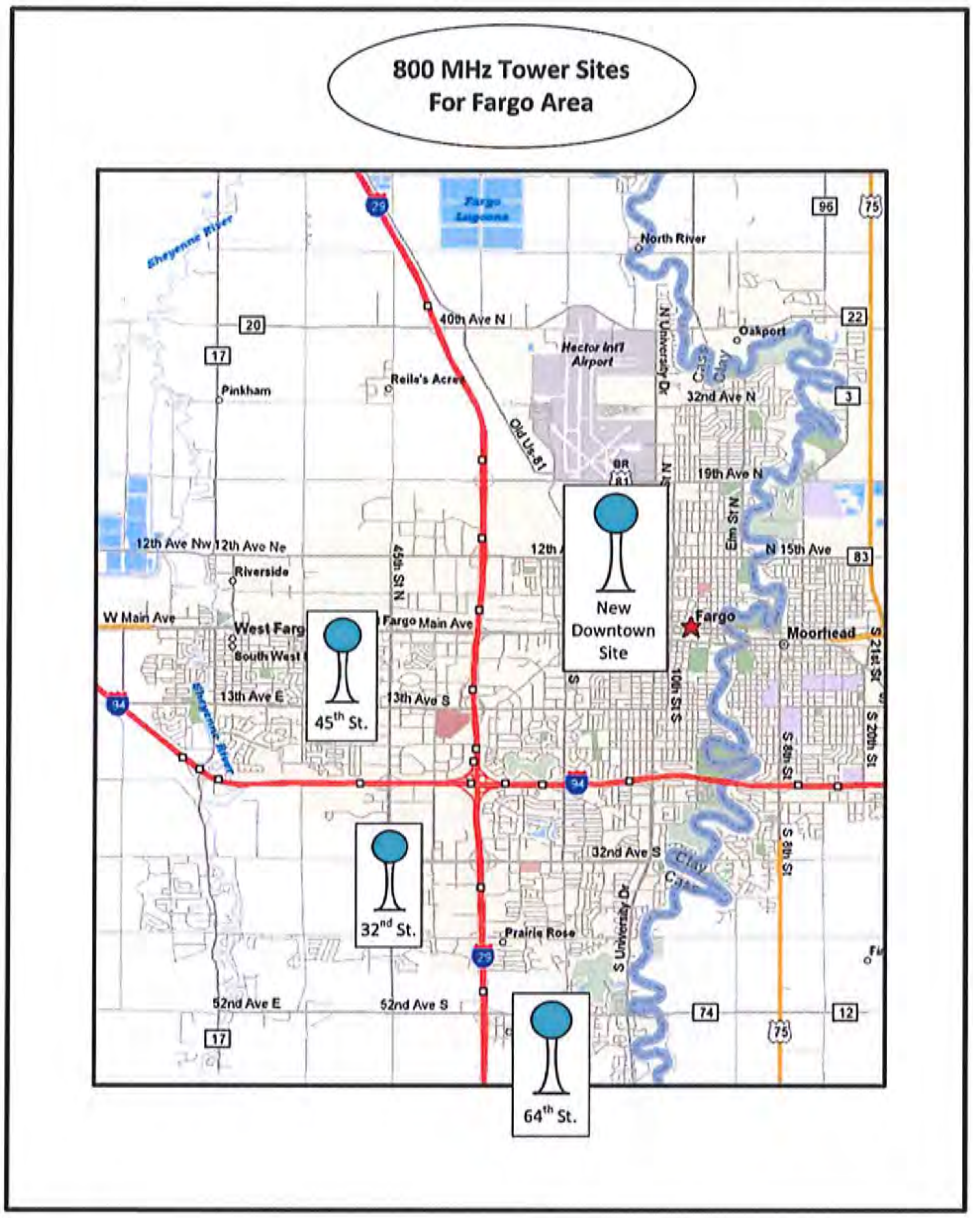
☐ **Fargo area: 4-site, 10 channel Simulcast system**

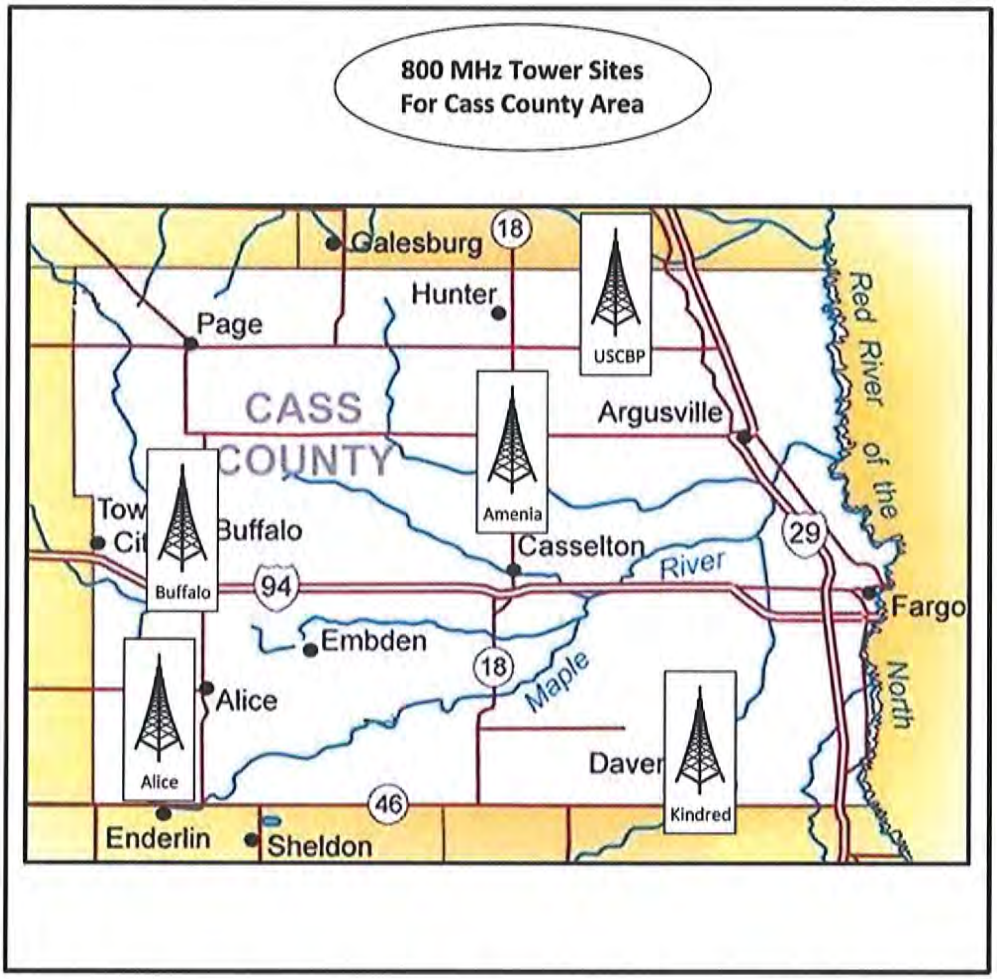
1. Downtown water tower (new Prime site)
2. 45th Street water tower
3. 32nd Avenue water tower (new site)
4. 64th Avenue water tower

☐ **Cass County area: 5-site, 5-channel ASR system**

5. Amenia tower
6. US Customs and Border Patrol tower (USCBP)
7. Buffalo tower (new)
8. Kindred tower
9. Alice tower (new)

The proposed radio system will reuse several existing tower and water tower sites where possible to reduce the cost of new sites. Maps of the proposed site locations for the Fargo/West Fargo and Cass County areas are shown below and on the next page.





Section 2.A.4. provides technical information about the network connectivity planned for the new 800 MHz subnetwork.

2. Local Equipment Additions and Enhancements

This section of the ARMER plan would normally provide specific details about new tower sites, 800 MHz RF channels being added to existing tower sites, and other system equipment being added to the ARMER network by the sponsoring agency. Because this plan is presenting a completely independent 800 MHz RF network from existing ARMER tower sites, the entire plan can be considered a "local enhancement".

3. 800 MHz Frequency Planning and Traffic Loading

The proposed 800 MHz tower sites within Cass County will operate as either trunked Simulcast or Multicast (ASR) mode of operation:

- Fargo/West Fargo: 4 sites, 10 RF channels, Simulcast
- Cass County: 5 sites, 5 RF channels, Multicast/ASR

Cass County/Fargo recognizes that trunked radio system sites need be established with a sufficient number of 800 MHz RF channels to ensure that all radio users are able to access the system when needed for both routine and emergency radio communications traffic. The number of RF channels planned for the tower sites as noted above is based on practical experience with Trunked radio systems, in conjunction with standard Erlang traffic calculations. More information regarding the calculations is provided in later paragraphs of this section of the plan.

The proposed 800 MHz Trunked Radio system for Cass County/Fargo will require a total of 35 new 800 MHz channels/frequencies for operation of the system and sites:

- Fargo/West Fargo: 10 RF channels (Simulcast)
- Cass County: 25 RF channels (5 x 5 sites) (Multicast/ASR)

The State of North Dakota (Region 32) NPSPAC Plan has a group of 14 – 800 MHz frequency assignments allocated to Cass County/Fargo, shown in the table below.

Table of 800 MHz NPSPAC Region 32 (North Dakota) Channel Assignments to Cass County ND

	Chan. No.	Status		Chan. No.	Status
1	610	Dedicated	8	743	Shared
2	630	Dedicated	9	746	Dedicated
3	648	Shared	10	761	Dedicated
4	685	Shared	11	781	Shared
5	698	Shared	12	802	Shared
6	705	Shared	13	816	Shared
7	723	Shared	14	821	Dedicated

As noted above, some channels have been dedicated or assigned for exclusive use by the agency, while some may be shared with others. The new system is planned for use of the channels shown in the above table, along with other Public Safety (non-NPSPAC) channels. 800 MHz channel availability in North Dakota is very good, due to the limited use of 800 MHz systems.

800 MHz RF Channel Loading Review

To better calculate the expected traffic loading the Cass County radios would have on the system's tower sites, the industry-standard Erlang-C process is used in this plan to determine the expected voice traffic on the ARMER system. This process is used when a shared and limited number of communications paths (trunks) are used to handle the voice traffic in a radio network. Neighboring county and state estimated radio totals are added to the Cass County radios in these calculations.

A full discussion of how this process works is beyond the scope of this plan; however, several critical factors are used to determine the expected radio traffic usage of the tower sites:

- Number of local (Cass County/Fargo) agency radios
- Number of neighboring county agency radios that are likely to use any given tower site
- Number of Minnesota agency radios that are likely to use the sites
- Number of 800 MHz radio channels available at the site(s)
- Estimation of how many radios are in use/service at a point in time
- Average radio transmission length of time (in seconds)
- Average expected number of transmissions from the radios (per hour)

When these radio inventory and usage parameters are entered into the Erlang calculation formula, a resulting Grade of Service (GOS) parameter is generated, indicating the calculated or expected availability of the radio system channels for the radio users. This GOS number could also be viewed as a "likelihood of getting a busy signal" when pressing the transmit button on a radio. The lower the number, the better GOS.

Public Safety Wireless Network (PSWN), the governmental agency which establishes operational standards and recommendations for public safety radio communications, has established a minimum GOS for these radio systems at "equal or less than two percent."

In other words, there should be less than a two percent chance that a radio user's transmission would be blocked by the system due to radio traffic levels. This could also be viewed as "greater than 98 percent" chance of a radio user's transmission being properly handled by the system when needed. This two percent GOS is considered a "Standard Busy Hour" level of usage. It should be noted that many agencies have elected to move beyond the PSWN recommendation and a common goal in Public Safety today is a GOS of 1 or better.

The parameters used for the Cass County radio traffic calculations are as follows:

- Quantity 932 Fargo and West Fargo agency radios
- Quantity of 706 Cass County agency radios

- Quantity 150 neighboring county radios (interoperability use in Cass County)
- Quantity 175 State of Minnesota and Federal agency radios
- 33 percent estimate percentage of how many radios are in use/service at one time
- 8 seconds average radio transmission time for normal use
- 12 seconds average radio transmission time for busy use
- .51 average expected number of transmissions from the radios (per hour)
- 1.25 seconds average busy time (in seconds)

The GOS is then calculated for each site, based on the number of radio channels planned for the sites, to show the impact of the differing number of channels that would be implemented at the sites.

This formula does not necessarily incorporate any parameter for the number of talk groups being planned for use by the local county agencies. The number of talk groups can have a dramatic effect on system loading, as the larger the number of talk groups, the greater potential for spreading the traffic among the RF channels. Nonetheless, it remains the most reliable method for calculating radio traffic levels.

The table shown below contains the predicted 800 MHz radio channel and tower site traffic loading for typical operational radio activity for the sites that are located within Fargo and Cass County, based on the parameters in the previous data table:

Predicted 800 MHz Standard Voice Channel Traffic Loading for Fargo/West Fargo/Cass County Tower Sites

Number of Voice Channels Normal Conditions									
Site and GOS	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Fargo Simulcast	129.5%	42.0%	11.5%	2.6%	0.5%	0.1%	0.0%	0.0%	0.0%
Amenia (ASR)	49.8%	8.9%	1.2%	0.1%	NA	NA	NA	NA	NA
USCBP (ASR)	38.6%	5.7%	0.6%	0.1%	NA	NA	NA	NA	NA
Buffalo (ASR)	38.6%	5.7%	0.6%	0.1%	NA	NA	NA	NA	NA
Kindred (ASR)	38.6%	5.7%	0.6%	0.1%	NA	NA	NA	NA	NA
Alice (ASR)	33.2%	4.4%	0.4%	0.0%	NA	NA	NA	NA	NA

One channel at each site is allocated as the Control Channel, which is not used for voice and not reflected in the table above. As shown, a GOS of better than two percent is achieved with 5 voice channels for the Fargo/West Fargo Simulcast group, and 3 channels for the Cass County ASR sites (highlighted in yellow).

The above calculations are again based on the PSWN "Standard Busy Hour" calculations, and do not account for the increased traffic loads that would be expected during emergency periods (tornado, large fire, multiple events). PSWN has established a recommendation of an additional 20 percent capacity for these events. The table below shows the predicted ARMER system traffic loading and GOS for the Cass County sites when the PSWN 20 percent additional emergency operations data is incorporated into the usage calculations.

Predicted 800 MHz Voice Channel Traffic Emergency Loading for Fargo/West Fargo/Cass County Tower Sites

Number of Voice Channels Normal Conditions									
Site and GOS	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Fargo Simulcast	232.3%	103.5%	41.1%	14.4%	4.4%	1.2%	0.3%	0.1%	0.0%
Amenia (ASR)	92.6%	25.4%	5.6%	1.0%	NA	NA	NA	NA	NA
USCBP (ASR)	83.4%	22.0%	4.6%	0.8%	NA	NA	NA	NA	NA
Buffalo (ASR)	83.4%	22.0%	4.6%	0.8%	NA	NA	NA	NA	NA
Kindred (ASR)	83.4%	22.0%	4.6%	0.8%	NA	NA	NA	NA	NA
Alice (ASR)	74.3%	18.1%	3.5%	0.5%	NA	NA	NA	NA	NA

As shown, 6 voice channels are now required to maintain the minimum recommended GOS during emergency traffic periods for the Fargo/West Fargo Simulcast sites, and 4 voice channels for the Cass County ASR sites.

Overall, the planned number of voice channels for all sites within the system should be capable of handling the traffic levels expected from local user agencies.

4. PSAP, Tower Site and Network Connectivity

Connectivity between the proposed Cass County/Fargo 800 MHz subnetwork and the ARMER Zone 6 Master Site in Detroit Lakes is required for operation of the system, if approved for ARMER use. The new MCC7500 consoles at the RRRDC in Fargo are now connected into the ARMER network through both a local fiber optic link and microwave radio link to the Moorhead ARMER tower site.

A new combined microwave radio and fiber optic link is planned between the new Cass County/Fargo system Prime site, to be located in downtown Fargo, and the Moorhead ARMER tower site.

The new radio system will require connectivity between the many tower sites, as well as the new system Prime site in downtown Fargo. Multiple connection technologies will be used to meet this need:

- ☐ Microwave radio links (licensed)
- ☐ Fiber Optic cable
- ☐ Leased circuits from local telephone companies

Microwave radio links are the preferred solution for connectivity to sites located in rural areas, due the high cost of installing fiber optic cabling over great distances to rural tower sites. Fiber optic is a preferred solution within the larger city and metropolitan areas, where the sites are closer together, and the local city governments often own a dedicated fiber network (vs. paying a local communications provider). This is the case with the City of Fargo, as they have been expanding their fiber network over the past several years, with reliable connectivity throughout much of the city. As such, fiber optic will be the primary method of connectivity to the Fargo tower sites, with diverse routing (multiple circuits for backup in case of failure) to all locations.

The new system plan will continue to use this combination of technologies, with some expansion and replacements:

- ☐ Microwave radio: This technology will continue to be used for connectivity to the rural tower sites. As noted above, the existing microwave radio now being used is a combination of licensed and unlicensed equipment, varying in age from 10 years old to less than 4 years old.

  All existing unlicensed radio equipment will be replaced with new licensed microwave equipment, and licensed as required. This includes the links from Buffalo to Alice, and from downtown Fargo to Kindred.

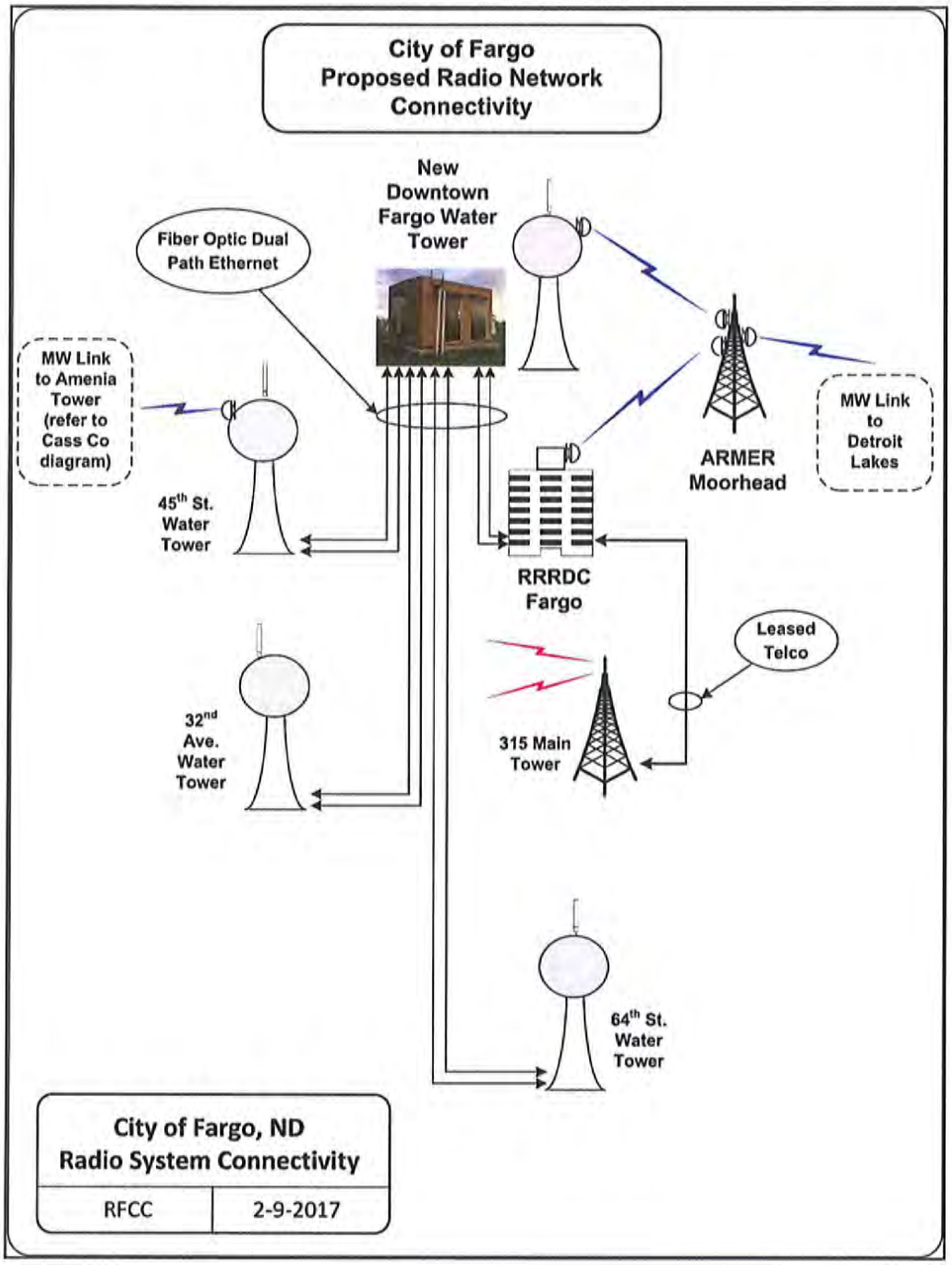
  Much of the existing licensed equipment is in excellent condition, and may be reused for the new system. Further research is required on this issue, but funding has been placed in the overall project budget for the replacement of the unlicensed links.

- Fiber Optic: This is currently used to the 45th St and 32nd Ave. water tower sites. New fiber circuits will be planned to all four of the water tower sites planned for the 4-site Fargo/West Fargo Simulcast system. The system will require new fiber optic installations to all sites, including 45th St., because of the need for dual circuit paths from downtown to this site.
- Leased Circuits: These circuits are only minimally used within the existing VHF system, connecting the RRRDC facility in Fargo to the 315 Main tower site in downtown Fargo, where most of the system's backup stations are located. These circuits may be retained for future radio use.

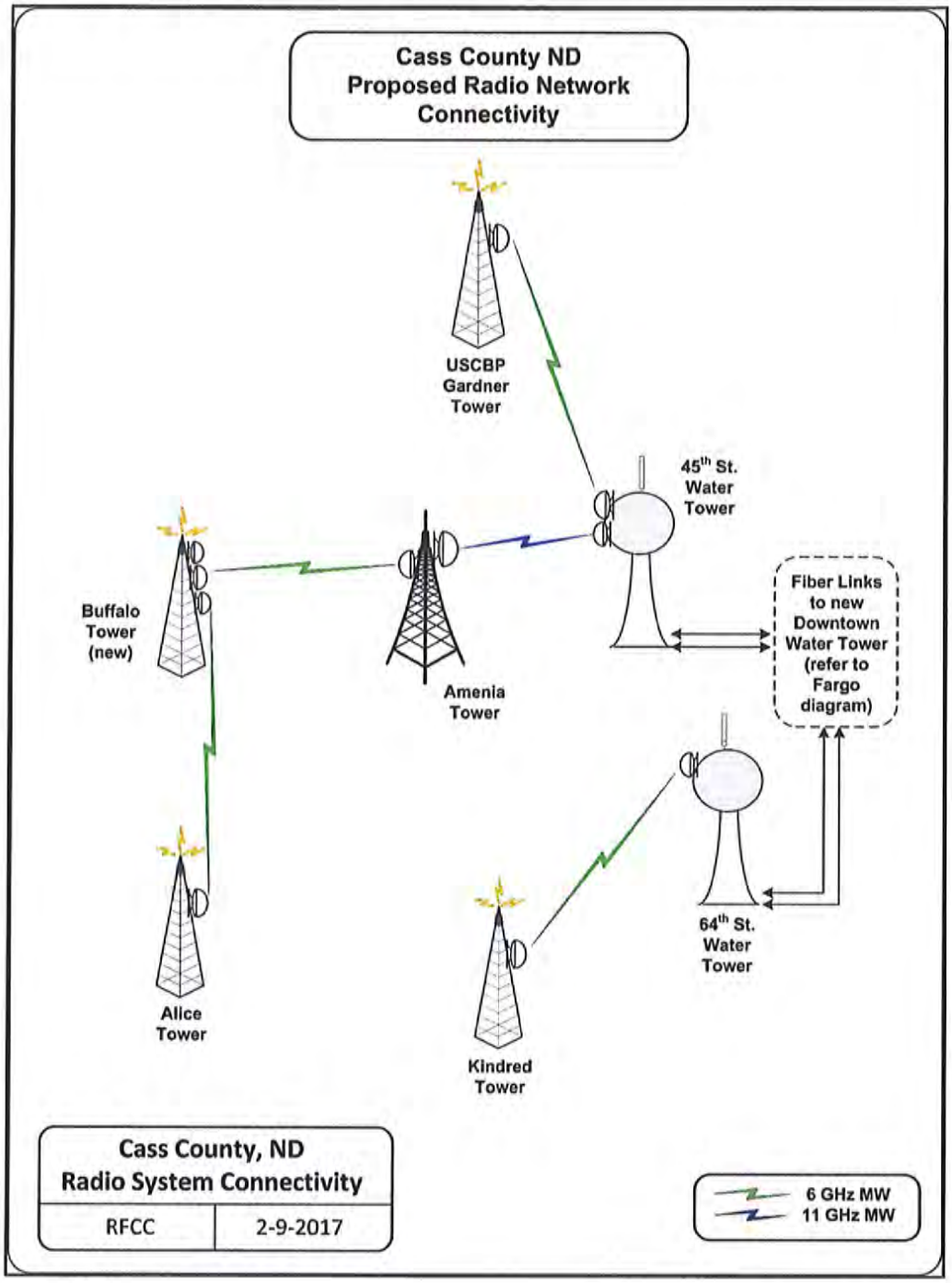
A group of ten (10) 800 MHz RF control stations will be located at the RRRDC PSAP, and used as another level of backup in the event of other system failures. These stations communicate on-channel with the Fargo and Cass County tower sites, and can be used for Site Trunking as well.

Refer to the Fargo and Cass County system connectivity diagrams on the next two pages.

City of Fargo ND Proposed Radio System Connectivity



Cass County ND Proposed Radio System Connectivity



5. PSAP/Dispatch Center Equipment and Logging/Recording

The RRRDC (Red River Regional Dispatch Center) located in Fargo provides all 911 and dispatch related services for Cass County/Fargo, North Dakota and Clay County/Moorhead, Minnesota public safety agencies. The RRRDC has recently implemented a new Motorola MCC7500 radio console control system, with a total of 9 operator positions.

This console system is now connected to the ARMER network (for use with Clay County/Moorhead ARMER operations), along with multiple VHF law, fire and EMS systems, including:

- Clay County and City of Moorhead, MN (VHF legacy systems)
- Cass County North Dakota
- City of Fargo North Dakota
- 800 MHz RF control stations for interoperability with ARMER system users

Additional RRRDC MCC7500 console technical details:

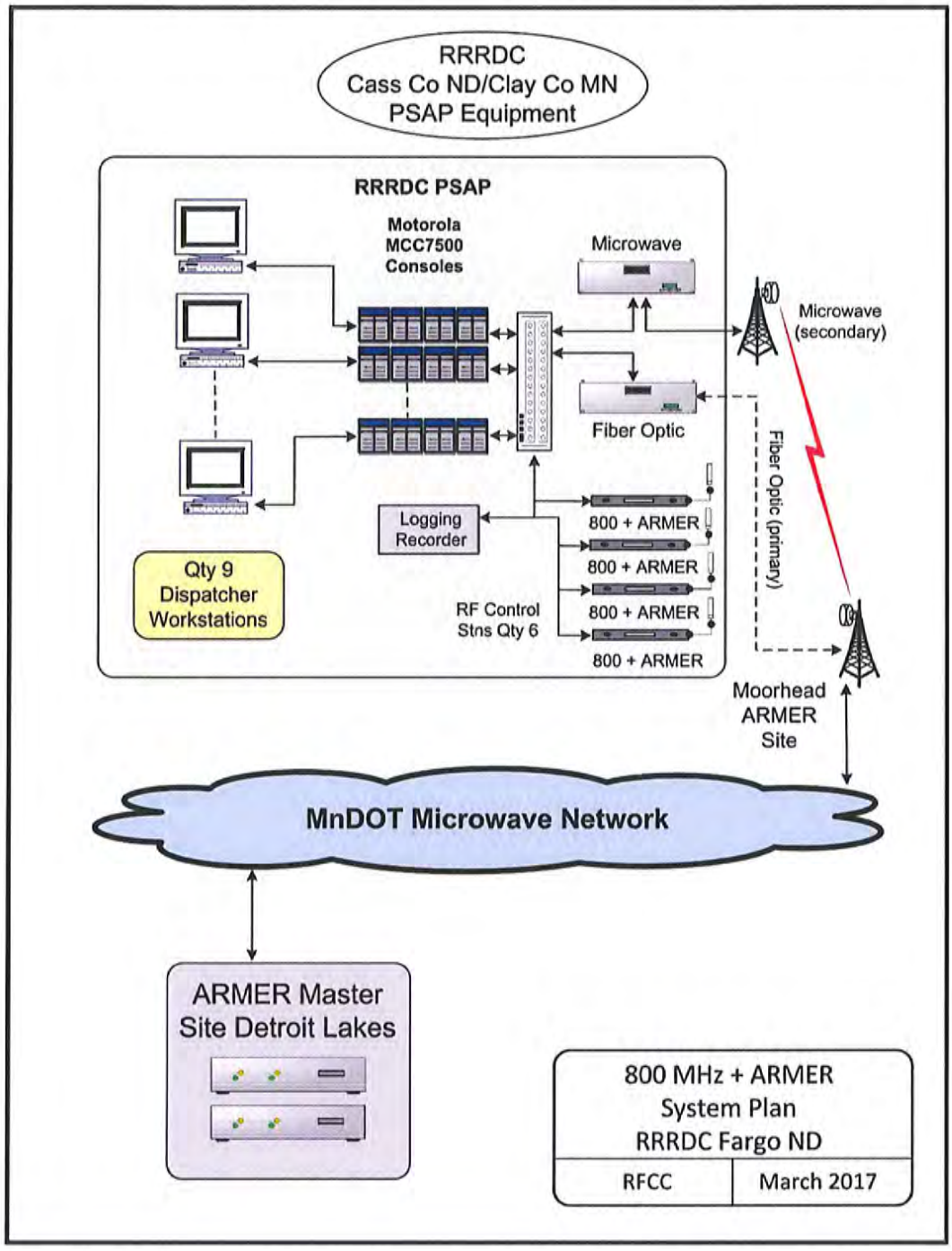
- *CCGW Ports: The new MCC7500 console system is connected to forty (40) conventional channel resources, and is now configured with 40 CCGW ports (the maximum allowed). As Clay County operations migrate from VHF to the ARMER network, fewer VHF channel resources will be required; however several 800 MHz RF control stations will be needed for ARMER backup operations. Assuming Cass County/Fargo migrate from VHF to an 800 MHz system,*
- One existing workstation has been established with a CAD/Paging system interface, to allow direct access to the County's VHF tone-and-voice paging system.
- A total of six (6) 800 MHz RF Control Stations will be implemented at the RRRDC
- System Administration: The RRRDC has implemented an ARMER System Management workstation to allow access to the ARMER database, for management of the Clay County radios and technical parameters.

A high-level system connectivity diagram is provided on the following page (from the original Clay County/RRRDC ARMER Plan document).

- In addition to the RRRDC 911 PSAP, a backup PSAP has been established at the West Fargo Police Department. This location currently uses 4 older Motorola Gold Elite consoles, which will be retained and connected to six (6) 800 MHz RF control stations.

Voice Logging: The dispatch center will continue to use its existing local voice logging recorder for the recording of 800 MHz, ARMER and conventional channel radio traffic, through the local ARMER 800 MHz RF control stations planned for the PSAP. A "Trunked" logging system is not included in the plan at this time.

RRRDC Cass County/Clay County PSAP ARMER Architecture



6. Legacy VHF Equipment

Cass County/Fargo will continue to operate and control a number of existing or updated VHF radio system channels, for local paging and interoperability. Emergency paging for fire and EMS operations is currently conducted via county-owned VHF system(s). These existing systems will be retained and modified or expanded as needed for improved paging coverage. This expansion may include the installation of some equipment at ARMER tower sites for improved coverage and reliability.

In addition, the existing law enforcement VHF repeater channels may be utilized for local interoperability between VHF and 800 MHz radio system users.

B. System Talk Group Planning and ID Requirements

A new Fleetmap has been developed for Cass County/Fargo based on the needs of participating agencies, and will have a total of 82 talk groups. In addressing the talk group needs for the county agencies, the following basic outline will be used:

- ☐ Primary and secondary dispatch talk groups for law enforcement
- ☐ Primary and secondary dispatch talk groups for fire service
- ☐ Primary and secondary dispatch talk groups for EMS service
- ☐ Individual dispatch talk groups for non-traditional public safety agencies
- ☐ Countywide talk groups for special events
- ☐ Countywide talk groups for interoperability
- ☐ Individual talk group(s) for each participating agency
- ☐ Non-trunked tactical talk groups for "Scene of Action" use

Refer to Attachment 1 for a copy of the preliminary Cass County/Fargo agency fleet map.

A total of 2,000 ARMER system IDs are being requested for the Cass County/Fargo system implementation, which includes three year estimated totals:

- ☐ 932 for Fargo and West Fargo mobile and portable subscriber units
- ☐ 706 for Cass County and rural agency mobile and portable subscriber units
- ☐ 342 for future expansion
- ☐ 20 for PSAP operations

C. 800 MHz Radio System Coverage Review

Radio system range or coverage is considered the most critical function of any radio system, especially in public safety operations. While there are other important elements to a good system (equipment reliability, channel capacity), the ultimate factor by which a system's measure of success or failure is usually measured is how reliably it covers the intended service area.

Radio system coverage is a function of several key elements:

- The radio frequency being used (VHF, UHF, 700/800 MHz)
- The transmitter power of the radios (base units, portable units, etc.)
- The height of the antennas of the base stations and repeaters
- The distance from the field units needing to communicate and the base station or repeater they are trying to reach

These parameters are incorporated into the design of a radio system.

1. Design Parameters

The overall system design and resulting communications coverage of the 800 MHz system can be affected by the following goals and concerns:

- The need and desire to obtain in-building coverage as best as possible in more densely populated areas of the county
- Need to cover the geographic area with a reasonable number of tower sites
- Minimize the cost of developing new tower sites, including structures, land acquisition, Federal Aviation Administration (FAA)/FCC/National Environmental Policy Act (NEPA) considerations, as well as local zoning
- Availability of and costs associated with existing and planned tower sites

The proposed 800 MHz system will be using a combination of existing and new tower sites, with a focus on reusing existing sites when possible.

- The coverage goal for Cass County is 95 percent "on-the-street/outdoor" reliability to a portable radio with a standard antenna held at a height of five feet above ground level.
- The same 95% is desired within "6db loss" building structures within the Fargo and West Fargo metropolitan areas.

2. Coverage Propagation Mapping

In the planning for this project, coverage modeling and propagation analysis was done to determine if the basic tower site planning assumptions were valid and could be expected to result in a system that would meet Cass County's coverage needs.

The coverage maps presented in this plan were prepared by Motorola for the Cass County/Fargo project, utilizing Motorola's standard computer-based Hydra program.

Multiple coverage maps were done for portable talk-in and talk-out usage, as this is the most difficult coverage scenario. Provided below are the parameters used for the coverage modeling:

Site Parameters	Value
Transmit Antenna Gain	9 db, omnidirectional
Transmit Output Power (into main line)	35 watts
Transmission Line Size (tower over 300 feet)	1.25 inch Heliax®
Transmission Line Size (tower under 300 feet)	7/8 inch Heliax®
Transmission Line Length	Based on tower height
Receive Antenna Gain	9db, omnidirectional
Receive Tower Top Amplifier Gain	5db
Receive Transmission Line Size	7/8 inch Heliax®
Receive Transmission Length	Based on tower height
Field Unit Parameters	**Value**
Type of Unit	Portable radio
Environment 1	Outdoors, On-street
Environment 2	In-Building, 6dB loss
Environment 3	In-Building, 12dB loss
Antenna Height	5 feet
Transmit Power	3 watts

Preliminary coverage maps for portable radio talk-in and talk-out are shown on the following pages. The color coding for these maps is:

- Green: Reliable signal coverage, 95% or greater reliability
- White: Weaker signal coverage, less than 95% reliability

Ten predicted-coverage maps are provided in this plan, showing the calculated coverage for the 800 MHz system. The maps are divided into two groups:

- Fargo and West Fargo city areas (5 maps)
- Cass County areas (5 maps); note also that the Cass County maps include the radio signal coverage provided by the Fargo area Simulcast tower sites.

The maps show the predicted coverage from radios used outdoors, as well as inside "6dB loss" and "12dB loss" buildings. There are many different types of building structures, which have differing levels of signal loss for radio systems. The 6dB and 12dB loss factors are an attempt to categorize the different types of buildings for the purpose of calculating radio system coverage. In general, these building categories are:

- 6dB loss: Wood-framed residential homes and similar structures, and commercial "strip mall" buildings which have numerous windows and few deep interior rooms
- 12dB loss: These are typically larger structures such as government buildings, hospitals, schools, large stores and shopping malls, etc. These structures often include brick and steel construction, limited windows, and other factors which greatly affect the radio signal penetration into the building.

  It is expected that there are also many buildings with greater than 12dB loss in the Fargo and West Fargo areas. Several of the "Critical" buildings identified in the Phase 1 report are in this category. It is extremely difficult to predict the coverage levels in these buildings, and will require field testing once a new system is completed. Some locations will undoubtedly require "In Building Amplifiers" (BDAs) to obtain the required level of radio system coverage. These will be dealt with on a case-by-case basis.

Fargo/West Fargo area maps:

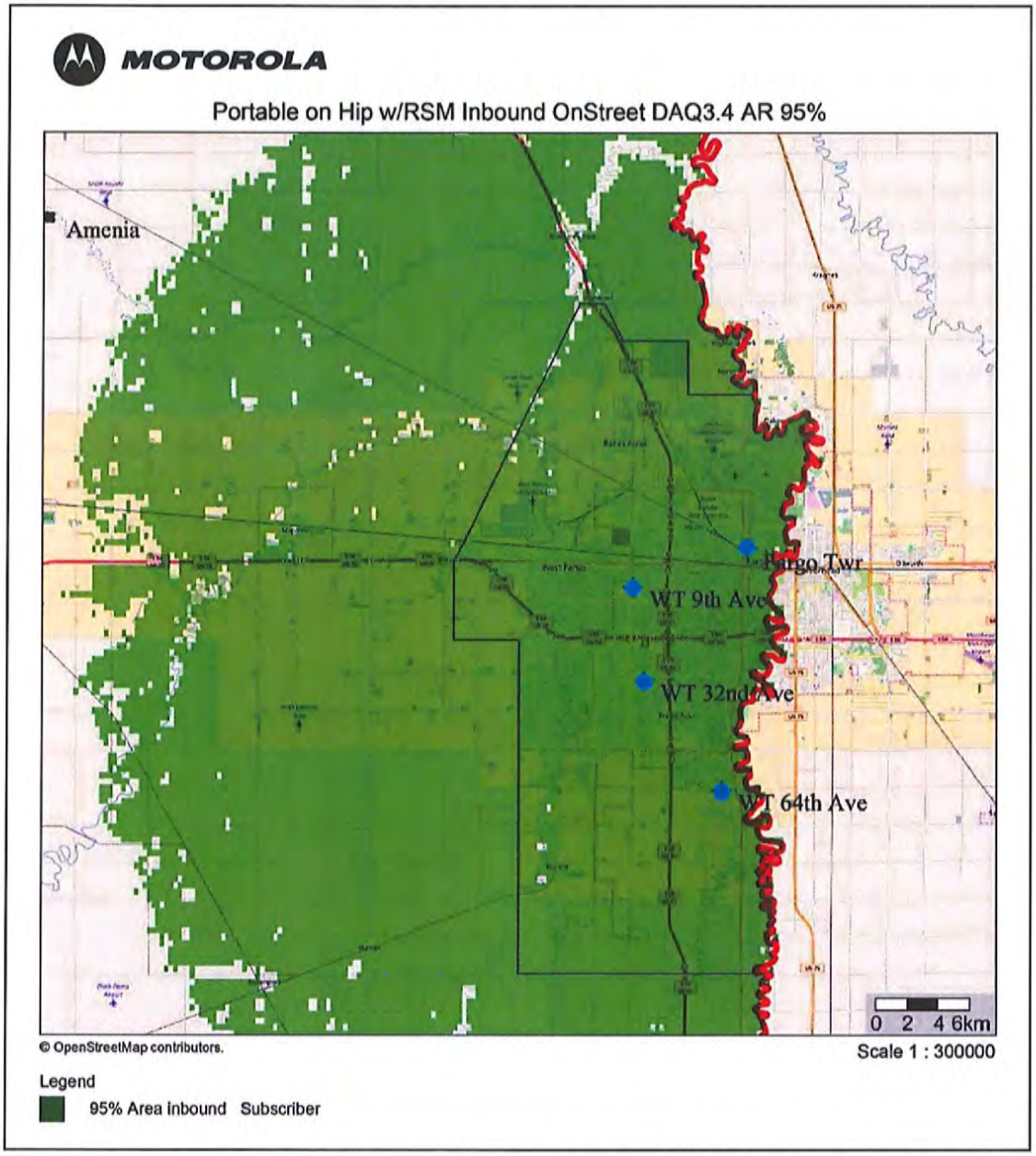
1. Talk-In coverage from Portable radios, On-Street (outdoors)
2. Talk-In coverage from Portable radios, inside 6dB loss buildings
3. Talk-Out coverage to Portable radios, inside 6dB loss buildings
4. Talk-In coverage from Portable radios, inside 12dB loss buildings
5. Talk-Out coverage to Portable radios, inside of 12dB loss buildings

Cass County area maps:

6. Talk-In coverage from Portable radios, On-Street (outdoors)
7. Talk-In coverage from Portable radios, inside 6dB loss buildings
8. Talk-Out coverage to Portable radios, inside 6dB loss buildings
9. Talk-In coverage from Portable radios, inside 12dB loss buildings
10. Talk-Out coverage to Portable radios, inside 12dB loss buildings

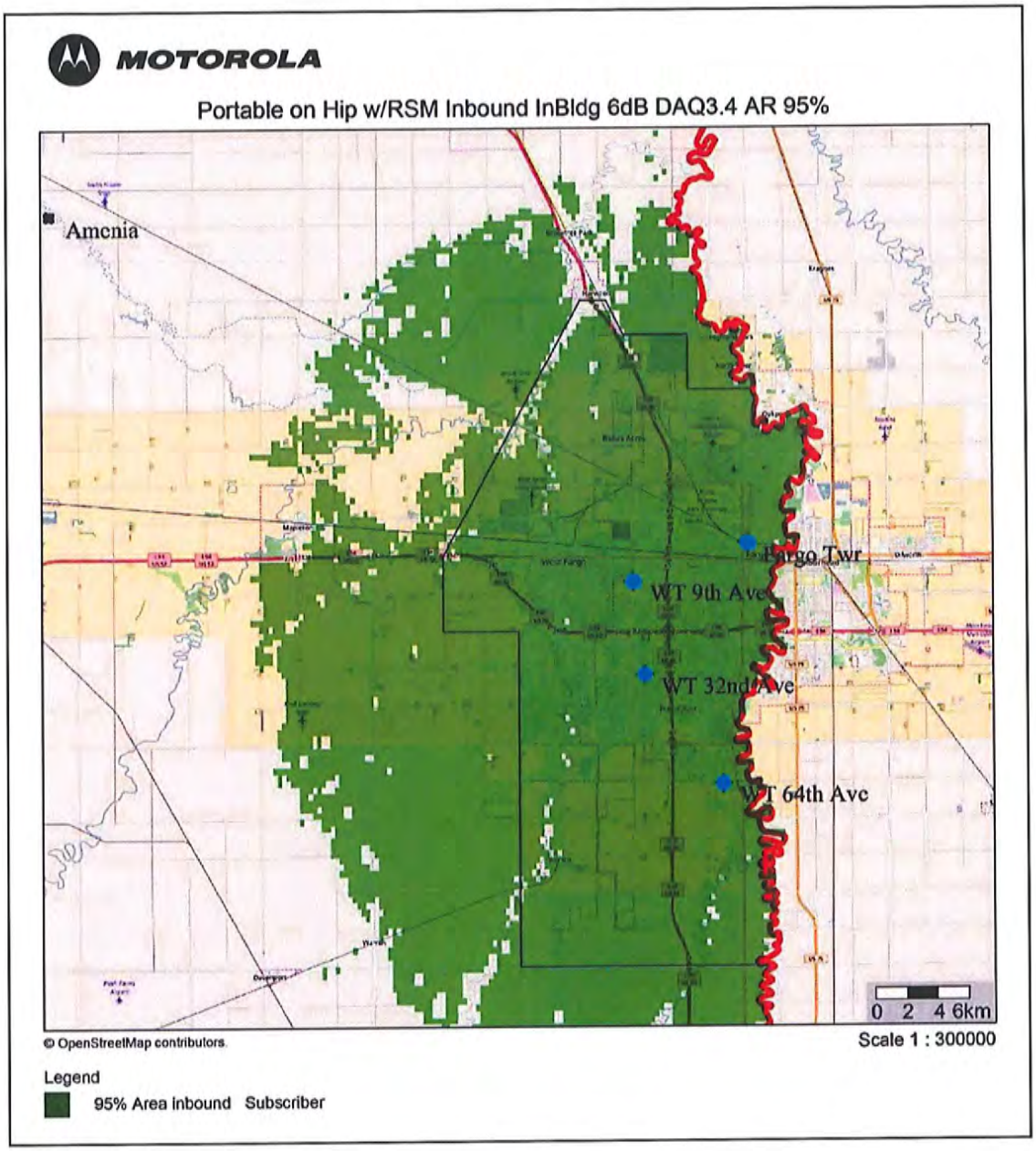
Note that separate "Talk-In" and "Talk-Out" maps are shown for most of the various coverage levels. This is due to the differing transmit power levels between the field radios and the repeaters at the tower sites. The 800 MHz trunked system include technology that works to balance these differing signal levels; this is done through the installation of "Tower Top Amplifiers" (TTA's) at each tower site. These amplifiers receive in the lower-powered signals from portable radios and boost the signal levels before sending the signals down the coax cables to the repeater receivers. This greatly improves the "balance" of the system. The predicted coverage maps are shown on the following pages.

Map 1: 800 MHz Talk In from Portable Radios On Street/Outdoors Fargo/West Fargo



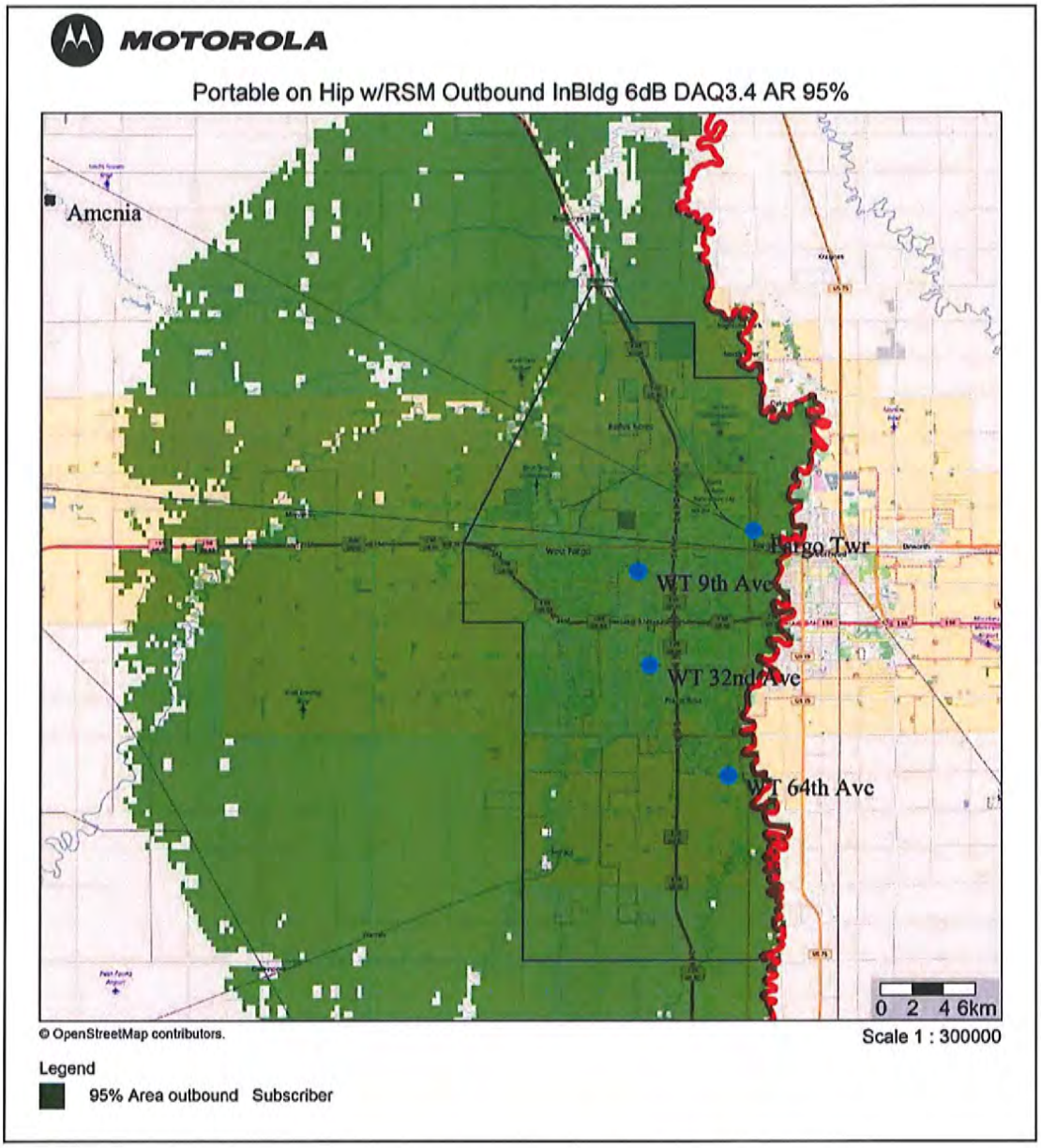
The proposed system's predicted Talk In coverage from portable radios On Street, when all tower sites are included, is very good. The Fargo/West Fargo Simulcast tower sites are shown as the blue circles on the map, and the black line indicates the general city border of the combined Fargo and West Fargo areas.

Map 2: 800 MHz Talk In from Portable Radios 6dB Loss In-Building Fargo/West Fargo



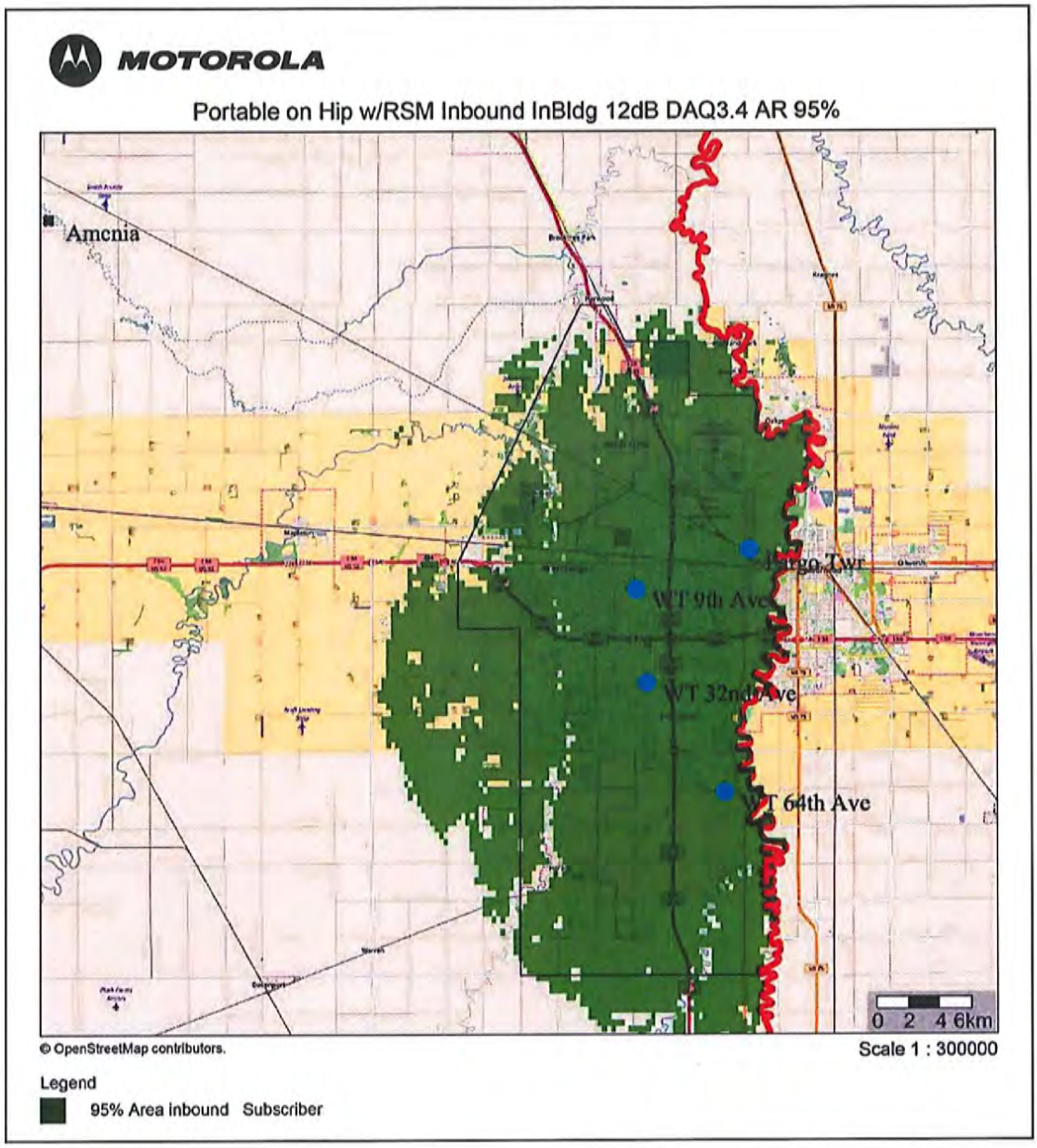
The proposed system's predicted Talk In coverage from portable radios when all tower sites are included, is also good in most areas of the Fargo/West Fargo area, with the same "95%" observations made from the previous map.

Map 3: 800 MHz Talk Out to Portable Radios
6dB Loss In-Building Fargo/West Fargo



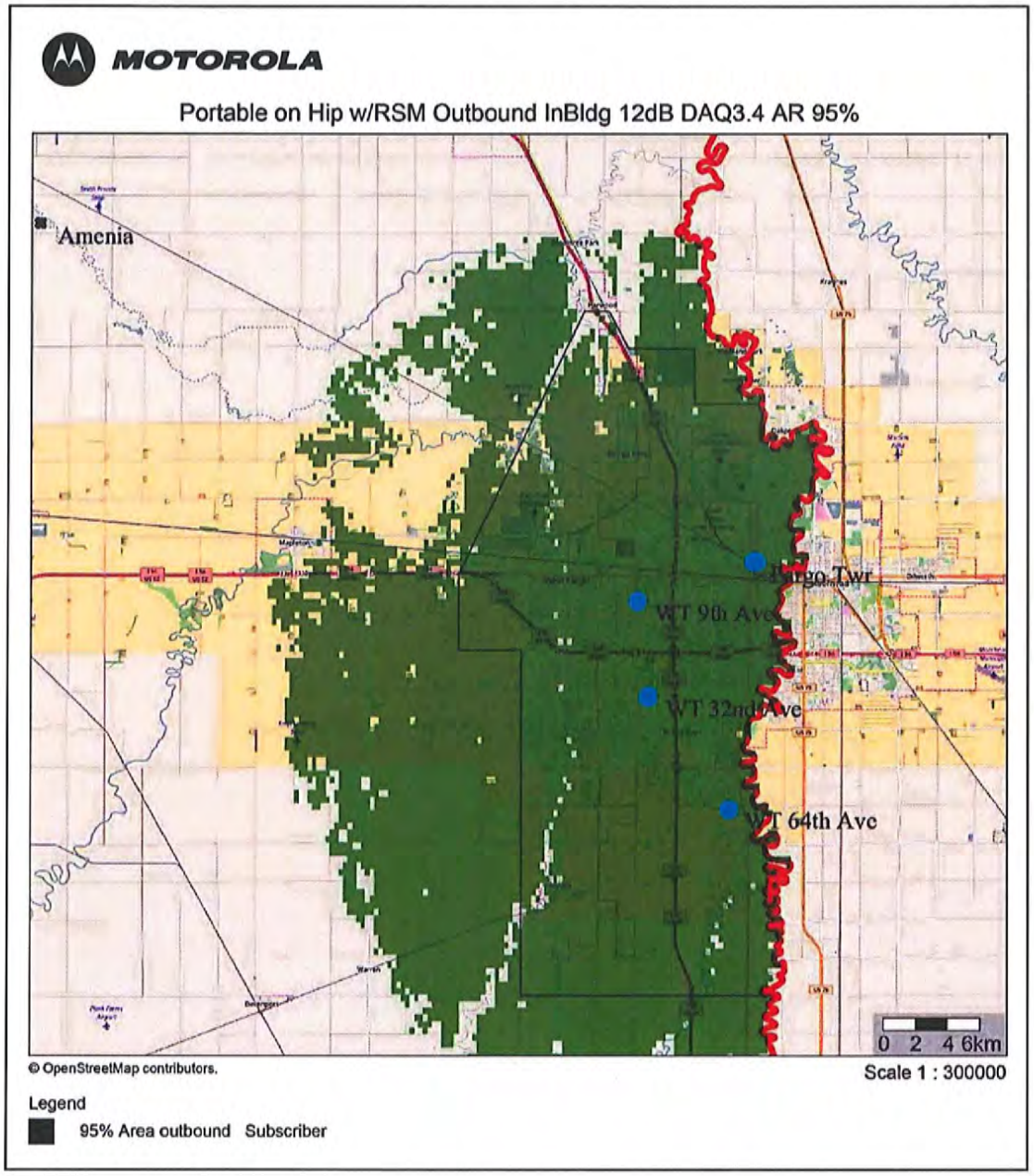
The proposed system's Talk Out coverage to portable radios – inside "6db loss" buildings – appears to be very good throughout the Fargo and West Fargo areas.

Map 4: 800 MHz Talk In from Portable Radios
12dB Loss In-Building Fargo/West Fargo



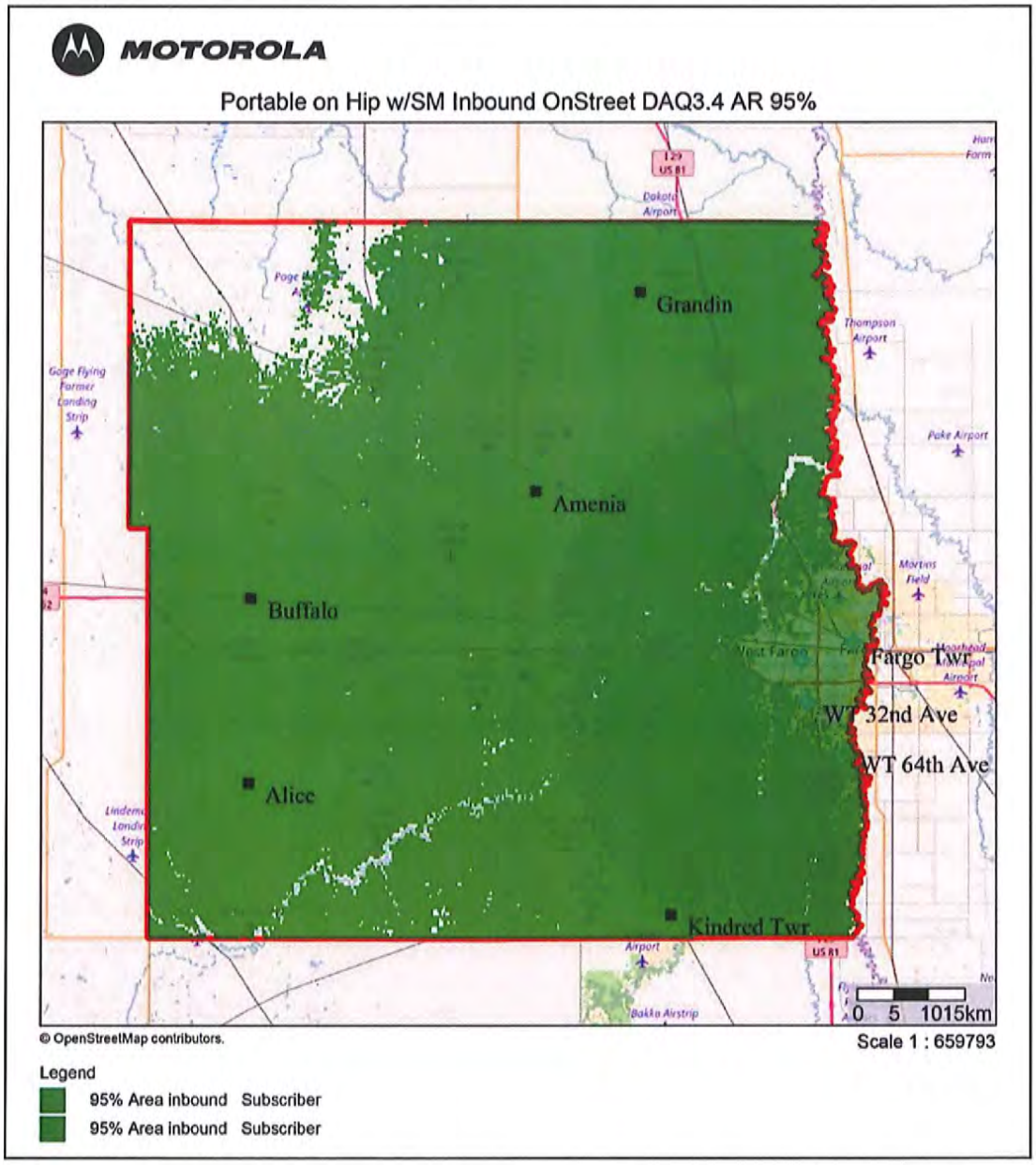
The proposed system's Talk In coverage from portable radios – inside "12db loss" buildings – appears very good in most areas of the Fargo and West Fargo area. Some areas of "white" (<95% predicted reliability) can be seen in the northwest and southwest areas of the target coverage area. However, this only matters if there are "12dB loss" buildings in these specific areas.

Map 5: 800 MHz Talk Out to Portable Radios
12dB Loss In-Building Fargo/West Fargo



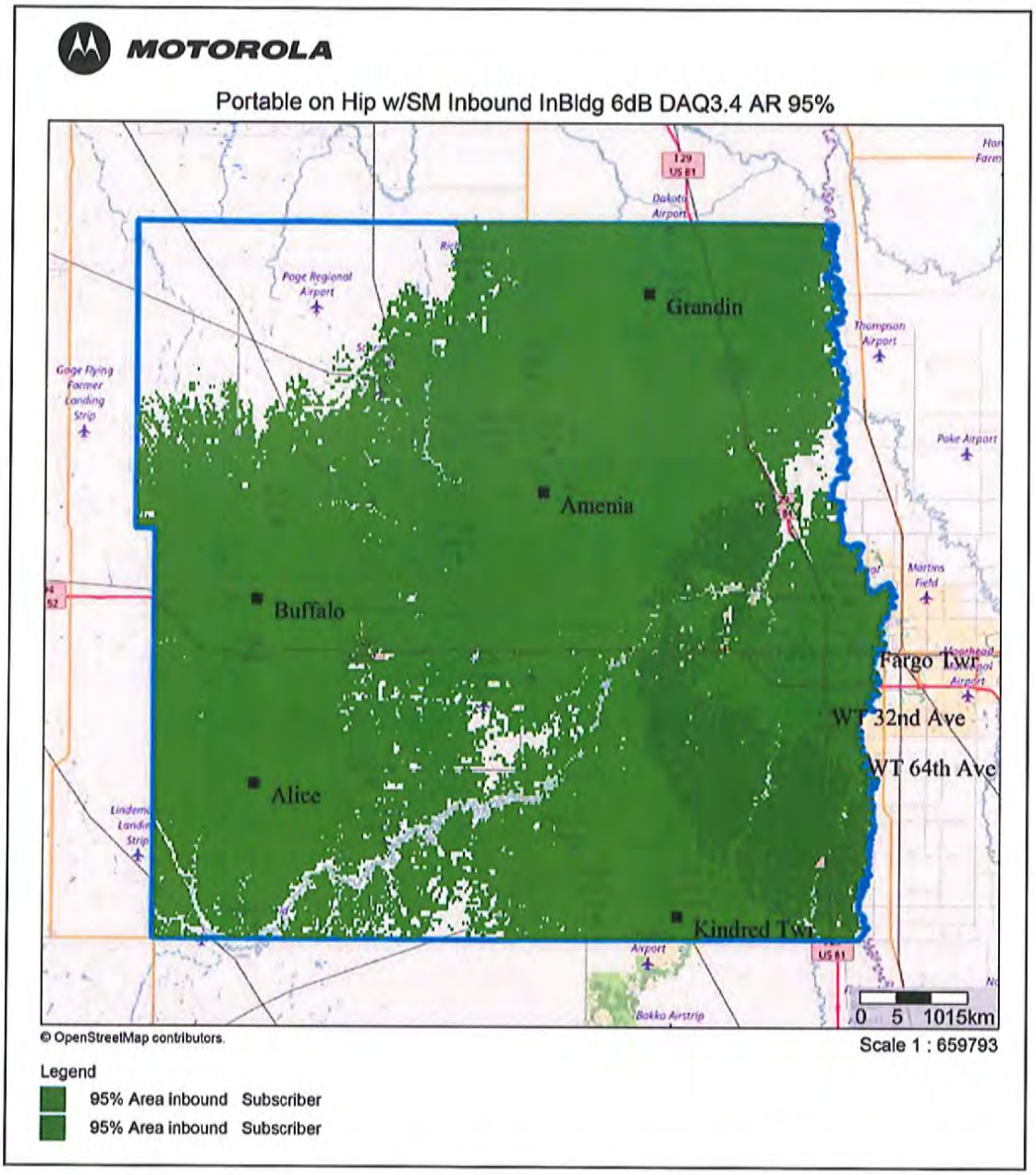
The proposed system's Talk Out coverage to portable radios – inside "12db loss" buildings – is good in most areas of the Fargo/West Fargo service area, other than a few spotty areas in the far north.

Map 6: 800 MHz Talk In from Portable Radios On Street/Outdoors Cass County



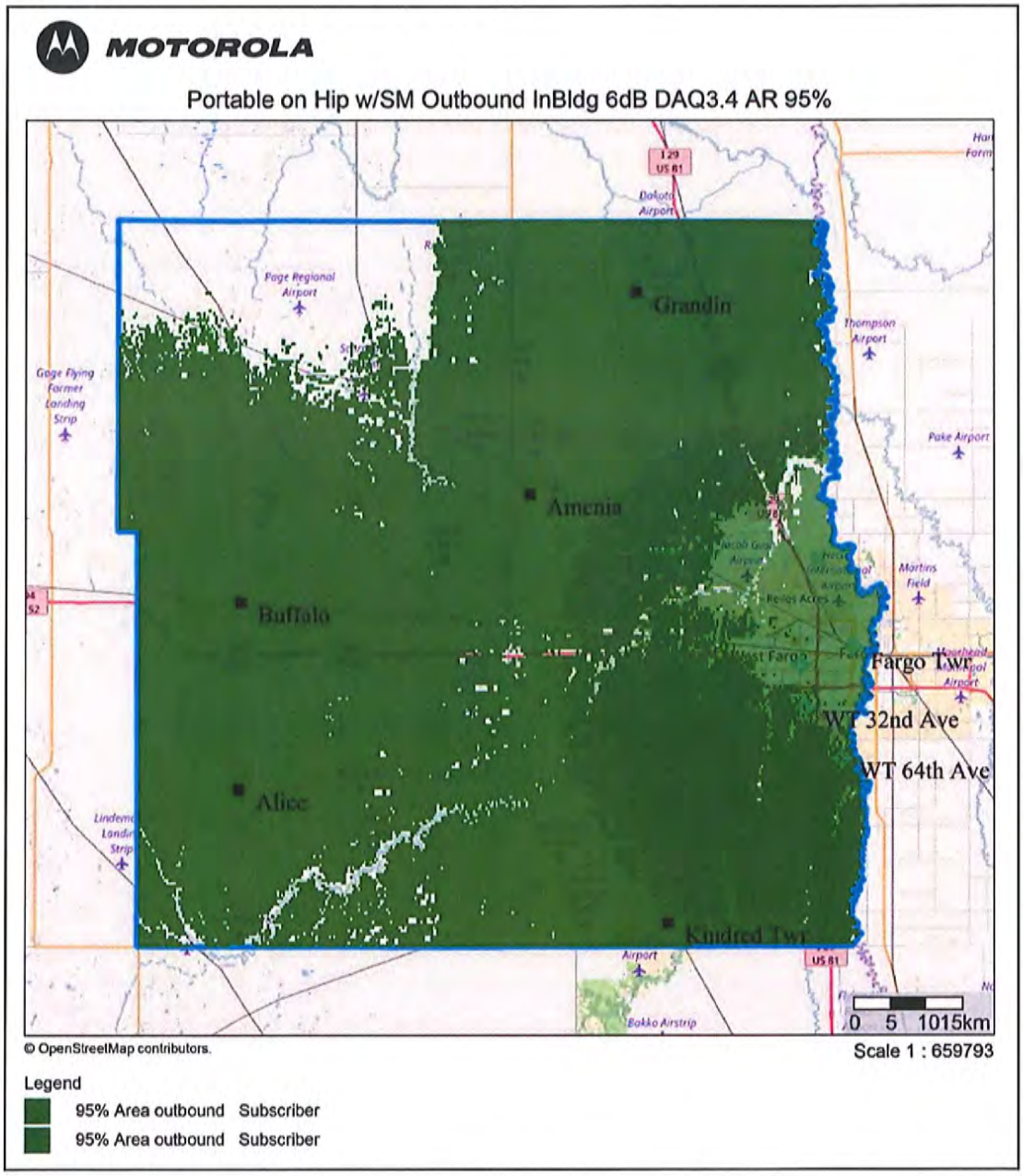
The proposed system's Talk-In coverage from portable radios when used outdoors looks very good throughout most of Cass County, with the exception of the far northwest corner. This issue is discussed in the summary of this section of the plan document. The coverage provided by the Fargo Simulcast sites is included in the Cass County maps.

Map 7: 800 MHz Talk In from Portable Radios 6dB Loss In-Building Cass County



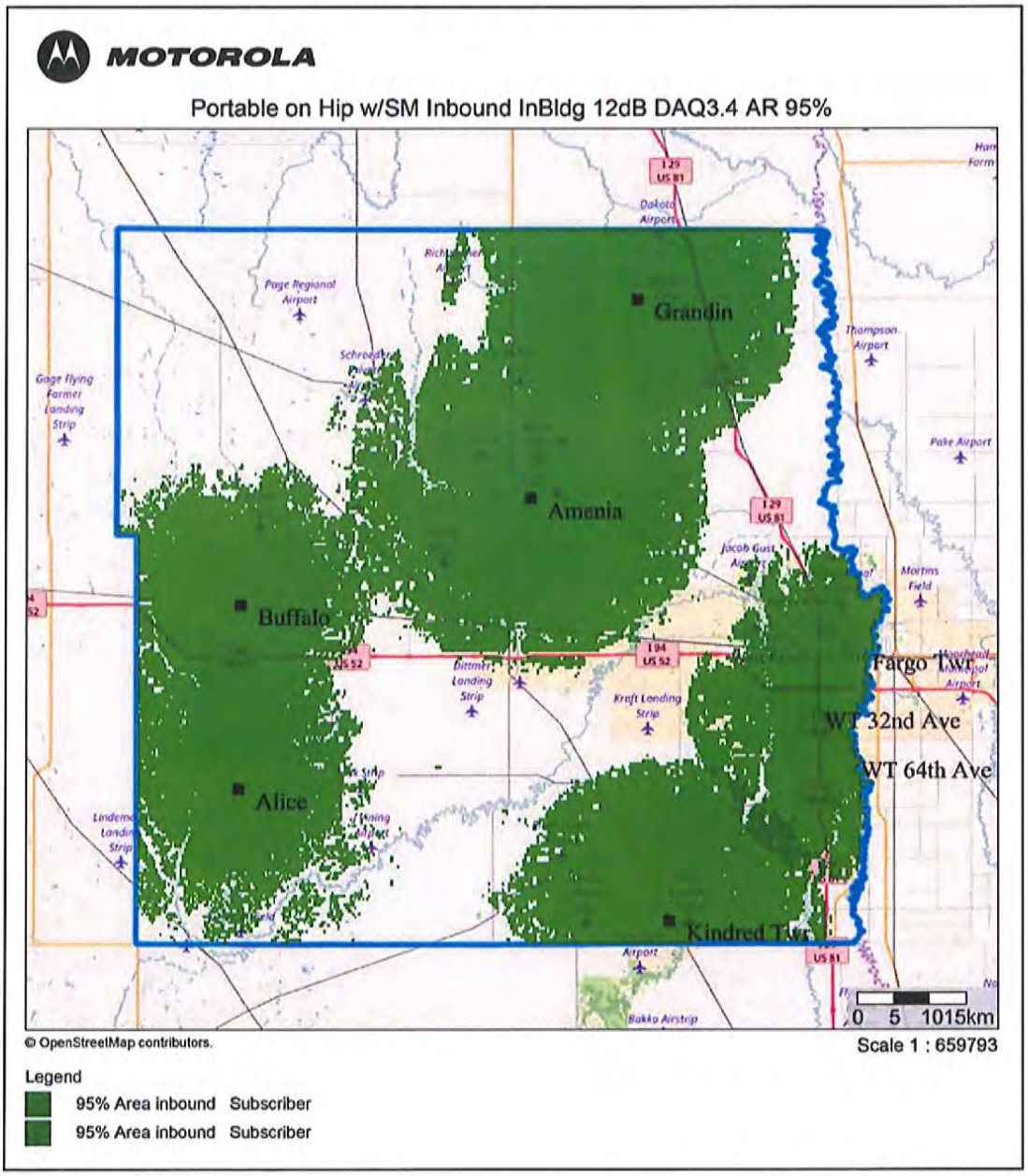
The proposed system's Talk-In coverage from portable radios when used inside 6dB loss buildings looks good throughout most of Cass County, with the exception of the far northwest corner, along with some other pockets north of Fargo, and the south central area of the county.

Map 8: 800 MHz Talk Out to Portable Radios
6dB Loss In-Building Cass County



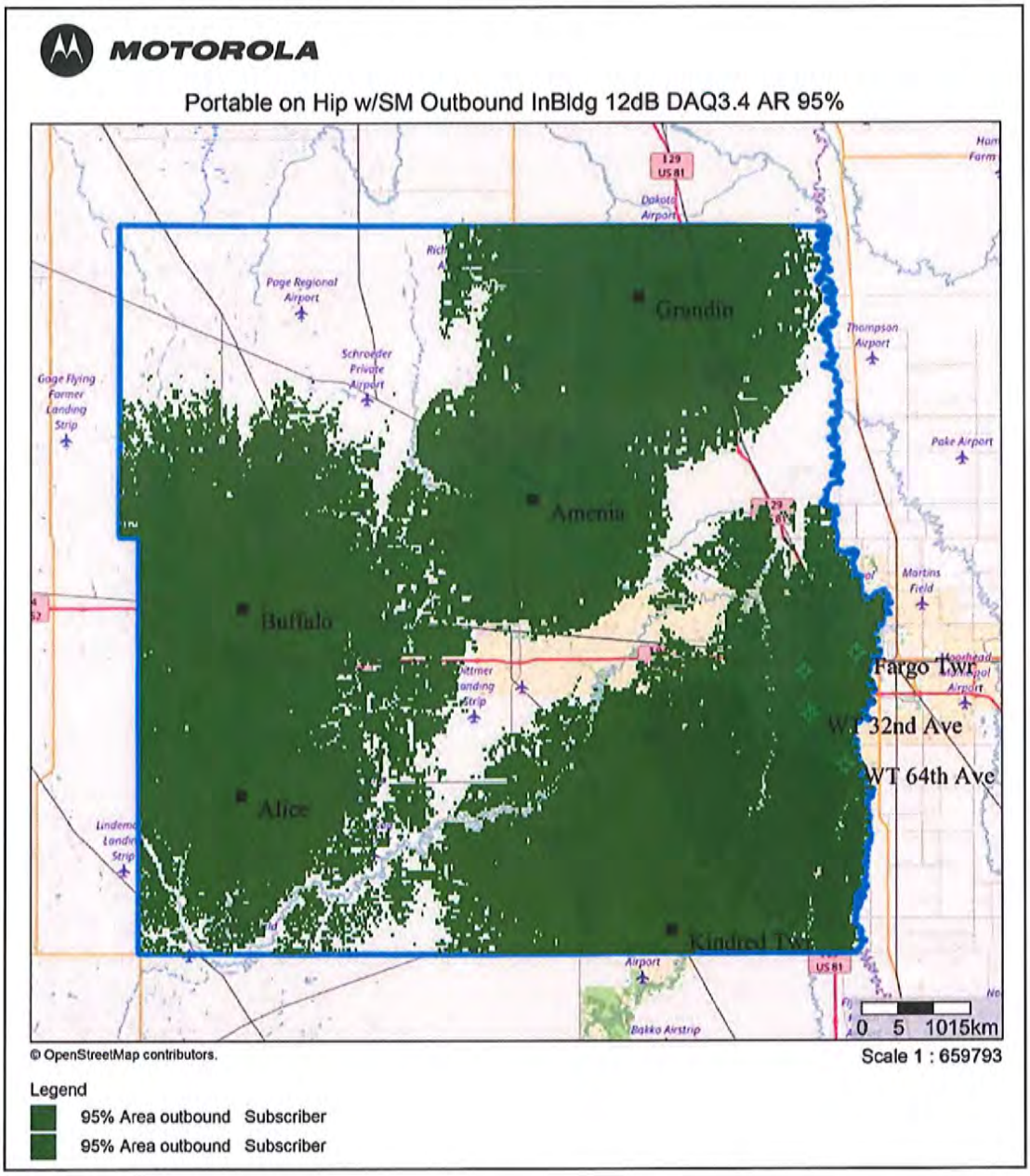
The proposed system's Talk-Out coverage to portable radios when used inside 6dB loss buildings looks good throughout most of Cass County, with the exception of the far northwest corner of the county.

Map 9: 800 MHz Talk In from Portable Radios
12dB Loss In-Building Cass County



The 12dB loss building Talk-In coverage from portable radios is where the "circles of coverage" drastically shrink, and because highly dependent on the radio's distance from the tower sites. Additional sites could be added to improve this coverage, but many of the areas shown in white do not necessarily have "12dB buildings" requiring radio coverage.

Map 10: 800 MHz Talk Out to Portable Radios
12dB Loss In-Building Cass County



The 12dB loss building Talk-Out coverage to portable radios is better than the "Talk In" coverage shown on Map 9, but again is dependent on the radio's distance from the tower sites.

Summary of coverage and maps: The Motorola computer-based maps for the proposed system indicate excellent On-Street portable radio coverage in most areas of the Fargo, West Fargo, and Cass County. The predicted 6dB and 12dB In-Building coverage for the Fargo/West Fargo areas is excellent. The 6dB In-Building coverage throughout Cass County is also very good in most areas. The 12dB In-Building coverage in Cass County is somewhat limited to a 5 to 8 mile radius of the tower site.

- ☐ It is important to keep in mind that 6db and 12db coverage only matters if there are building structures in these areas. In other words, if no building exists in an area shown with "less than 95% coverage", then there is not necessarily a problem.
- ☐ There are building structures in Fargo, West Fargo and Cass County that most certainly have greater than 12db loss factors. Typical examples of this are hospitals, schools, and steel buildings, especially those with no windows. The radio coverage in these locations will need to be tested once a new system is operational, and BDA's (in-building amplifiers) added as necessary.

It is understood that no radio system, public safety or otherwise, can be expected to provide 100% radio coverage. There exist too many variables in providing reliable radio signals to every area and building within the targeted coverage area. Developing a radio system to provide reliable coverage on a day-to-day basis can be an expensive process. The goal is to have a radio system that meets most daily communications needs, again with a typical target of 95% or greater reliability.

For those buildings that exceed 12db loss, and require solid in-building coverage, either the building owner, or the county, should consider the addition of in-building amplifier/boosters, also know as "BDA's" (Bi Directional Amplifiers). These devices should be considered on a case-by-case basis depending on the coverage needs for the location.

Coverage testing is included in the Motorola proposal; this is a process whereby they will assemble a testing team with radio coverage measurement equipment, and "drive the county" measuring the signal levels and digital Bit Error Rate (BER) in 1-mile grids throughout the county. BER testing is much more structured than the typical "Can you hear me now" process that has been used with previous testing. Motorola will provide a full report on the results of this testing process.

A final note is that Motorola (or any vendor) does not "guarantee" coverage for the whole county; what they will stand behind is the system coverage shown in these maps. If there is an area showing less than 95% and field testing shows no coverage, which is to be accepted by the customer.

D. Subscriber Radios

The conversion from VHF to a new 800 MHz Trunked Radio system will require the purchase, programming and installation of new mobile and portable radios for all Cass County, Fargo and West Fargo agencies. The following estimated quantities of new 800 MHz radios will be needed for the various user groups:

Agency	Mobiles	Portables	Ctl Stns
Fargo Police	100	235	
Fargo Fire	32	111	
Fargo Public Works	96	61	6
Fargo Utilities	59	13	
West Fargo Police	34	62	
West Fargo Fire	13	30	
West Fargo Public Works	70	16	2
Cass County Sheriff	70	70	4
Cass County Highway	54	12	1
Cass Co. Rural Fire/EMS	156	321	18
Totals	**684**	**931**	**31**

An estimated total of 1,646 radios will be needed to equip all Cass County, Fargo and West Fargo agencies with the new radios needed for the 800 MHz system. The above quantities include a variety of different models of radios, with various features, options, and associated pricing.

Cass County/Fargo recognizes and agrees that any radios implemented on this system will meet the criteria and requirements established by ARMER and MnDOT for 800 MHz mobile and portable radios to be used on the ARMER system.

E. Contingency Planning

In planning for ARMER system migration and connecting to the ARMER system the following failure modes are being addressed:

1. Loss of connectivity between the dispatch center and the 800 MHz and/or ARMER system.
2. Loss of network connectivity to the 800 MHz tower sites, which will result in the system reverting to Site Trunking mode.

The primary method of redundancy for Cass County operations will be the implementation of redundant links between the Cass County/Fargo Prime Site in Fargo and the Moorhead ARMER tower site, including fiber optic connectivity and microwave radio. In addition, multiple 800 MHz RF control stations will be implemented at the PSAP location. This would typically include one control station for each primary public safety discipline, such as:

- ☐ Law operations
- ☐ Fire operations
- ☐ EMS operations

If scenario 1 occurs, the PSAP loses direct connectivity with the ARMER network, and talk group access and control is lost. The control stations will allow the PSAP staff to access the county-specific and system interoperability talk groups over the air and function much like a mobile or portable radio.

If scenario 2 occurs, (local ARMER sites lose connectivity to the master site in Detroit Lakes, or the master site experiences a failure), the sites will revert to a site Trunking mode, which results the sites operating independently from each other. The effect on field units is that they can only communicate with each other if they are in range of the same tower site. If they are not, communication is not possible. This is due to the local sites and network operating in a multicast mode of operation (rather than simulcast).

The resulting effect on the dispatch center is the same; however, the county plans to implement multiple RF control stations at the dispatch center, with access to all of the tower sites within the county. The challenge with this approach is that the number of stations could be cumbersome and difficult to manage, depending on the number of talk groups incorporated in the backup station plan. A total of ten (10) 800 MHz RF control stations have been implemented at the RRRDC PSAP.

F. Training

Implementation of a new 800 MHz Trunked Radio system for Cass County/Fargo will follow the ARMER system requirement and associated operational standards which requires that all personnel who will be using the system receive proper training on the use, capabilities, and features of the system. Trunked radio systems, including the ARMER system, have operational requirements that differ from traditional conventional repeater systems, and it is necessary that dispatchers and end users be trained on the capabilities and proper operation of the system.

The Cass County/Fargo administration recognizes this need, and will conducted in-house training for the all radio system users. Additional training is planned through the services of independent contractors recognized by the state as proficient in the operation of the ARMER radio system. The program will include training for the following workgroups and functions:

- ☐ Radio end user training
- ☐ PSAP dispatchers
- ☐ Local system administrator
- ☐ Interoperability

Funding for the end user and dispatcher training has been included in the project budget.

G. Interoperability

The need for interoperability is a primary, driving factor in the Cass County/Fargo plan to adopt an 800 MHz radio system, due to Clay County/Moorhead's plan for a conversion from VHF to 800 MHz ARMER. Radio interoperability can exist at multiple levels within public safety radio operations. However, having all local public safety operations using a common radio system platform is the preferred and easiest method to establish good interoperability. The areas specifically addressed are:

Internal: Between the many agencies within the general jurisdictional are of Cass County and Fargo/West Fargo (i.e. law enforcement, fire service, and EMS agencies). The implementation of a common 800 MHz trunked radio system for all public safety agencies, as well as other units of local government, should resolve most interoperability communications issues that may currently exist.

External: Between the county agencies and other public safety (law, fire, and EMS) and government agencies operating both within and sharing borders with Cass County, to include the following:

- ☐ Clay County/City of Moorhead MN agencies
- ☐ Neighboring North Dakota agencies remaining on VHF radio systems and channels
- ☐ Norman County MN agencies

- Minnesota State Patrol, Mn/DOT, Department of Natural Resources (DNR) enforcement, and fire agencies operating on 800 MHz ARMER
- North Dakota State Patrol, DOT, DNR and other agencies operating on VHF system and channels
- Border Patrol and other Federal law enforcement and fire agencies

The Minnesota county agencies bordering Cass County are now ARMER system users (Becker, Wilkin, and Otter Tail), which improves and simplifies communications interoperability for those agencies if Cass County/Fargo converts to 800 MHz operation. However, interoperability with North Dakota agencies will continue to be a high priority, and these agencies will continue to operate on VHF systems for the foreseeable future. Cass County and the RRRDC intend to establish permanent patches between selected 800 MHz talk groups and local VHF channels, either through console or "hard" patches. These talk groups are incorporated into the master Fleet map included in this plan.

To accommodate other communications between agencies that may operate with Cass County that are not on the ARMER system in the short-term using legacy system technology, access to the ARMER radio system, a variety of interconnectivity options will be needed:

- The most basic requirement will be for Cass County to continue operation of their VLaw31 155.4750 MHz base station. This can be patched to an 800 MHz talk group via the PSAP console system when required.
- Cass County Fire and EMS agencies will maintain the use of VHF radios in their vehicles, in conjunction with new 800 MHz radios.
- Cass County repeater channels will be retained, and will become local "interoperability" channel resources, capable of being patched to the 800 MHz system, to allow local VHF radio users a simple and effective link to agencies operating on the 800 MHz system.

H. Standards

The primary technology standard applied to this project is that of the Project 25 (P25) ARMER system. The P25 standard is specifically for digital radios systems for public safety. In this case, the Phase 1 Frequency Division Multiple Access (FDMA) standard is currently in use.

Cass County will adopt and comply with the standards published by ARMER, the State Emergency Communications Board (MN SECB) and the Northwest Minnesota Regional Radio Board. Use of these standards will ensure that users of the Cass County/Fargo system will adopt the appropriate naming conventions, talk group usage, and other operational and technical standards that are in use throughout the ARMER system.

I. Alarms and Monitoring

The new system when purchased from Motorola would include Network Monitoring services through Motorola's NOC in Schaumburg. Cass County/Fargo will also be implementing an alarm and monitoring system for sites in the new system.

J. Maintenance

Cass County/Fargo plans to enter into a Maintenance Agreement with Motorola for service and maintenance of the primary 800 MHz tower site and system network equipment implemented for the new 800 MHz Trunked system.

If this application for ARMER system connectivity is approved, Cass County/Fargo agrees to maintain the system at the same required level of software version as is being used by the ARMER system.

K. System Administration

Local system administration for the proposed Cass County/Fargo system will be the responsibility of the Cass County Sheriff's Office, in conjunction with the RRRDC administration.

4. Project Costs and Budget

Funding for proposed 800 MHz Trunked Radio System for Cass County/Fargo agencies is being considered from three different sources:

- Local bonding
- Local levy
- Grant opportunities

Cass County and the City of Fargo have established a "line item" within the respective county and city budgets for the purchase and implementation of the new radio system, although the specific funding mechanism has not been finalized. Grant funding will be considered for the purchase and implementation of the other system equipment, and 800 MHz mobile and portable radios needed for public safety agencies.

Motorola will be the selected vendor for the 800 MHz radio system equipment needed for this project. They have provided Cass County/Fargo with a "Budgetary Proposal" for the equipment and services needed for the purchase and installation of a new radio system. A "Budgetary" proposal is a detailed proposal that addresses all of the technical and equipment requirements of the desired system, with the pricing based on nominal State Contract equipment and service rates. Once the final technical details are established for the new system, a final and formal proposal will be obtained and negotiated with the vendor for final pricing and options.

Project Cost Estimates:

	Project Element	**Est. Cost**
1A	800 MHz system equipment (repeaters, antennas, network technology, software, installation services, etc.) for Fargo/West Fargo Simulcast network	$2,536,052
1B	800 MHz system equipment (repeaters, antennas, network technology, software, installation services, etc.) for Cass County ASR network	$1,316,113
1C	Master/Zone Controller (Optional, may not be needed)	$1,665,391
	1st Year Maintenance Services (Included)	
	Subtotal for 800 MHz System	**$5,517,556**

Additional project equipment and services are shown on the next page.

In addition to the primary project items and costs shown above, other items will be needed for completion of the project:

	Project Item	**Est. Cost**
1D	Microwave Radio Equipment	$ 625,000
1E	Fiber Optic Equipment	$ 299,870
1F	System Coverage Testing (Motorola)	$ 35,000
2A	Buffalo Site Tower, Shelter and Civil Work	$ 150,000
2B	Fargo Prime Site Shelter and Civil Work	$ 205,000
2C	32nd Ave Water Tower Shelter and Civil Work	$ 127,500
2D	64th Ave Water Tower Shelter and Civil Work	$ 90,000
2E	US CBP Tower, Shelter and Civil Work	$ 295,000
2F	Alice Tower, Shelter and Civil Work	$ 167,500
2G	Kindred Tower Structural Review	$ 2,500
3	800 MHz Mobile and Portable Radios	$6,158,442
4A	Training for Dispatchers and Radio Users	$ 20,000
4B	FCC Licensing	$ 10,000
4C	Consulting & Project Management	$ 150,000
	Project Contingency	$ 700,000
	Subtotal for Other Project Items	**$9,035,812**
	Subtotal for Motorola (from prev. page)	**$5,517,556**
	Grand Total for Project	**$14,554,000**

5. Project Implementation

A. Schedule

The implementation of an 800 MHz radio network for an organizational group the size of Cass County and Fargo, with the number of agencies, tower sites, and quantity of radios being planned, would typically be expected to require a 12 to 24 month period to complete. There are several tower and water tower sites needing development and modification, in conjunction with the implementation of the new radio system equipment. Some existing microwave radio equipment may be reused, but new equipment will be needed for some locations.

Cass County, Fargo and associated agencies will continue to seek the funding needed to obtain the 800 MHz mobile and portable radios needed for public safety agencies. The RRRDC has recently completed the replacement of its Centracom Gold Elite radio dispatch console with a new Motorola MCC7500 console, and direct connectivity into the ARMER network.

The County will continue to use their existing VHF radio systems into the future until a new 800 MHz system is ready for use, and will retain such equipment as needed for Interoperability purposes.

As outlined in Section 3.0 Project Costs and Budget, the Cass County/Fargo administrations are prepared to move forward with establishing the funding for the new system, possibly later in 2017. Development of a new radio system could begin in 2018, with implementation completed in 2019.

Attachment 1: Cass County/Fargo 800 MHz Trunked System Fleet Map

	Law Enforcement Operations	TG Alias
1	Cass County LE Announcement TG	CS LAW ANNCE
2	Cass County Sheriff Primary	CS SO MAIN
3	Cass County Sheriff Alternate Encrypted	CS SO2E
4	Cass County Sheriff Alternate	CS SO3
5	Cass County Sheriff Alternate Car to Car	CS SO C2C
6	Cass County Sheriff Investigations	CS INV1E
7	Cass County Sheriff Investigations	CS INV2E
8	Cass County Jail	CS JAIL1
9	Cass County Public Safety Roam	CS PS ROAM
10	Cass County Law Emergency Button	CS EMER LAW
11	Fargo PD Primary	CS FGO PD1
12	Fargo PD Alternate	CS FGO PD2
13	Fargo PD Alternate	CS FGO PD3
14	Fargo PD Alternate Encrypted	CS FGO PD4E
15	Fargo PD Alternate- Car to Car	CS FGO PD C2C
16	Fargo PD Investigations Encrypted	CS FGO INV1E
17	Fargo PD Investigations Encrypted	CS FGO INV2E
18	West Fargo PD Primary	CS WF PD1
19	West Fargo PD Alternate	CS WF PD2
20	West Fargo PD Alternate Encrypted	CS WF PD3E
21	West Fargo PD Alternate- Car to Car	CS WF PD C2C
22	West Fargo PD Investigations Encrypted	CS WF INV1E
23	West Fargo PD Investigations Encrypted	CS WF INV2E
24	NDSU PD Primary	CS NDSUPD1
25	NDSU PD Alternate Encrypted	CS NDSUPD2E

Attachment 1: Cass County/Fargo 800 MHz System Fleet Map (continued)

	Fire and EMS	TG Alias
26	Cass County FIRE & EMS Announcement TG	CS FIRE ANNCE
27	Cass County Fire/EMS Primary	CS F/E MAIN
28	Cass County Fire/EMS Alternate 2	CS F/E 2
29	Cass County Fire/EMS Alternate 3	CS F/E 3
30	Cass County Fire/EMS Alternate Encrypted	CS F/E 4E
21	Fargo FD Primary	CS FGO FD1
32	Fargo FD Alternate 2	CS FGO FD2
33	Fargo FD Alternate 3	CS FGO FD3
34	Fargo FD Alternate 4 Encrypted	CS FGO FD4E
35	West Fargo FD Primary	CS WF FD1
36	West Fargo FD Alternate	CS WF FD2
37	Cass Co Fire Truck to Truck	CS FR C2C
38	Fargo Fire Truck to Truck	CS FGO FDC2C
39	West Fargo Fire Truck to Truck	CS WF FDC2C
40	Cass County Fire Emergency Button	CS EMER FIRE
41	Cass County FIRE & EMS Announcement TG	CS EMS ANNOUNCE
42	Cass County FM Ambulance Dispatch	CS FMA DSP
43	Cass County FM Ambulance Primary	CS FMA 1
44	Cass County FM Ambulance Alternate E	CS FMA 2E
45	Cass County Public Health	CS P HLTH 1
46	Cass Emergency Mangement	CS CO EM1
47	Fargo Emergency Mangement	CS FGO EM1

	Local Metro/County Interoperability	TG Alias
48	Cass County Announce TG	CS ANNOUNCE
49	Cass County Calling/Hailing TG	CS CALL
50	Cass County Operational TG	CS 1
51	Cass County Operational TG	CS 2
52	Cass County Operational TG	CS 3
53	Cass County Operational TG	CS 4
54	Cass County Operational TG	CS 5
55	Cass County Operational TG	CS 6
56	Cass County Operational TG	CS 7
57	Cass County Operational TG	CS 8
58	Cass County Operational TG	CS 9

59	Cass County Operational TG	CS 10
60	Cass County Operational TG	CS 11
61	Cass County Operational TG	CS 12
62	Cass County Common Encrypted	CS 13E
63	Cass County Common Encrypted	CS 14E
	Public Works and Schools	**TG Alias**
64	Cass County PW Announcement TG	CS PW ANNOUNCE
65	Cass County Highway Department	CS HWY1
66	Cass County Highway Department ALT	CS HWY2
67	Fargo Street	CS FGO PW1
68	Fargo Street	CS FGO PW2
69	Fargo Street	CS FGO PW3
70	Fargo Water/Wastewater	CS FGO WW1
71	Fargo Solid Waste	CS FGO SW1
72	West Fargo Street	CS WF PW1
73	West Fargo Street	CS WF PW2
74	Fargo Schools-Emergency	CS FGO SCH 911
75	West Fargo Schools-Security	CS WF SCH SEC
76	West Fargo Schools-Emergency	CS WF SCH 911
77	Fargo Schools-Security	CS FGO SCH SEC
78	Cass County School Future	CS SCH1
79	Cass County School Future	CS SCH2
80	Cass County PW 1 Future	CS PW 1
81	Cass County PW 2 Future	CS PW 2
82	Matbus-Metro Transit	CS MATBUS

All regional and statewide interoperability talk groups will be incorporated into Cass County radios as defined by ARMER standards.

Cass County – City of Fargo, North Dakota

Public Safety Radio System Analysis and Planning Project

Phase 2 Plan

March 2017

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Cass County-Fargo, North Dakota — Public Safety Radio System Planning

February 2017

Phase 2: Planning for a New 700/800 MHz Radio System

Introduction

The Phase 1 radio system report prepared by RFCC and presented to Cass County and Fargo in January 2017 provided a review of the existing Public Safety VHF P25 digital radio communications systems being used by Cass County, Fargo, West Fargo and dependent agencies. The report provided a summary of the status and condition of the system's equipment, tower sites, and connectivity, along with a review of the coverage and performance provided by the system to its user agencies.

The report included data regarding specific buildings and locations throughout the Fargo and West Fargo areas where ongoing performance problems are being experienced with this VHF system, which was purchased and installed in 2006, and is also now approaching the end of its equipment life cycle. The numerous Motorola Quantar base and repeater stations which form the core of the network are now a 20-year-old technology product, and obtaining repair parts and software will become problematic in the very near future.

Technology and radio Interoperability needs have also evolved over the past decade. While the 5-channel VHF system being used by Fargo city agencies, and the 3-channel VHF system used by Cass County agencies provided a huge improvement in public safety communications when implemented in 2006/2007, the needs of the city and county agencies have grown along with the population of the area, and these existing systems no longer provide the level of radio coverage (especially in-building) needed for effective operations. It also does not provide the channel capacity required by the numerous agencies using the systems. Another factor is the city of Moorhead and Clay County planning for a migration from VHF to the State of Minnesota 800 MHz ARMER radio network. Refer to the Phase 1 report for more detailed information about the VHF system status, issues and conclusions.

As a first step in addressing these concerns, the RRRDC in Fargo has recently replaced the aging Motorola Centracom radio control consoles with new MCC7500 radio consoles. These units are the newest technology platform from Motorola, and allow direct connectivity into the Minnesota ARMER Trunked Radio network, along with the upgrade to an IP-based technology.

As a result of this review process, and the issues and needs identified in Phase 1, Cass County, the cities of Fargo, West Fargo, and dependent agencies are planning for a change from the existing VHF system to a new 700/800 MHz Trunked radio network. Our work in this Phase 2 process and report will include a review of 700/800 MHz Trunked radio systems, along with the operational benefits available from the use of these systems. The report will also review the Minnesota 800 MHz ARMER system, and its impact on local Interoperability.

Additionally, Cass County/Fargo has received a budgetary proposal from Motorola for a new multi-site 800 MHz subnetwork, which would provide radio coverage expansion throughout the county, including Fargo, West Fargo, and all other areas of Cass County. We will review the predicted coverage data and costs in this report.

Many states throughout the U.S. have been working to implement "Statewide" radio networks. These networks provide a common radio system network and platform which can be used by state, county, city and other levels of governmental radio system users, and allows a sharing of costs along with greatly promoting radio interoperability with neighboring agencies. The State of Minnesota has now fully implemented the ARMER (Allied Radio Matrix for Enhanced Reliability) 800 MHz Trunked Radio network, a project that was started in 2002 and has been completed over the past few years. This system has been very successful, with 84 of the 87 counties in Minnesota now using the system on a full-time basis.

The State of North Dakota has been planning for the implementation of such a system for several years, but has struggled with the (significant) funding sources needed for the purchase, installation and operation of such a system. Cass County and Fargo/West Fargo have been watching the developments (or lack thereof) within North Dakota, participating in various committees and working with local legislators in an attempt to move this project forward, however there appears to be no near-term action to make this a reality. This is compounded by the state legislature only convening every two years; if funding is not approved during a given session, there is a two-year wait until the next opportunity for action.

It should be noted that even if North Dakota moves forward with a new statewide radio network at some point in the future, the tower sites and coverage provided by the system in the Cass County/Fargo/West Fargo areas would not meet the coverage or capacity needs of these agencies. Cass County, Fargo and West Fargo would need to implement a local subnetwork (as discussed within this report) to provided the required levels of coverage and capacity.

However, a Statewide system provides a key component needed for these systems: A Master or Zone Controller site, which serves as a "Host" or "Server" to operate and manage the network. This is a complex and expensive system element, costing $1 million or more. If there is no nearby State system to provide this device, Cass County/Fargo would need to purchase and maintain this device.

The Minnesota ARMER system is a driving factor in this discussion for several reasons:

- The City of Moorhead and Clay County, agencies who are dispatched by the RRRDC, will be moving away from their existing VHF radio system and be using the MN ARMER 800 MHz radio system sometime in 2017. Interoperability between Cass County/Fargo and Clay County/Moorhead agencies is a critical element of daily operations between these agencies.

  With all agencies currently operating on VHF radio systems, and several shared radio channels for Interoperability, radio communications between these agencies today is relatively simple. But this will change once Clay County and Moorhead convert to the 800 MHz ARMER system. There are plans to implement "patch" channels between the new 800 MHz system and the existing VHF channels which will continue to be used by Cass/Fargo agencies, but it will certainly be more complicated than the current operation.

- If Cass County/Fargo planned for the implementation of a local 700/800 MHz Trunked Radio network, it is technically feasible for a new Cass/Fargo multi-site subnetwork to operate through the ARMER system's Master/Zone Controller site located in the Detroit Lakes (MN) area. This would result in Cass/Fargo not needing to spend the estimated $1 million dollars on a new Master/Zone Controller to operate a new Trunked subnetwork.

  From a technical perspective, this is easily "do-able", and has already been done for numerous similar county-level subnetworks within Minnesota. Microwave radio connectivity between the Fargo/Moorhead area and Mn/DOT tower site in Detroit Lakes could easily be implemented for operation of a new Trunked subnetwork in the Cass/Fargo area.

  However, the operational and "business case" for allowing this to happen is potentially the bigger challenge. Funding for the purchase, operation and maintenance of the MN ARMER system is provided by a variety of funding sources, but primarily through MN State Trunked Highway Funds, along with the state's 9-1-1 telephone surcharge. The charter and bylaws of the ARMER system, and the use of these funding sources, generally allow the system to only be used by Minnesota-based agencies for daily radio operations. Other agencies (mainly Federal) are allowed and do use the system for Interoperability with Minnesota agencies, but again only for Interoperability.

  For a portion of the system to be used for daily primary operations by a group of public safety agencies geographically located outside of Minnesota will require both a persuasive business case and operational benefits to be established for this concept to be considered and approved. It will no doubt require a formula be established for Cass/Fargo to pay a fee for the use of the Detroit Lakes Master/Zone Controller site.

The various sections of this planning report will address all of these issues and concepts.

Work Overview

The approach to be taken for this radio system review and planning project will encompass multiple phases, as follows:

- Phase 1: Review of existing VHF system and operations (completed)
- Phase 2: Review of options for a new 700/800 MHz Trunked Radio system, including connectivity to the State of Minnesota 800 MHz ARMER network. Prepare a radio system planning report; Prepare and obtain approval of an ARMER Participation Plan with the State of Minnesota
- Phase 3: Assist Cass County/Fargo with the procurement and implementation of new 700/800 MHz network or subnetwork (optional)

This Phase 2 report is being provided to the Cass County and Fargo user group in advance of the actual ARMER Plan document, and will provide a review of the options available to Cass County and Fargo for a new 700/800 MHz Trunked Radio System or Subnetwork, and determine whether it is the appropriate solution for Cass County and Fargo public safety radio communications operations.

To accomplish this work, the following tasks have been conducted:

1. Provide a brief overview of 700/800 MHz Trunked Radio systems
2. Provide a review of the Minnesota ARMER 800 MHz Trunked Radio system
3. Provide a review of the State of North Dakota SIRN 20/20 radio system plans
4. Conduct a review of a 700/800 MHz Trunked Radio System for Cass County and Fargo:
   A. Technology and details of the new system
   B. Predicted radio coverage of the new system
   C. Tower and Water Tower Site work needed for a new system
   D. Mobile and portable radios needed for a new system
   E. Other Work needed for the Project
   F. Pricing and estimated costs of the new system
   G. Maintenance, site leasing and costs associated with the new system
5. Review the operational and administrative issues and factors associated with connecting the new system to the Minnesota ARMER network
6. Consider if there are any other viable radio system options that should be considered for Cass County and Fargo agencies
7. Prepare a summary with conclusions based on the above data

The results of this work are incorporated into this Phase 2 report.

1. 700/800 MHz Trunked Radio Systems

Trunked Radio Systems (TRS) have been used for commercial and public safety operations for over 30 years, dating back to the late 1970's.

Trunked Radio Systems can be developed to operate in many different radio frequency bands, including VHF, UHF and 700 or 800 MHz radio frequency bands, although the majority of "Statewide" public safety networks use 700 or 800 MHz channels. Some exceptions are the states of South Dakota, Nebraska and Wisconsin, which have chosen to use VHF channels in more rural areas (due to the large geographic areas needing to be covered, and limited population needing to use the system), although some of these VHF systems also use 700/800 MHz in the more populated cities and counties. The State of North Dakota's SIRN 20/20 Statewide radio plan follows this model, with the use of VHF planned for the rural areas, and 800 MHz sites for the more heavily populated areas (Fargo, Bismarck, Grand Forks, etc.).

TRS is a technology that uses a computer-managed network to allow the sharing of radio frequencies and associated repeaters among a large group of radio system users. Radio system frequencies and channels are considered a finite resource; while there are a somewhat limited number of 700 or 800 MHz frequencies, (though there are more of them than VHF frequencies), radio frequencies in general are considered a limited resource.

An important and critical difference in a Trunked System, vs. "conventional" systems (such as the VHF network now used in Cass/Fargo) is that the radio "channels" shown on a dispatcher's radio screen or the field user's radio are no longer a "frequency". With conventional VHF and UHF systems, a radio "Channel" = "Frequency". A separate frequency is needed for each radio channel.

In a Trunked System, the 700 or 800 MHz radio frequencies at the tower sites are dynamically assigned to the radio users on an "as needed" basis, for each radio channel being used. The computer system creates "Virtual" radio channels for the system's users. To try and avoid confusion between the terms "channels" and "frequencies", in a TRS the individual agency's channels are now referred to as "Talk Groups" (TG's). This term is somewhat logical, as most radio channels are assigned to and used by various agencies or groups of users (Law, Fire, EMS, Roads, etc.).

Talk Groups = "Virtual" Radio Channels.

If this at first seems confusing, fear not! Most radio system users (both dispatch and field personnel) rarely care what actual radio frequency is being used when communicating. It is far more important that personnel have selected the proper channel (Talk Group) where the specific operations are occurring.

The core concept being used within Trunked Systems is that only a limited number of radio users will talk at exactly the same time, and most transmissions are rarely longer than 10 or 12 seconds. This technology has been used in telephone systems for decades, and operates on the same principle. This allows the core repeater channels to be used on an "as needed" basis by the different agencies using the system.

This process is again in contrast to the conventional VHF systems now being used for Cass/Fargo agencies. In the current system, there are dedicated repeaters and channels for each agency's operations. As detailed in the Phase 1 report, there are for example:

- 2 repeaters for Fargo Police
- 2 repeaters for Fargo Fire
- 1 repeater for Fargo Metro ops
- 2 repeaters for Fargo Public Works
- 1 repeater for West Fargo Police
- 1 repeater for West Fargo Fire
- 2 repeaters for Cass County Sheriff
- 1 repeater for Cass County Fire/Local Government
- 1 repeater for Cass County Highway
- ...and others

As shown, there are at least 13 repeater channels in place for use by the various local agencies (and many of these repeaters are duplicated at multiple tower sites). However, as an example, the Fargo Police Department needs more than two wide-area repeater channels (now available) for an operation that involves 168 police officers! (Fargo PD is the largest law enforcement agency in the state of North Dakota). But it is not wise or really possible for FPD to use any of these other repeater channels for their operations (if both FPD repeater channels are busy, they can't use the FFD repeater channels).

As shown above in the list of VHF repeater channels for Cass/Fargo agencies, there is now a large group of repeaters that are only available for singular purposes. If additional repeater channels are needed, it is an expensive process, because every new county-wide channel [in a VHF conventional system] requires that new repeaters be purchased, licensed and installed at the tower sites, along with the associated antennas, transmission lines, and the monthly site rental costs (with some locations).

Trunked Systems resolve this problem. A key benefit of Trunked Systems is that it allows a greatly expanded radio channel (Talk Group) inventory for the agencies using the system. In a Trunked System, because the "channels" (Talk Groups) are no longer tied to a specific frequency or repeater (and function as "virtual" channels), the system can support a much greater number of channels (Talk Groups) for the

local radio users. It is not uncommon for a Trunked System tower site to be able to support 50 to 75 Talk Groups for local agencies and operations.

Another challenge with the existing VHF system is that the coverage from these channels in the system is somewhat "geographically localized", which means that (for example) the repeater channels used by Fargo agencies are only available in the Fargo service area. They do not provide reliable coverage once outside the Fargo city area, especially for portable radio users. The same is true for the Cass County channels, which have the main repeaters located at the Amenia tower site in the central area of the county. A secondary repeater site is located at the County Annex in Fargo, but this site does not provide good portable and in-building coverage throughout Fargo and West Fargo.

Trunked Systems can again address this issue, as the tower sites within the larger geographic service can be programmed to handle the radio traffic from the Talk Groups established for all local user agencies. This would, for example, allow Fargo Police talk groups to be used in many areas of Cass County where it is not possible today. And Cass County law talk groups would work through the 4-site Simulcast network in the Fargo city areas.

This "roaming" feature is also available on a wider-area basis when statewide systems are in use, such as the MN ARMER system. Fargo and Cass County agency radios could roam into the Clay County area of Minnesota and work through the ARMER system, allowing direct Interoperability with these neighboring agencies.

While the reader of this report might think that "Trunking" for radio systems is a relatively new technology, it has been used for commercial radio systems since the early 1980's. Its use in public safety has been slowly accepted since that time, along with the use of P25 digital technology. Each Trunked System tower site is typically equipped with five to ten 700 or 800 MHz repeaters; these repeaters are then dynamically assigned to the radio user Talk Groups on an as-needed basis.

Another important technical element included in these systems is the use of APCO P25 (referred to as P25) digital modulation technology, which has become accepted as the industry standard for public safety. The first generation of P25 is "Phase 1" and uses what is known as FDMA modulation technology. FDMA (Frequency Division Multiple Access) provides one "talk path" per repeater channel or frequency. P25 Phase 1 is currently being used in the Minnesota ARMER system, and most other 800 MHz statewide systems. P25 digital modulation is currently being used in the existing Cass, Fargo and West Fargo VHF repeater systems.

As one might assume, Trunked Radio Systems are also somewhat complex, depending on the number of tower sites within the network, although – to a certain extent – no more complex (in terms of the number of tower sites and repeater channels) than the existing Cass/Fargo/West Fargo VHF network. The added complexity is due to the computer-managed operation of the system.

The purpose, need and implementation of statewide radio networks is a concept which has been gaining significant support over the past decade or more. The primary purpose is to establish a single, common radio network that can be shared by any or all public safety agencies that choose to use it. A common radio network platform, if properly designed and implemented, can provide significant performance improvements for the radio users, and greatly enhances Interoperability between agencies for both day-to-day operations, as well as larger scale emergency events.

States in the Midwest that have implemented statewide radio systems in recent years include Minnesota (ARMER), South Dakota, Nebraska (SRS), Wisconsin (WISCOM), Illinois (Starcom), Michigan, Colorado, Ohio, and others around the country. We (RFCC) have spent the last several years working with over 25 counties in Minnesota converting from local VHF systems to the ARMER 800 MHz network. The ARMER system is a huge success, with 84 of the 87 counties have now converted to the ARMER system. The State of Iowa is currently in the process of implementing a new 700 MHz P25 statewide Trunked System for public safety operations.

From our experience working with numerous agencies converting to the use of a state network, we greatly support the use of these statewide networks.

The State of North Dakota has been planning for the implementation of a new statewide radio network (SIRN 20/20) for many years, which included recent planning work conducted by Televate Consulting in 2014, and some preliminary conceptual work prior to that time. However, as is often the situation with large (and expensive) system projects, it requires years for all of the critical elements to come together (including technical details, agency support, costs of implementation, and funding) for the system. As noted in the introductory section of this planning report, as of this time there has been no further action or movement towards the funding of the new system, and there is no planned implementation date for this new system.

However, the Minnesota ARMER system currently has the potential for a greater impact on Cass/Fargo radio operations. Clay County and Moorhead agencies and operations are planning to convert from existing VHF radio systems to the ARMER 800 MHz system in late 2017. This move from VHF to 800 MHz Trunking will present a radio Interoperability challenge between the Clay/Moorhead and Cass/Fargo agencies. Refer to Section 2. of this report for a more detailed review of the ARMER system.

Regardless of the type of radio system, the universal goals for any public safety radio system focus on four core elements:

- Coverage
- Capacity
- Reliability
- Redundancy

The key factors within each of these goals are:

- Coverage: The system needs to have enough tower sites, designed and/or tall enough, to provide the required level of coverage for the local agencies service area. Statewide systems are often designed with a basic level of coverage, and additional sites can be added by local agencies if more coverage is needed.

  An important use of the tower sites in the system is the ability of radio users to "roam" automatically between tower sites as needed. The system uses the measured signal strength of the radios to direct the radios to the best tower site. The mobile and portable radios are constantly measuring the signal strength from the tower site, and will automatically switch to a different tower site with a better signal. This includes other tower sites that may be outside the county boundaries.

- Capacity: The system should provide enough "channel" capacity to support all agencies using the system and tower sites. In a Trunked System, capacity is greatly expanded over conventional systems through the dynamic assignment of frequencies for use as talk paths (Talk Groups or Channels) for agencies using the system. The system also needs to provide easy to use Interoperability between neighboring agencies.

- Reliability: A system should utilize a high level of equipment and technology to minimize the possibility of equipment or system failure, in conjunction with meeting user coverage requirements. This includes multiple tower sites, connectivity paths, backup AC power and generators at tower sites, alarm systems, lightning and grounding protection, and other critical elements.

- Redundancy: The system should be designed with enough overlap between sites, along with backup systems, to ensure that the failure of any one site, repeater, or link results in a loss of system access for user agencies.

Any new system planned for Cass County/Fargo implementation will incorporate all of these requirements into the core system design, to ensure the primary goals are met.

A Trunked Radio System, using 800 MHz RF channels, is the preferred and recommended solution for Cass County/Fargo/West Fargo public safety and governmental communications and operations.

2. State of Minnesota 800 MHz ARMER System

The initial planning for the development of the ARMER system began back in 2000, and the purchase and installation shortly thereafter. The first tower sites became operational in 2002 in the Minneapolis/St. Paul metropolitan area, with the Rochester and St. Cloud areas by 2005. The next major surge of development commenced in 2008, and continued steadily through 2015, when the system reached approximately 95% completion. At that time, most of the tower sites were completed and on the air. There are currently a few remaining tower sites in remote areas near the Canadian border that are being developed.

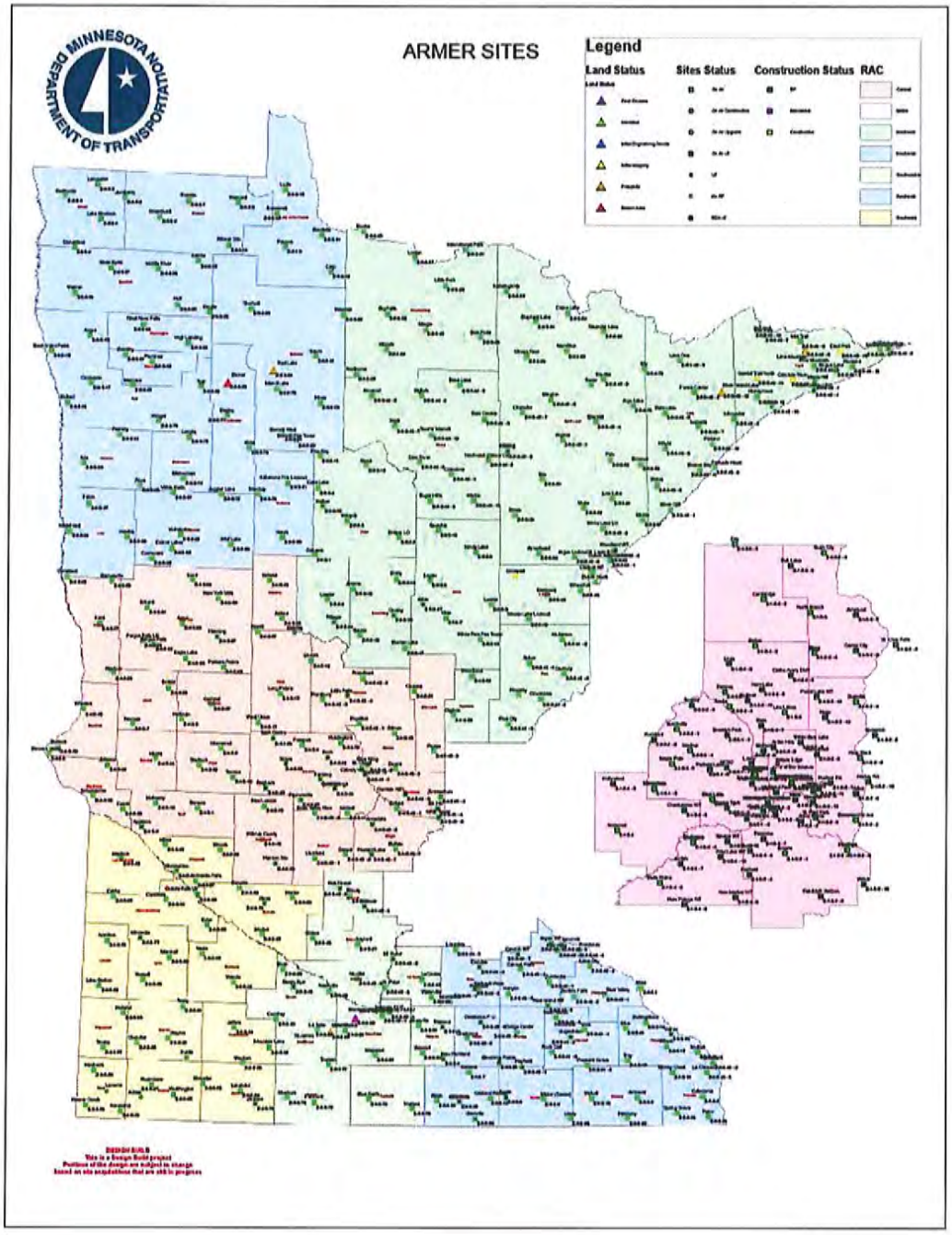
At the time of this report being prepared, 84 of the 87 counties in Minnesota have converted to the ARMER system for daily operations use. The ARMER system is considered one of the most successful statewide radio systems in the country. A key element to the success of the system is that there are no radio user fees being charged to the agencies using the system. The purchase, installation and operation of the system has been and continues to be funded by State of Minnesota Trunk Highway funds, in conjunction with 9-1-1 telephone surcharge fees. This is in contrast to many of the other statewide systems, which typically charge $20 - $50 per radio per month for use of the system. The State of Iowa has recently adopted the "ARMER model" for their ISICS 700 MHz system, whereby there are no user fees for city, county and state agencies who choose to use the system.

The ARMER 800 MHz system currently has approximately 325 tower sites around the state, with another 100 "Local enhancement" sites added by city and county agencies for increased local portable radio coverage and capacity. The system was initially designed to provide a mix of coverage for both Mobile (vehicle-mounted) radios and Portable (hand held) radios. As can be expected, the number of tower sites needed for portable radio coverage is much greater than what is needed for mobile coverage.

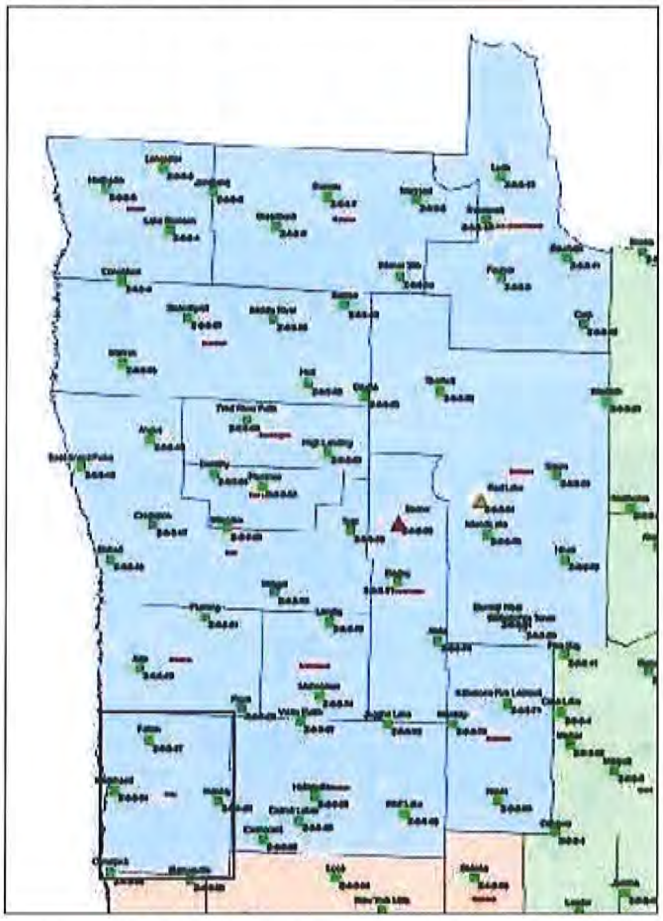
As a result, city and county agencies interested in joining the system, and desiring a higher level of portable radio coverage (both outdoor and in-building) bear the responsibility of adding local tower sites, which are then connected into the statewide network. These added tower sites are known as "Local Enhancement" sites.

Provided on the next page is a map of the Minnesota ARMER system, showing the tower site locations and the Regions of system in the state.

State of Minnesota ARMER System Map



Cass County and Fargo adjoin the Northwest Region of the ARMER system. Shown below is a map with greater detail of the Northwest Region (Clay County is highlighted with a black line border):



As noted in the previous section of the report, Clay County and the City of Moorhead public safety agencies are planning to move from their existing VHF radio systems to the ARMER 800 MHz system at some point in later 2017. All of the other counties in the Region bordering North Dakota have now converted to the ARMER system. The only counties in Minnesota that have not fully converted to ARMER operation are Red Lake, Clearwater and Beltrami, although Beltrami is now in the process of expanding their ARMER use.

All of the tower sites in the Northwest Region are connected by microwave radio to the Master/Zone Controller Site, which is located at the MnDOT facility in Detroit Lakes. It is this device that is an important element in the plan to migrate Cass County/Fargo to a new Trunked Radio System.

3. State of North Dakota SIRN 20/20 Radio System

The State of North Dakota has been working to plan for a new statewide radio system for several years. This system has been named "SIRN 20/20" (Statewide Interoperable Radio Network). This process has been underway for several years, which came into focus with a study and report conducted by Televate, a communications consulting firm.

This work resulted in a conclusion that a new statewide radio network is needed; this system would use Trunked Radio System technology, with VHF tower sites in the more rural areas, and 800 MHz sites in the more populated areas. This again is the approach being used by the states of Nebraska and Wisconsin. The following link provides more information about the program and related activities:

https://www.nd.gov/itd/statewide-alliances/siec/sirn-2020

The estimated cost for the new system infrastructure (tower sites, repeaters, network equipment, dispatch center equipment, etc.) was estimated between $73 million and $105 million, dependent on final system design. The estimated cost of mobile and portable radio "subscriber" equipment ranges from $57 million to $90 million dollars. The annual operating costs for the new system were estimated at between $9.6 million and $12.9 million dollars. These costs are typical for large statewide radio systems.

The approach and basic design of the new system appears to be sound, and similar in many ways to the systems implemented by other states.

The current funding sources for SIRN 20/20 are uncertain, with no defined sources identified or established. Any possible funding sources currently being debated by 2017 North Dakota legislature are not directed toward local RF infrastructure or subscriber needs within SIRN 20/20. With the uncertainty and lack of project timelines, this option cannot currently be effectively reviewed or considered. As such, no further review of this system is included in this plan and report."

A closing comment on this topic is that at such time North Dakota moves forward with a new system, any new system equipment purchased and installed by Cass County and Fargo will be compatible with the North Dakota system.

4. 800 MHz Radio Network for Cass County and Fargo

With the understanding and conclusion that the best solution for the Cass County and Fargo area agencies and operations is an 800 MHz Trunked Radio System, this section of the report provides a detailed review of the system planning that has been conducted for this project. Included is a review of the coverage and performance to be expected from the system, the equipment and services required for implementation, and the expected costs of a new system.

Also provided is a review of the operational, technical and administrative considerations to be addressed for the connection and operation of the new subnetwork through the Minnesota ARMER radio system.

A. Technical Details of an 800 MHz Network for Cass County/Fargo

The Cass County/Fargo/RRRDC technical staff (Brian Zastoupil) and RFCC have been working together to determine the technical design for a new 700/800 MHz Trunked Radio Network to serve the Cass County and Fargo agencies and geographic operational area. This planning and design work has also been shared with Motorola for the preparation of a budgetary system proposal, and the provision of predicted-coverage maps for a new system.

One of the goals within this project is to reuse existing tower and/or water tower sites where possible, to minimize the costs associated with the construction of new sites, and/or the leasing costs associated with additional sites. We believe the plan created for the new meets the goals of this mission.

We have used the terms "network" and "subnetwork" within this report when referring to a new radio system. Although the two terms are similar, and both would use the same number of tower sites, they differ somewhat:

- "Network" implies an independent, self-contained system that is fully self-sufficient, and does not rely on any other outside network for operation. This also generally implies that the system has a local Master Site/Zone Controller for operation and management of the system. This system may be interconnected to other neighboring systems, but is inherently a self-contained system.

- "Subnetwork" implies that the local system is part of and connected to a larger network using the same technology. For example, if Cass County/Fargo were to implement the 9-site 800 MHz system being outlined in this plan, but the sites were connected to and managed through the ARMER Master Site/Zone Controller in Detroit Lakes, then the local group of tower sites and equipment are considered a "Subnetwork" of the ARMER system.

The implementation of this new Trunked Radio System will require the complete replacement of all existing radio system equipment, to include:

- 800 MHz Repeaters at tower sites (including antennas, transmission lines, grounding and lightning equipment, power supplies, network routing and management equipment, and related items)
- Dispatch consoles at the RRRDC facility (recently completed)
- Network control and management devices
- 800 MHz frequencies and FCC licenses (for operation of the repeaters)
- 800 MHz mobile and portable radios (for user agencies)

In addition the replacement of these items, some existing system elements may be reused and upgraded as needed for the new system:

- Tower and water tower sites (including shelters, generators, etc.)
- Microwave radio links between tower sites

This planning document provides details on all of these topics.

1) <u>Primary System Technology:</u>

The new system will be a Trunked Radio System, operating on 700 or 800 MHz radio frequencies, with multiple tower sites to provide high-level coverage to all areas of Cass County, Fargo and West Fargo. The system and sites will be equipped with an appropriate number of RF channels to handle the expected radio traffic from all public safety, public works, and other local governmental agencies.

The new system has been planned with a total of nine (9) tower sites; four of the sites will serve the Fargo and West Fargo geographical areas, and five tower sites are planned for the rural Cass County area:

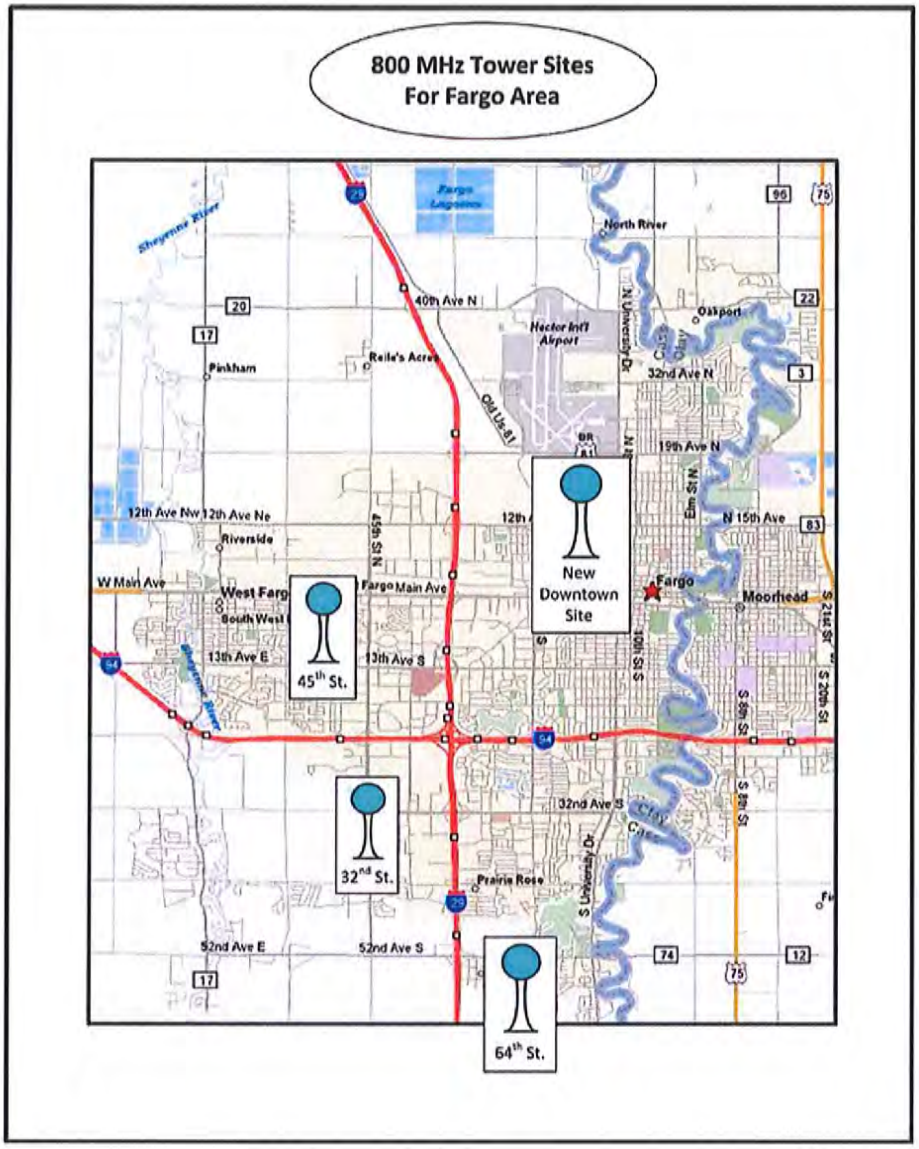
Fargo/West Fargo Sites:

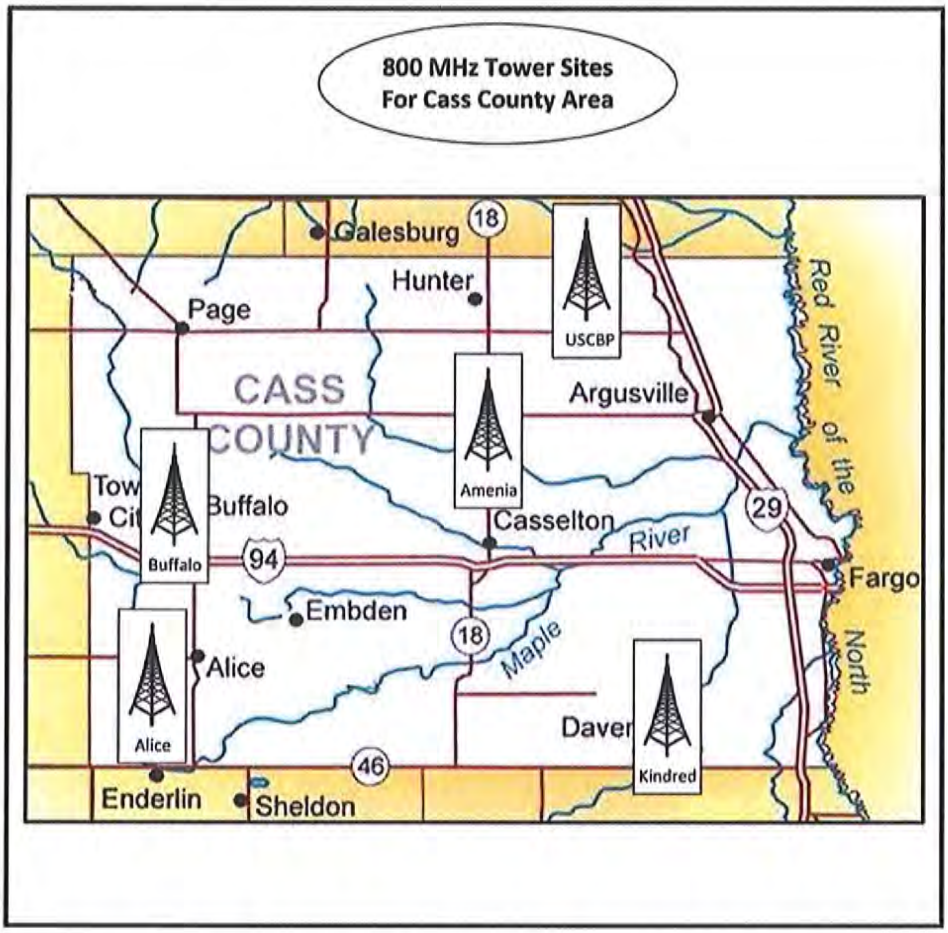
- New downtown water tower
- 45th Street water tower
- 32nd Avenue water tower (new)
- 64th Avenue water tower

Cass County Sites:

- Amenia tower
- US Customs & Border Patrol tower
- Buffalo tower (new)
- Kindred tower
- Alice tower (new)

Provided below are maps showing the general locations of the proposed tower and water tower sites for the Fargo and Cass County 800 MHz system.





Specific details about these sites are provided in the next section of this report. The new system will be configured into two separate (but fully integrated and interactive) subnetworks:

- Fargo/West Fargo: 4-site Simulcast, ten (10) 800 MHz RF channels
- Cass County: 5-site ASR, five (5) 800 MHz RF channels per site

The new system will utilize APCO P25 Phase 1 (FDMA) modulation technology (and associated features), along with other current radio system technologies. The primary technologies incorporated into the new system to improve radio system coverage are:

a. Simulcast Transmission
b. Voting Receivers
c. Multicast Transmission
d. Automatic Site Selection

These technology features function as follows:

a. Simulcast Transmission is a feature where all of the tower sites within a group of sites transmits simultaneously on the same radio channel or Talk Group (i.e., Law Ops, Fire Tac, etc.) and on the same radio frequencies. This allows a single operations channel or Talk Group to have coverage from multiple tower sites at the same time, and provides a much larger "footprint" than it would from a single tower site. With this technology, the same transmit frequency is used at each tower site.

   In the proposed design, the four Fargo/West Fargo area tower sites will operate with this technology. As a result, there is a significant increase in signal levels in the service area between the tower sites, especially for in-building coverage. When field units are operating within the area formed by these sites, signal will be transmitted from each site "simultaneously", and the signals from these sites overlap and compound in the field (they are additive). A Simulcast system is somewhat complex technology, and requires special equipment at the tower sites for proper operation, but provides significant improvement for in-building coverage use. This technology is being used by the existing Fargo VHF radio system.

b. Voting Receivers: Like Simulcast, the repeater receivers within a tower site group all operate on the same frequency for the same radio channel or Talk Group. This allows the transmissions from a field unit to potentially be heard at multiple tower sites, rather than just a single site. This feature again greatly improves in-building and overall portable radio coverage. This will be included in the 4-site Fargo Simulcast group of tower sites. This technology is again being used by the existing Fargo VHF radio system, as well as the Cass County VHF system.

c. Multicast is a feature where each of the tower sites transmits simultaneously on the same radio channel or Talk Group (i.e., Law Ops, Fire Tac, etc.) but on separate radio frequencies. This allows each Talk Group to have coverage from multiple tower sites at the same time, and provides a much larger "footprint" than it would from a single tower site. With this technology, a separate transmit frequency (and FCC license) is needed for each tower site. Sites that operate in this mode are known as "ASR" sites (vs. Simulcast).

   This technology is most often used for sites located in more rural areas. However, these sites are still linked to the main network, and will activate when units are in range of the site, and automatically route the proper Talk Group traffic to field units in the area.

   This technology will be used for the five tower sites planned for rural Cass County.

d. Automatic Site Selection is a feature that "steers" the user's mobile or portable radio to the proper tower site based on signal strength or digital Bit Error Rate (on the proper frequency), eliminating the need for the user to manually select tower sites on the radio, based on their physical or geographical location in the county. As such, the radio "roams" between sites, based on the signal strength from the radio and tower site. This is a core feature of Minnesota ARMER system, and provides a high degree of reliability when used within a Trunked Radio System.

The combination of these technologies, along with the tower sites and equipment planned for the new system, will give Cass County and Fargo agencies a system that provides excellent coverage for mobile and portable radios, both on-street and in-building throughout the city and county areas.

Refer to Section 4.B. for a review of the radio coverage expected from the new system.

2) Tower Sites:

The new system requires nine (9) tower sites for the installation and operation of the system repeater and networking equipment. As noted in an earlier section, one of the goals of the project was to continue using existing sites where possible, and if appropriate for the project. Careful planning and consideration has been given to the sites needed for this project, as the development of new sites can be expensive, whether the costs are for the construction of a new tower, or the leasing of space on an existing commercial site.

In general, the tower sites within a metropolitan area do not need to be as tall as sites that serve the larger rural areas, due to the priority of in-building coverage and penetration throughout a fairly small area (~ 62 sq. miles), vs. providing radio signals over a large county area (~ 1,700 sq. miles). The taller the tower (and antennas), the greater distance the signal will reach. However, antennas mounted at the 250 feet or higher level actually "overshoot" some areas near the tower site. While these higher sites again provide good wide-area signal coverage, they often do not provide the in-building penetration needed in the more dense populated areas.

As shown in the list above (4.A.1.), the sites needed for this system are grouped into two areas: The sites needed in the Fargo/West Fargo area, and the sites needed for Cass County. A review of these sites and the work needed at each is provided in Section 4.D. of this document.

3) 700/800 MHz Frequencies and FCC Licensing:

The new radio system will require the identification and licensing of new 700 and/or 800 MHz radio frequencies for operation of the system. There has been some discussion about whether the new system should utilize radio channels from the 700 or 800 MHz spectrum. Note that frequencies from the 700 and 800 MHz spectrum allocated for public safety radio system use operate essentially the same in terms of coverage and performance. When initially allocated by the FCC for use, the 700 MHz band channels had some restrictions requiring P25 Phase 2 modulation use (TDMA), but that has since been rescinded. As such, in theory either type of frequencies could be used for this system.

However, many of the 800 MHz mobile and portable radios being used by neighboring Minnesota agencies on the ARMER system are older units, not capable of operation on the 700 MHz band. Because Interoperability is critical for this proposed system, it would potentially be unwise to use 700 MHz for the system. As such, it is concluded that 800 MHz frequencies would best serve the goals of the new system.

The potential challenge with the use of 800 MHz frequencies is to ensure that there are enough frequencies available for operation of the system. The 800 MHz frequency band has been used for over 30 years, and in many populated areas (such as the Minneapolis/St. Paul metropolitan area) there are no 800 MHz frequencies available for any system expansions if needed (all are being used by local agencies).

Each state within the U.S. has developed a "NPSPAC" (National Public Safety Planning Advisory Committee) Plan for the allocation of 700 and 800 MHz frequencies for use by agencies within their state. Additionally, there is another pool of "Public Safety" frequencies for use by local and state agencies. The channels for use by non-state agencies are assigned at the "county" level, for use by all agencies within the given county.

For Cass County, a group of 14 NPSPAC 800 MHz frequencies have been designated and/or assigned within the North Dakota NPSPAC plan:

Table of 800 MHz NPSPAC Region 32 (North Dakota) Channel Assignments to Cass County ND

	Chan. No.	Status
1	610	Dedicated
2	630	Dedicated
3	648	Shared
4	685	Shared
5	698	Shared

6	705	Shared
7	723	Shared
8	743	Shared
9	746	Dedicated
10	761	Dedicated
11	781	Shared
12	802	Shared
13	816	Shared
14	821	Dedicated

As noted above, some channels have been dedicated or assigned for exclusive use by the agency, while some may be shared with others. Within the 800 MHz frequency band assignments, a 70-mile separation rule has been established for the reuse of any specific frequency. A similar rule exists for the VHF channel band, but in 700 and 800 MHz it is especially effective, as these frequencies do not experience "skip" conditions, and have a very finite service area, which allows the effective and interference-free reuse of these channels.

A total of 35 800 MHz channels will be needed for the new Cass County/Fargo system:

- 10 for the Fargo Simulcast network
- 25 for the Cass County ASR network (5 sites x 5 channels each)

There are not enough 800 MHz frequencies within the existing NPSPAC plan assignment for operation of the new system. However, there are other options to obtain the frequencies needed for the system:

- Reuse of other NPSPAC channels allocated to other counties around North Dakota
- Use of 800 MHz channels from the non-NPSPAC "Public Safety" pool of channels

Either or both of these options will easily meet the RF channel needs of the new system, due to the extremely limited use of 800 MHz systems throughout North Dakota. If for some reason 700 MHz RF channels were to be used for the system, the North Dakota plan has allocated 19 700 MHz channels for use in the Cass County area.

It will be important, however, to coordinate frequency assignments and FCC licensing with neighboring State of Minnesota ARMER sites, although this is not expected to be a problem. At such time that Cass County/Fargo are ready to move forward with the actual implementation of this system, a full 800 MHz frequency search will be conducted to identify the other RF channels to be used with the system.

4) Network Connectivity

The new radio system will require connectivity between the many tower sites, as well as the RRRDC (dispatch) in downtown Fargo. The existing VHF system currently uses several different connection technologies to meet this need:

- Microwave radio links (both licensed and unlicensed)
- Fiber Optic cable
- Leased circuits from local telephone companies

Microwave radio links are the preferred solution for connectivity to sites located in rural areas, due the high cost of installing fiber optic cabling over great distances to rural tower sites. Fiber optic is a preferred solution within the larger city and metropolitan areas, where the sites are closer together, and the local city governments often own a dedicated fiber network (vs. paying a local communications provider).

This is the case with the City of Fargo, as they have been expanding their fiber network over the past several years, with reliable connectivity throughout much of the city. As such, fiber optic will be the primary method of connectivity to the Fargo tower sites, with diverse routing (multiple circuits for backup in case of failure) to all locations.

The new system plan will continue to use this combination of technologies, with some expansion and replacements:

- Microwave radio: This technology will continue to be used for connectivity to the rural tower sites. As noted above, the existing microwave radio now being used is a combination of licensed and unlicensed equipment, varying in age from 10 years old to less than 4 years old.

  All existing unlicensed radio equipment will be replaced with new licensed microwave equipment, and licensed as required. This includes the links from Buffalo to Alice, and from downtown Fargo to Kindred.

  Much of the existing licensed equipment is in excellent condition, and may be reused for the new system. Further research is required on this issue, but funding has been placed in the overall project budget for the replacement of the unlicensed links.

  Note that several of the smaller site locations within Fargo (such as NDSU Seim Hall, the Cass County annex, Fire Station 7, and perhaps others) will not be needed with the new system. This is because the new 800 MHz system will provide better in-town and in-building coverage, eliminating the need for these locations.

- Fiber Optic: This is currently used to the 45th St and 32nd Ave. water tower sites. New fiber circuits will be planned to all four of the water

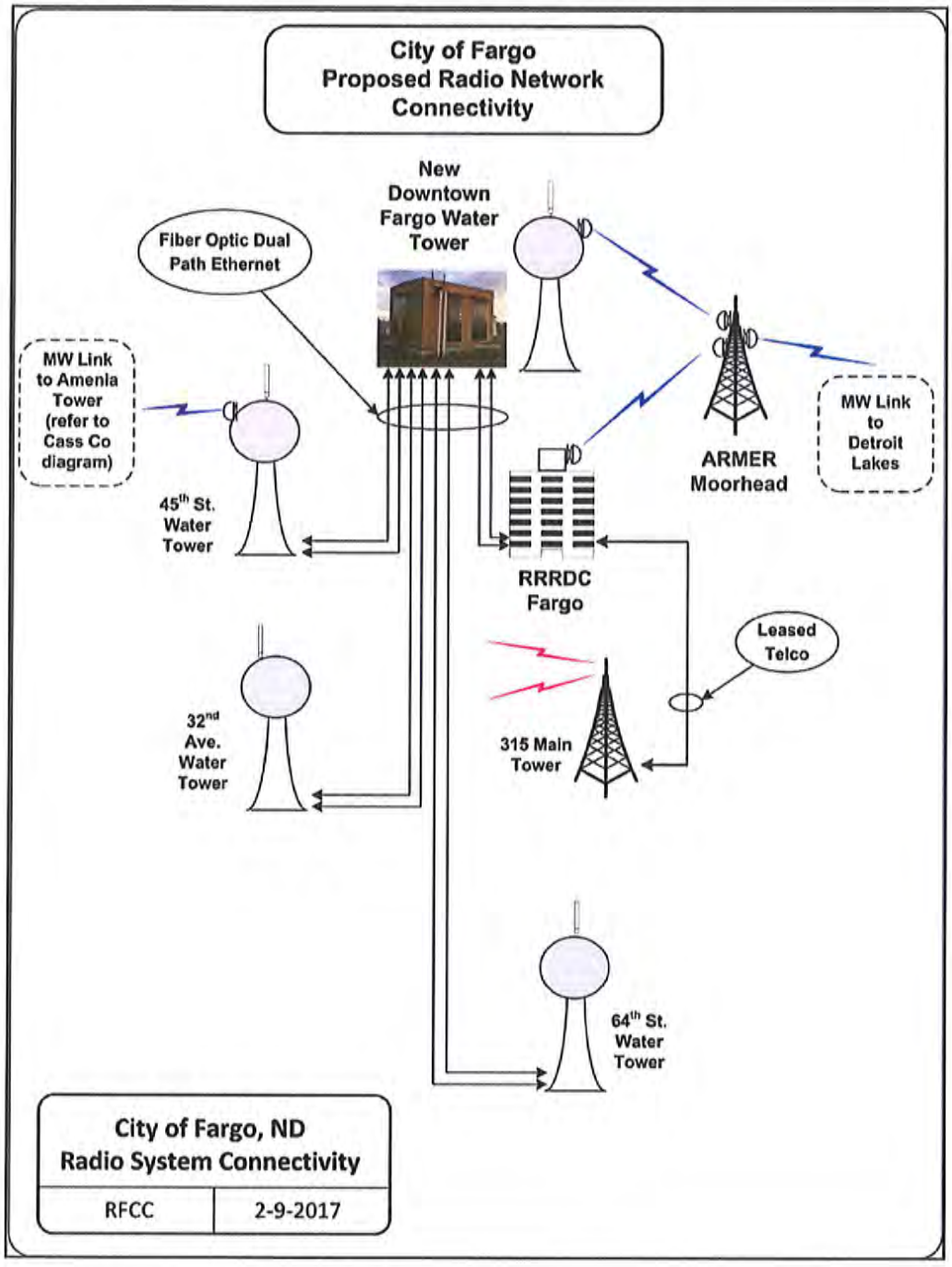
tower sites planned for the 4-site Fargo/West Fargo Simulcast system. The system will require new fiber optic installations to all sites, including 45th St., because of the need for dual circuit paths from downtown to this site.

Within Fargo there are two 32nd Ave. water tower sites (rather confusing!), one of which is located east of I-29 and is used with the existing VHF system. This site will not be used for the new 800 MHz radio system. The "new" 32nd Ave. water tower is located west of I-29, between 42nd and 43rd streets. This site is not currently being used for radio system, but has been incorporated into the new system plan because of the need for additional coverage in the southwest areas of Fargo and West Fargo, where the greatest population growth and development is happening.

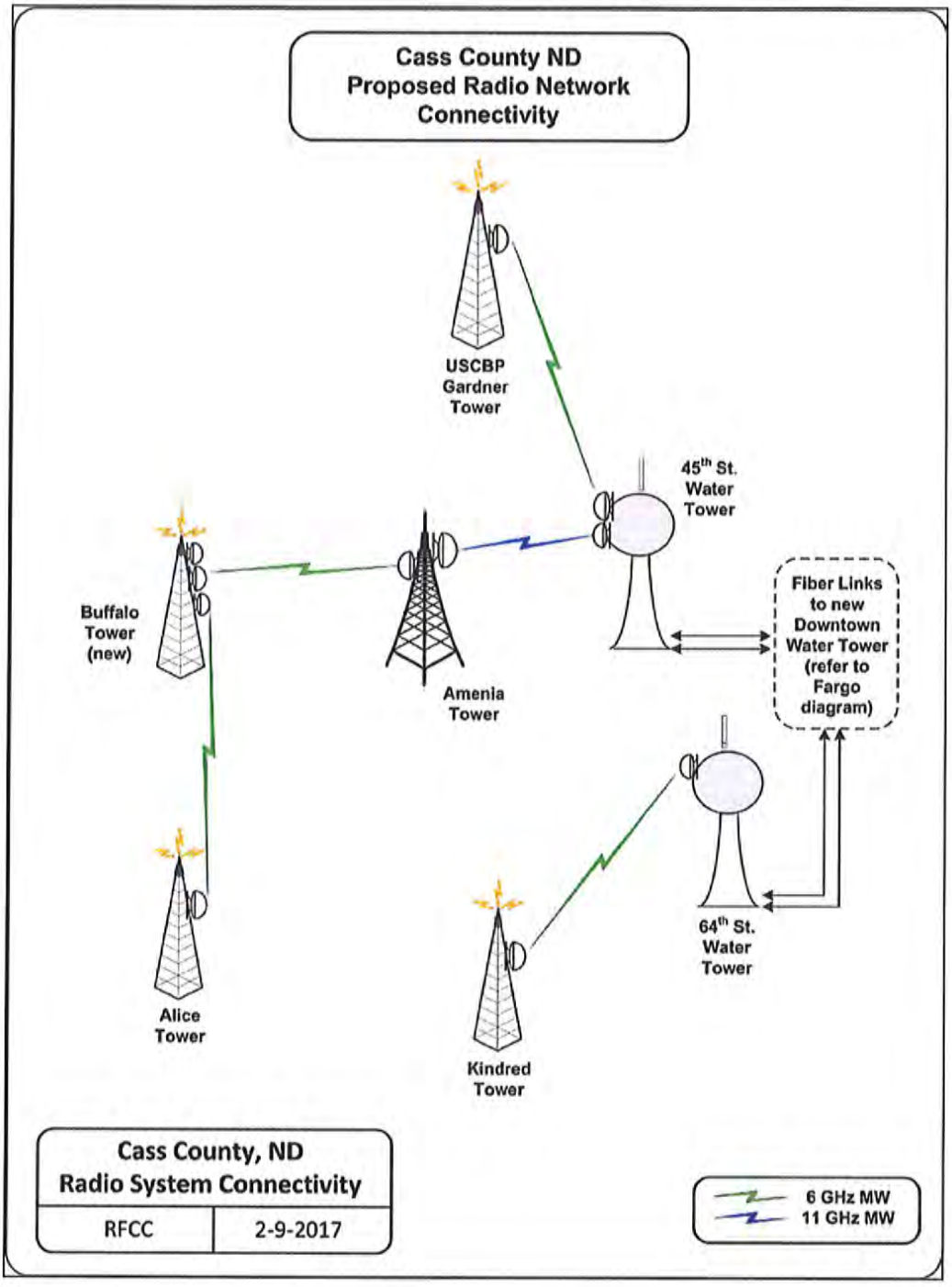
- Leased Circuits: These circuits are only minimally used within the existing VHF system, connecting the RRRDC facility in Fargo to the 315 Main tower site in downtown Fargo, where most of the system's backup stations are located. These circuits may be retained for future radio use.

Refer to the system connectivity diagrams on the next two pages.

City of Fargo ND Proposed Radio System Connectivity



Cass County ND Proposed Radio System Connectivity



5) Talk Groups and Fleetmap Planning

Within a Trunked Radio System, the radio "channels" that appear on the radio screens in dispatch and radios of the field radio are no longer actual radio frequencies (as is the case in the existing VHF system), but are instead computer-generated "channels", known as Talk Groups (TG's), and are considered "virtual" radio channels. Going forward in this planning document, they will be referred to as "TG's".

When developing a new Trunked Radio System, the planning for these TG's is known as the development of a "Fleetmap", which is a master list of all the TG's to be incorporated into the system for use by participating agencies.

The Cass County/Fargo staff and other radio team personnel have worked to develop an initial draft Fleetmap, which encompasses all of the agencies and operations planning to use the new system. Refer to Attachment A for a list of these new TG's. Some changes will be made prior to the actual implementation and programming of radios for use with the new system. This Fleetmap data would be programmed into the new radio system at the time of actual system implementation.

In addition to these new Talk Groups planned for the new system, there are a large number of other Local (Moorhead/Clay County, Norman County, etc.), Regional and Statewide TG's that will be incorporated into the new Cass County and Fargo/West Fargo 800 MHz radios, however these are not included in the Fleetmap, as they are not controlled or managed by Cass County/Fargo. Additional work to determine the proper radio programming will be addressed at the time a new system is being implemented.

B. Radio Signal Coverage Review of the Proposed 800 MHz System

Radio system range or coverage is considered the most critical function of any radio system, especially in public safety operations. While there are other important elements to a good system (equipment reliability, channel capacity), the ultimate factor by which a system's measure of success or failure is usually measured is how reliably it covers the intended service area.

Radio system coverage is a function of several key elements:

- The radio frequency being used (VHF, UHF, 700/800 MHz)
- The transmitter power of the radios (base units, portable units, etc.)
- The height of the antennas of the base stations and repeaters
- The distance from the field units needing to communicate and the base station or repeater they are trying to reach

These parameters are incorporated into the design of a radio system. When designing a new system, some compromises may be necessary to make the project possible. Tower site selection is one of these issues: To state the obvious, towers are expensive and challenging to fund and build, especially with the growing concerns of environmental and visual impact, wildlife, Native American and local historical sites, and related issues. ***As such, it is always best when existing tower sites can be used for a new system.***

This is the approach taken with the proposed Cass County/Fargo 800 MHz subnetwork as much as possible. Nine sites are planned for the new system (some existing, some new):

- New water tower (downtown Fargo)
- 45th St. water tower (Fargo)
- 64th Ave. water tower (Fargo)
- 32nd Ave "new" water tower (Fargo)
- Amenia tower (Cass County
- Buffalo tower (new, Cass County)
- Kindred tower (existing, Cass County)
- US Customs & Border Patrol tower (new structure, Cass County)
- Alice tower (new structure, Cass County)

These sites are incorporated in the computer-based available coverage maps generated for the new radio system, and will allow the new system meet the radio coverage goals for Cass County and Fargo/West Fargo agencies. Refer to Section 4.D.1. for more detailed information about these tower sites.

The new system will operate on 800 MHz radio frequencies, which is an important element to the success of the system. Our Phase 1 report presented concerns with the use of VHF (150-160 MHz) frequencies in the existing system and the common problems of interference from other co-channel frequency users, along with "Skip" and other forms of interference.

- Improved In-building coverage: 800 MHz frequencies provide better in-building portable radio coverage, due to the shorter radio wavelengths. VHF frequencies have relatively poor building penetration due to the long wavelength of the VHF signals.

The most common problem experienced with 800 MHz frequencies is the radio signal attenuation caused by foliage on trees, especially Pine trees, in the summer months. The length of the needles on these trees is very close to the 1/4-wavelenth of 800 MHz, and as the radio signal travels from the tower sites and field units, heavily forested areas can experience some signal attenuation and resulting affect on coverage. However, as this is a known factor, it can be

included in the radio system planning and coverage design to be mitigated as much as possible.

The other potential challenge with 800 MHz frequencies is their "line-of-sight" characteristics, when compared to VHF frequencies. The tower sites must be able to allow a direct signal path to the field units. VHF frequencies have a tendency to "bend" around some terrain obstacles, but this is not the case with the 800 MHz frequencies. Fortunately, the Fargo and Cass County area has rather flat topography, which is very conducive to 800 MHz signal propagation.

Computer-based Coverage Maps: In our Phase 1 report to Cass County/Fargo, we provided a group of computer-generated coverage maps to analyze the performance (or lack of) with the existing VHF radio system.

In a similar manner, but planning for the new system, Motorola has prepared a group of computer-based, color-coded predicted coverage maps for the proposed 800 MHz subnetwork for Cass County/Fargo. These maps are again created using a special software program, which uses important criteria to calculate how much range can be expected from a particular tower site (and radio system), based on the following factors:

- Ground topography of the geographical service area (in this case, Fargo and County)
- Physical location of the tower sites (based on latitude and longitude)
- Radio frequency spectrum being used (VHF, UHF, 700/800 MHz)
- Height of the antenna(s) above ground level
- Amount of transmitter power being used
- Type of field radio (mobile, portable, pager) that is being used
- Radio user location (outdoors, indoors)

The results of these calculations can be used for different purposes:

- To validate the coverage of an existing radio system, and compare with actual results from field testing (as was done in Phase 1)
- To determine the expected level of coverage from a new tower site or radio system – without needing to first build any of the expensive infrastructure (which is the purpose here)

This becomes an important tool in the review of an existing system, and the design of a new radio system. Note that it is usually beneficial to provide more than one type of coverage map for each channel or tower site:

- Transmit (Talk-Out) coverage to mobile and portable radios.
- Receive (Talk-In) coverage from portable radios. This is critical for portable (hand-held) radios, as they usually have much lower transmit power than a mobile unit (2.5 to 5 watts vs. 50 or 100 watts). As such,

a specific tower site will have a smaller coverage "footprint" for portable talk-in than for a mobile talk-in.

All coverage prediction maps are created using the proposed radio system technical parameters, based on Motorola's design. For field units, the following parameters are used:

- Portable Transmit Power: 2.5 watts
- Portable Antenna Height: 4 feet above ground level
- Portable Antenna Type: Standard helical rubber
- Signal losses: One of the key features in the use of the computer-based program is that signal losses for the various factors that affect radio system performance can be included in the calculations.

Radio coverage maps use colors to display the calculated amount of radio coverage in a specific area. The Motorola maps differ somewhat from the maps prepared by RFCC in the Phase 1 report. The color coding for the Motorola maps is:

- Green: Reliable signal coverage, 95% or greater
- White: Weaker signal coverage, less than 95%

Note: Coverage maps for digital radio systems are color coded with only two levels, such as green and white, with green representing usable signal and white showing weaker signal areas. This is done because in a digital system, the radio user "either has good coverage, or no coverage". This is due to the digital modulation technology's ability to take weak signals that might not otherwise be usable, and convert them to usable speech.

An important point to make when viewing the Motorola coverage maps: They are designed to show "95% or greater" level of coverage. In other words, if the area is shown as green, there is a "95% or greater expectation of good radio coverage". 95% coverage has been accepted as the public safety industry standard. However, even if an area is shown as white, this does not necessarily mean that the target area has no coverage. It means that the areas predicted coverage is less than 95%.

Ten predicted-coverage maps are provided in this plan, showing the calculated coverage for the 800 MHz system. The maps are divided into two groups:

- Fargo and West Fargo city areas (5 maps)
- Cass County areas (5 maps); note also that the Cass County maps include the radio signal coverage provided by the Fargo area Simulcast tower sites.

The maps show the predicted coverage from radios used outdoors, as well as inside "6dB loss" and "12dB loss" buildings. There are many different types of

building structures, which have differing levels of signal loss for radio systems. The 6dB and 12dB loss factors are an attempt to categorize the different types of buildings for the purpose of calculating radio system coverage. In general, these building categories are:

- 6dB loss: Wood-framed residential homes and similar structures, and commercial "strip mall" buildings which have numerous windows and few deep interior rooms
- 12dB loss: These are typically larger structures such as government buildings, hospitals, schools, large stores and shopping malls, etc. These structures often include brick and steel construction, limited windows, and other factors which greatly affect the radio signal penetration into the building.

  It is expected that there are also many buildings with greater than 12dB loss in the Fargo and West Fargo areas. Several of the "Critical" buildings identified in the Phase 1 report are in this category. It is extremely difficult to predict the coverage levels in these buildings, and will require field testing once a new system is completed. Some locations will undoubtedly require "In Building Amplifiers" (BDAs) to obtain the required level of radio system coverage. These will be dealt with on a case-by-case basis.

Fargo/West Fargo area maps:

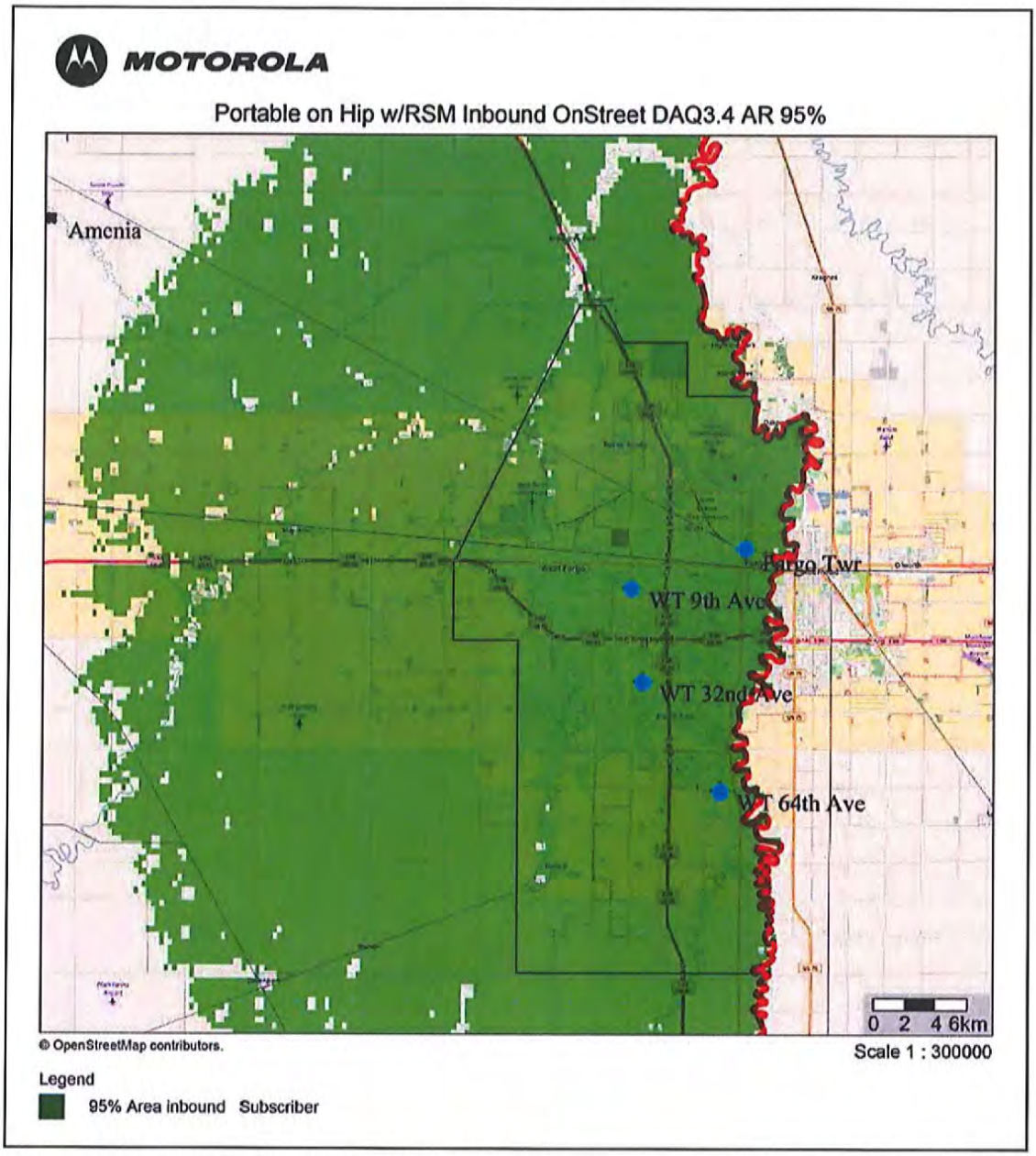
1. Talk-In coverage from Portable radios, On-Street (outdoors)
2. Talk-In coverage from Portable radios, inside 6dB loss buildings
3. Talk-Out coverage to Portable radios, inside 6dB loss buildings
4. Talk-In coverage from Portable radios, inside 12dB loss buildings
5. Talk-Out coverage to Portable radios, inside of 12dB loss buildings

Cass County area maps:

6. Talk-In coverage from Portable radios, On-Street (outdoors)
7. Talk-In coverage from Portable radios, inside 6dB loss buildings
8. Talk-Out coverage to Portable radios, inside 6dB loss buildings
9. Talk-In coverage from Portable radios, inside 12dB loss buildings
10. Talk-Out coverage to Portable radios, inside 12dB loss buildings

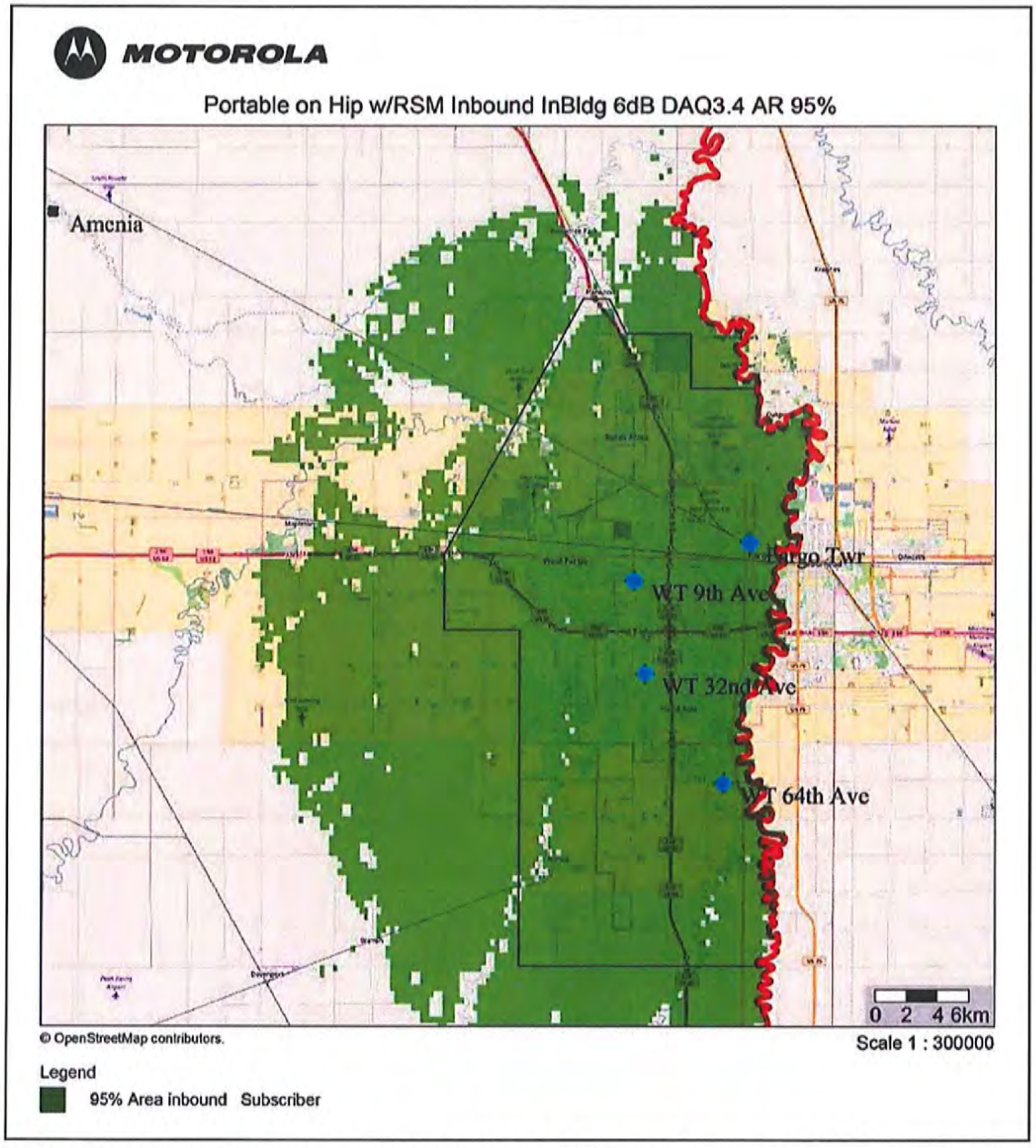
Also note that separate "Talk-In" and "Talk-Out" maps are shown for most of the various coverage levels. This is due to the differing transmit power levels between the field radios and the repeaters at the tower sites. The 800 MHz trunked system include technology that works to balance these differing signal levels; this is done through the installation of "Tower Top Amplifiers" (TTA's) at each tower site. These amplifiers receive in the lower-powered signals from portable radios and boost the signal levels before sending the signals down the coax cables to the repeater receivers. This greatly improves the "balance" of the system. The predicted coverage maps are shown on the following pages.

Map 1: 800 MHz Talk In from Portable Radios – On Street/Outdoors
Fargo/West Fargo



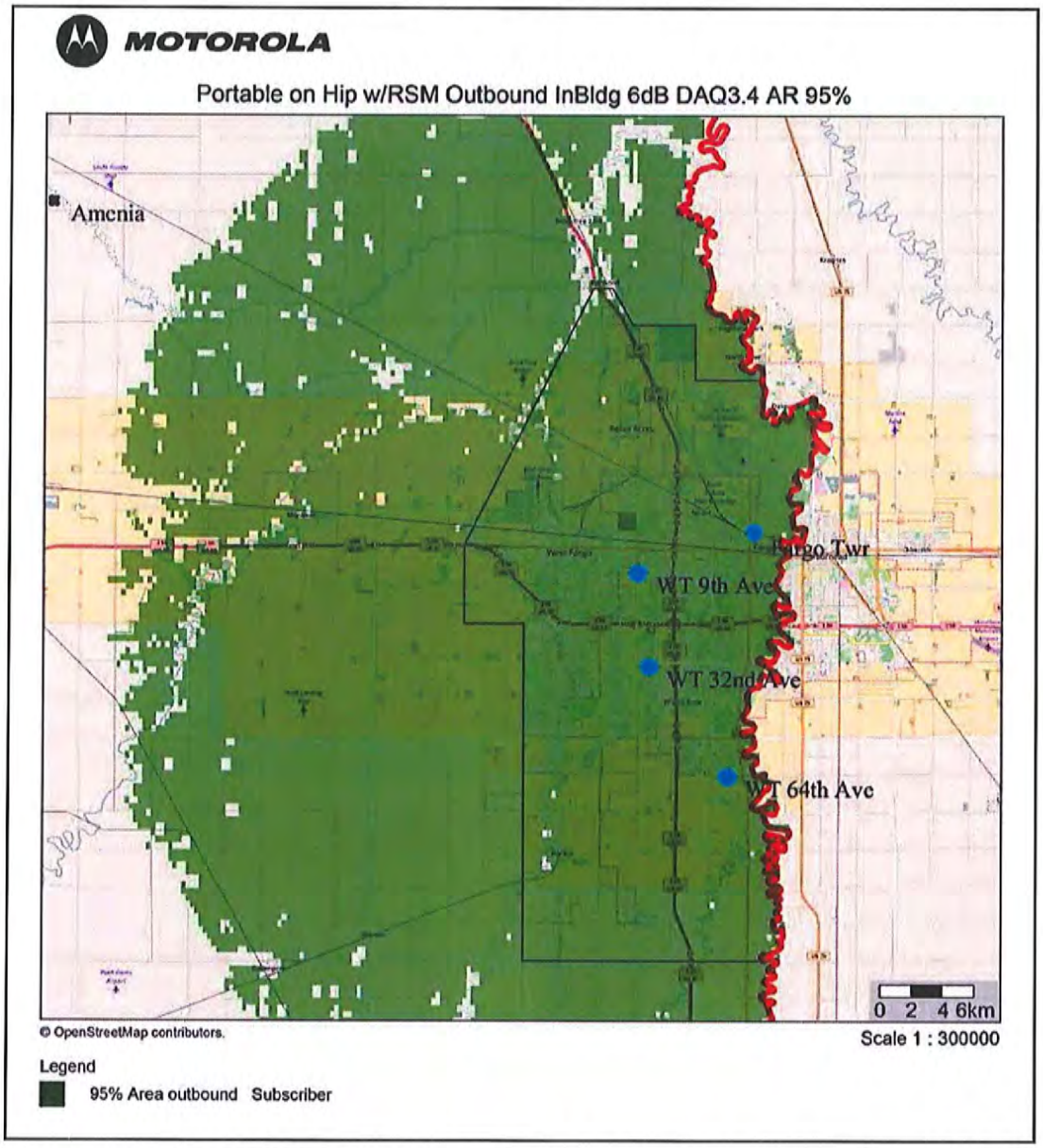
The proposed system's predicted Talk In coverage from portable radios On Street, when all tower sites are included, is very good. The Fargo/West Fargo Simulcast tower sites are shown as the blue circles on the map, and the black line indicates the general city border of the combined Fargo and West Fargo areas.

Map 2: 800 MHz Talk In from Portable Radios – 6dB Loss In-Building
Fargo/West Fargo



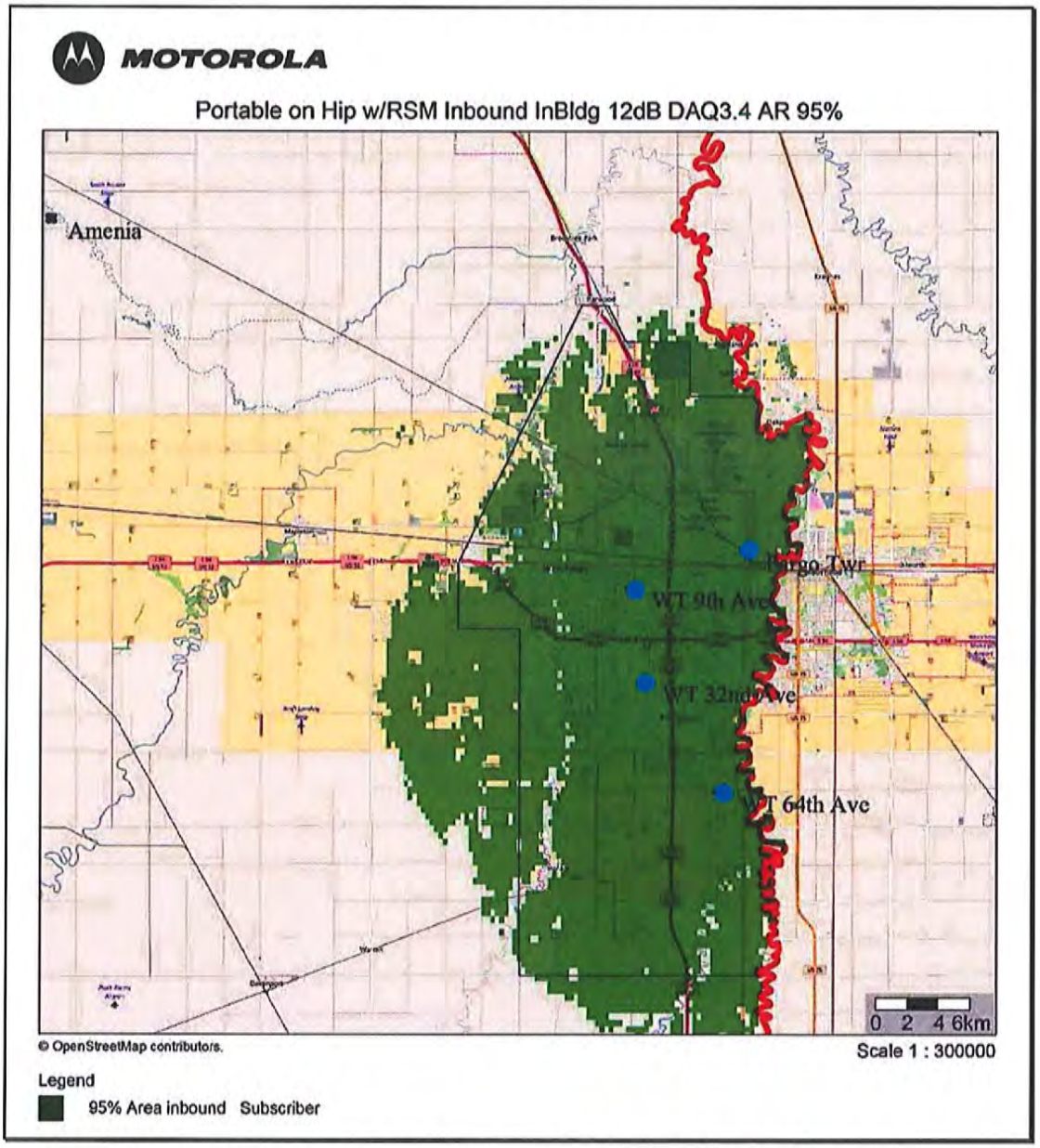
The proposed system's predicted Talk In coverage from portable radios when all tower sites are included, is also good in most areas of the Fargo/West Fargo area, with the same "95%" observations made from the previous map.

Map 3: 800 MHz Talk Out to Portable Radios – 6dB Loss In-Building
Fargo/West Fargo



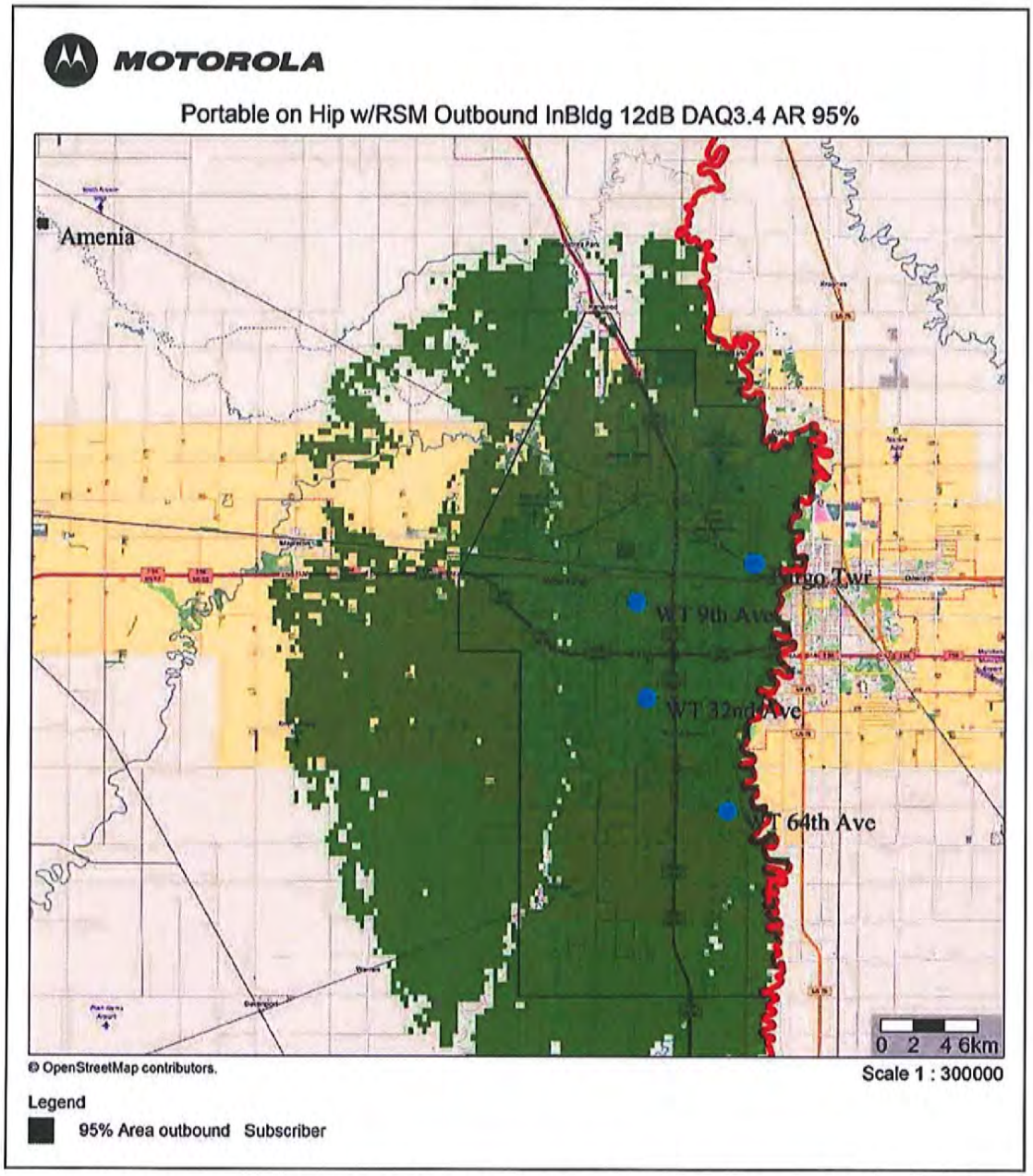
The proposed system's Talk Out coverage to portable radios – inside "6db loss" buildings – appears to be very good throughout the Fargo and West Fargo areas.

Map 4: 800 MHz Talk In from Portable Radios – 12dB Loss In-Building
Fargo/West Fargo



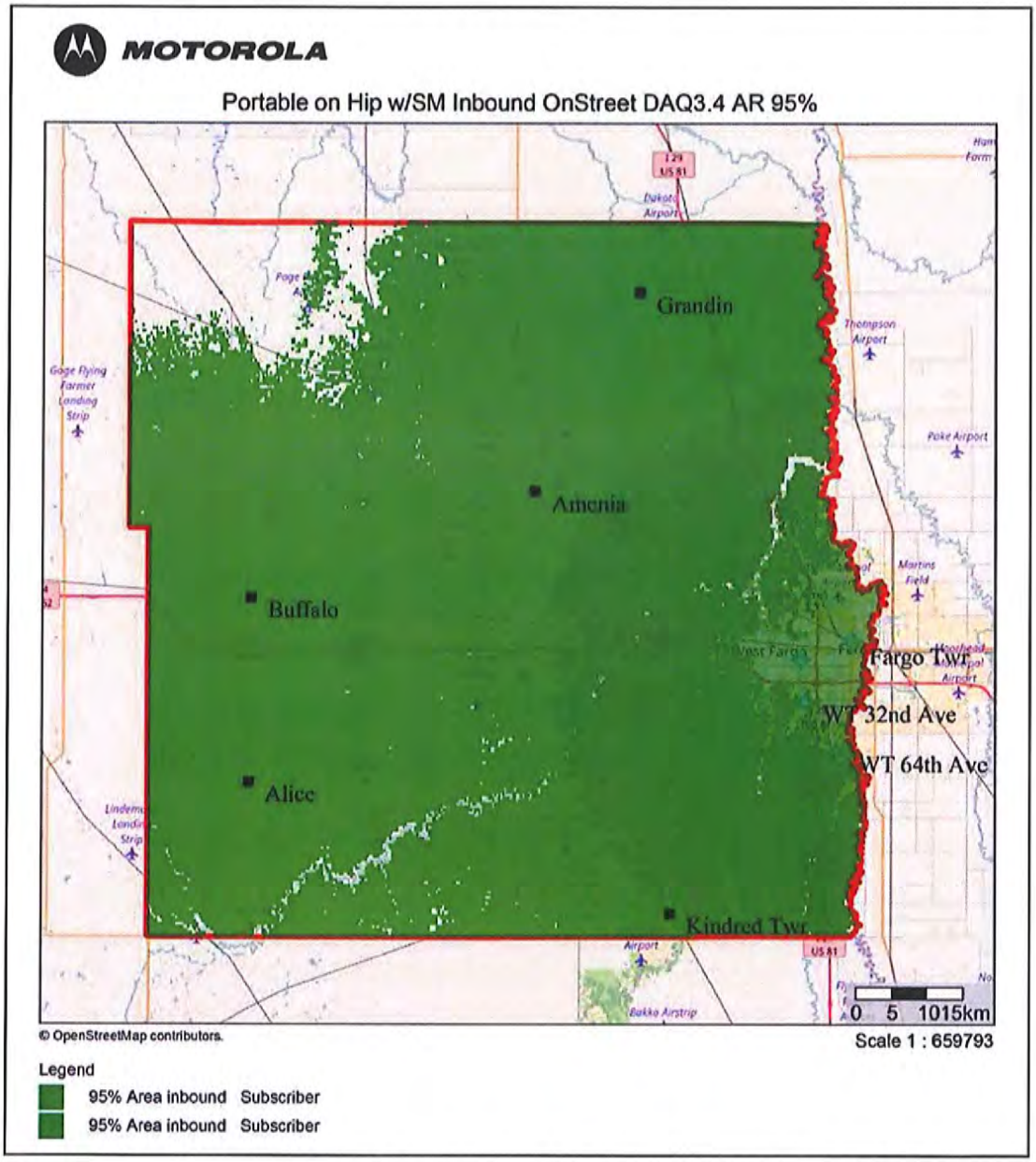
The proposed system's Talk In coverage from portable radios – inside "12db loss" buildings – appears very good in most areas of the Fargo and West Fargo area. Some areas of "white" (<95% predicted reliability) can be seen in the northwest and southwest areas of the target coverage area. However, keep in mind that this only matters if there are "12dB loss" buildings in these specific areas.

Map 5: 800 MHz Talk Out to Portable Radios – 12dB Loss In-Building Fargo/West Fargo



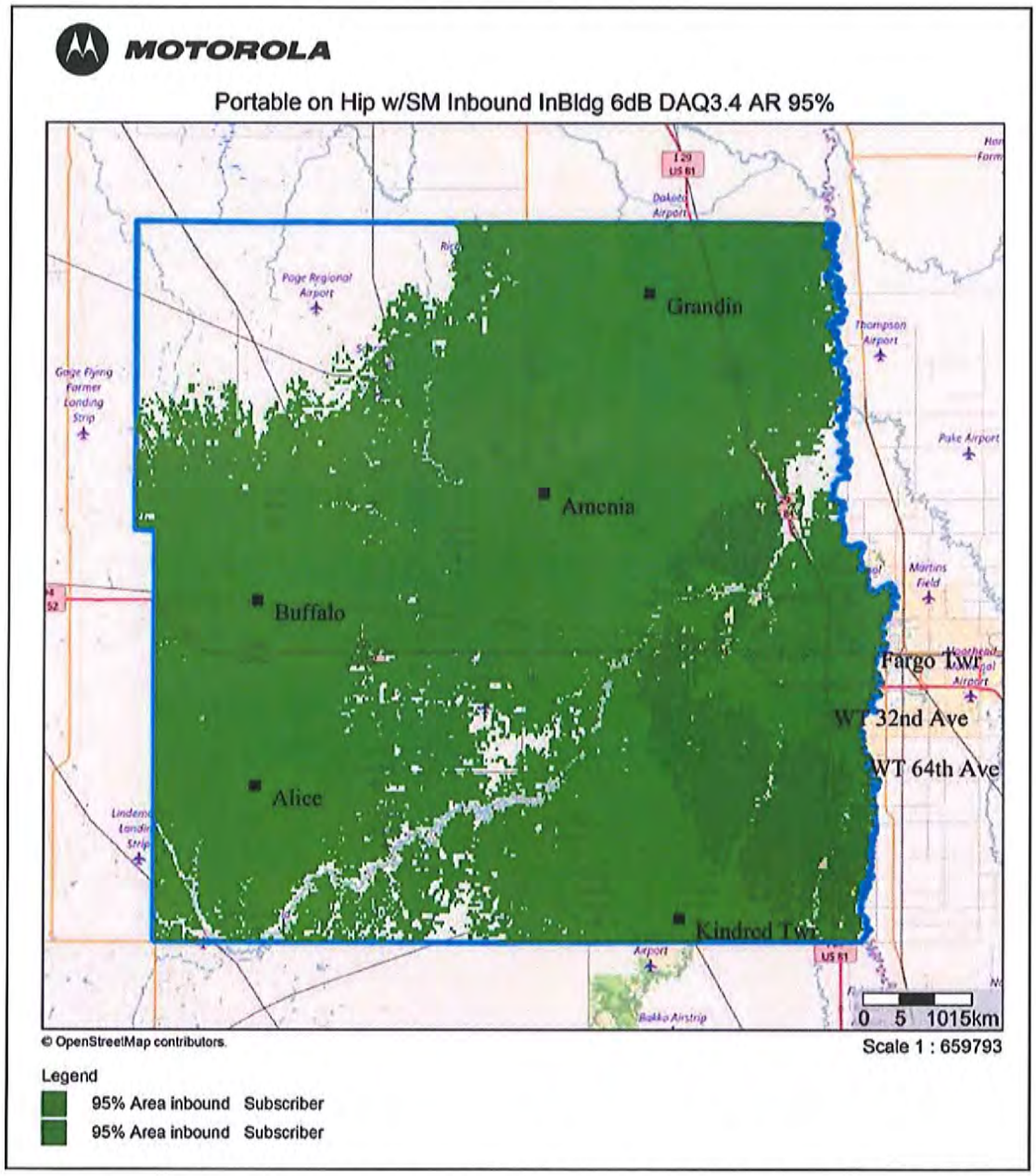
The proposed system's Talk Out coverage to portable radios – inside "12db loss" buildings – is good in most areas of the Fargo/West Fargo service area, other than a few spotty areas in the far north.

Map 6: 800 MHz Talk In from Portable Radios – On Street/Outdoors
Cass County



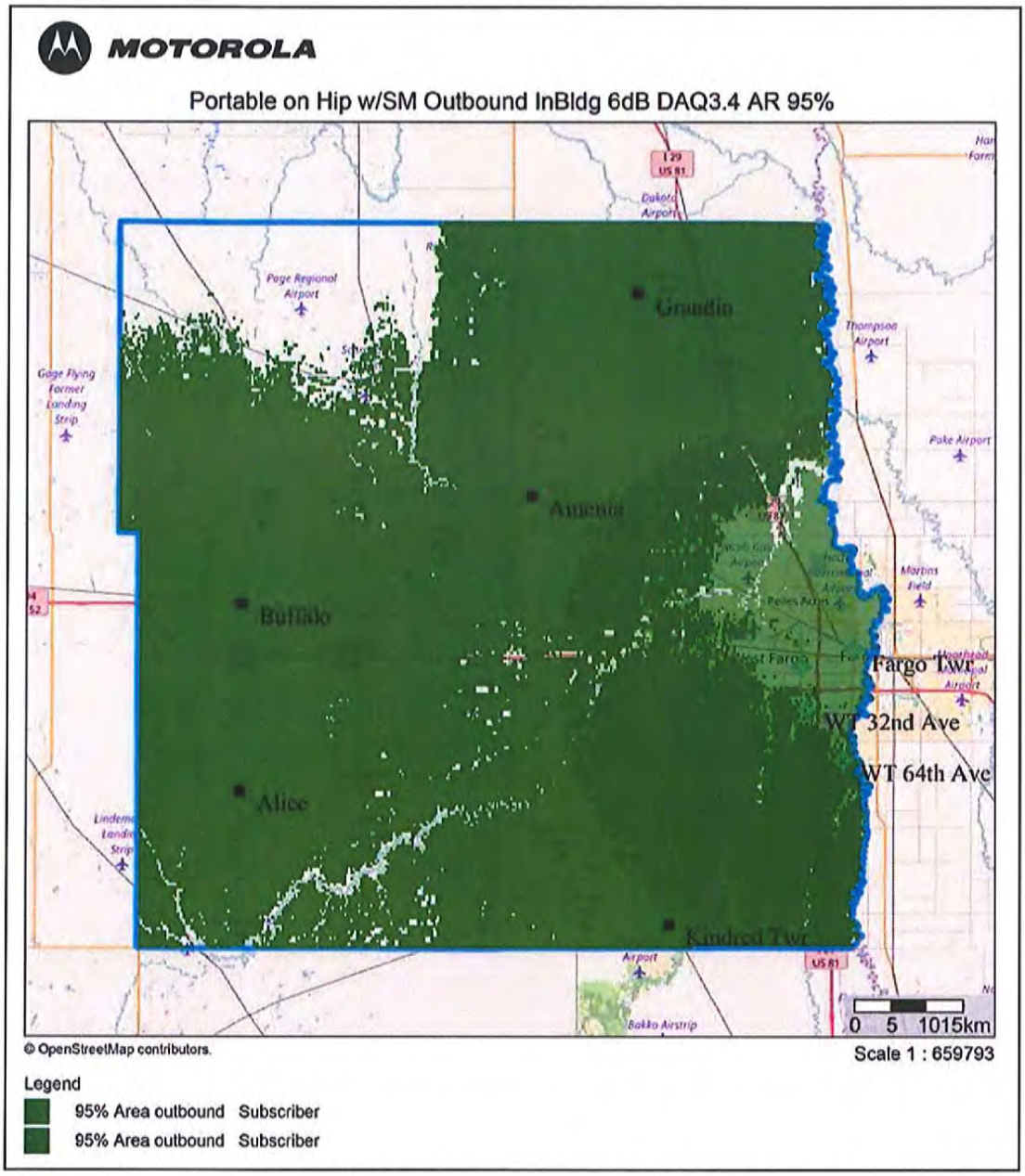
The proposed system's Talk-In coverage from portable radios when used outdoors looks very good throughout most of Cass County, with the exception of the far northwest corner. This issue is discussed in the summary of this section of the plan document. The coverage provided by the Fargo Simulcast sites is included in the Cass County maps.

Map 7: 800 MHz Talk In from Portable Radios – 6dB Loss In-Building
Cass County



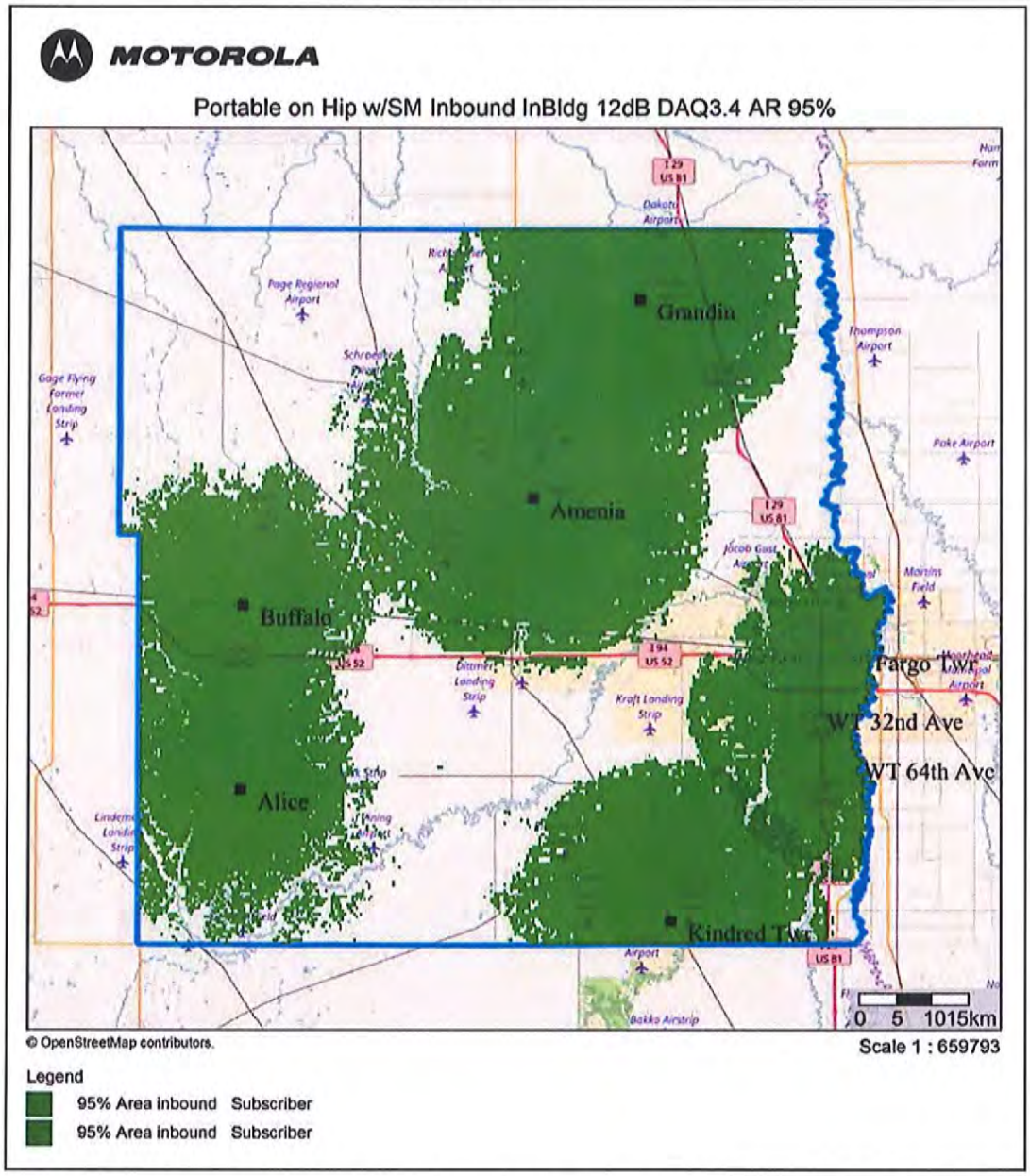
The proposed system's Talk-In coverage from portable radios when used inside 6dB loss buildings looks good throughout most of Cass County, with the exception of the far northwest corner, along with some other pockets north of Fargo, and the south central area of the county.

Map 8: 800 MHz Talk Out to Portable Radios – 6dB Loss In-Building
Cass County



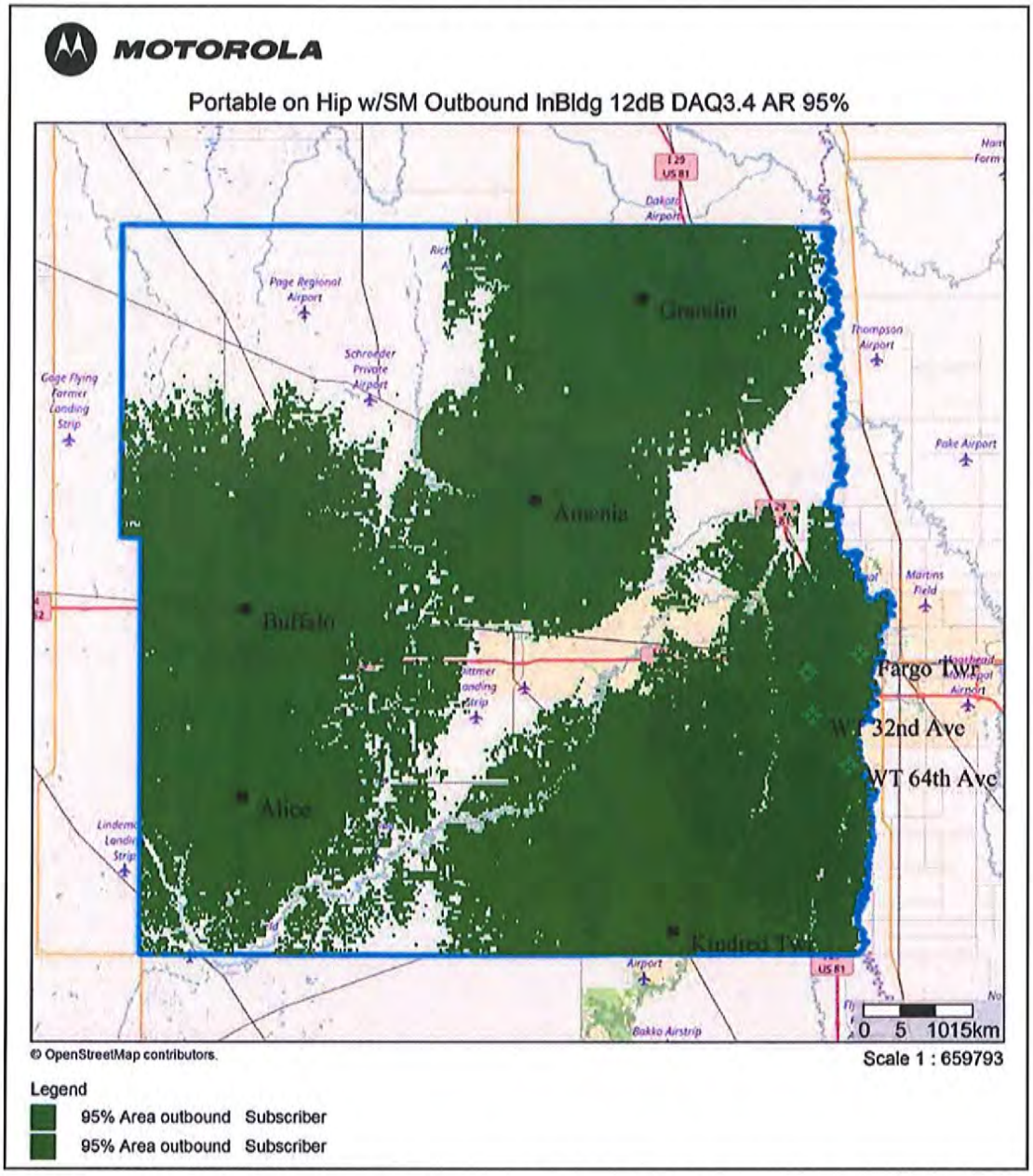
The proposed system's Talk-Out coverage to portable radios when used inside 6dB loss buildings looks good throughout most of Cass County, with the exception of the far northwest corner of the county.

Map 9: 800 MHz Talk In from Portable Radios – 12dB Loss In-Building
Cass County



The 12dB loss building Talk-In coverage from portable radios is where the "circles of coverage" drastically shrink, and because highly dependent on the radio's distance from the tower sites. Additional sites could be added to improve this coverage, but many of the areas shown in white do not necessarily have "12dB buildings" requiring radio coverage.

Map 10: 800 MHz Talk Out to Portable Radios – 12dB Loss In-Building
Cass County



The 12dB loss building Talk-Out coverage to portable radios is better than the "Talk In" coverage shown on Map 9, but again is dependent on the radio's distance from the tower sites.

Summary of coverage and maps: The Motorola computer-based maps for the proposed system indicate excellent On-Street portable radio coverage in most areas of the Fargo, West Fargo, and Cass County. The predicted 6dB and 12dB In-Building coverage for the Fargo/West Fargo areas is excellent. The 6dB In-Building coverage throughout Cass County is also very good in most areas. The 12dB In-Building coverage in Cass County is somewhat limited to a 5 to 8 mile radius of the tower site.

- It is important to keep in mind that 6db and 12db coverage only matters if there are building structures in these areas. In other words, if no building exists in an area shown with "less than 95% coverage", then there is not necessarily a problem.
- There are building structures in Fargo, West Fargo and Cass County that most certainly have greater than 12db loss factors. Typical examples of this are hospitals, schools, and steel buildings, especially those with no windows. The radio coverage in these locations will need to be tested once a new system is operational, and BDA's (in-building amplifiers) added as necessary.

It needs to be stated that no radio system, public safety or otherwise, can be expected to provide 100% radio coverage. There exist too many variables in providing reliable radio signals to every area and building within the targeted coverage area. Developing a radio system to provide reliable coverage on a day-to-day basis can be an expensive process. The goal is to have a radio system that meets most daily communications needs, again with a typical target of 95% or greater reliability.

For those buildings that exceed 12db loss, and require solid in-building coverage, either the building owner, or the county, should consider the addition of in-building amplifier/boosters, also know as "BDA's" (Bi Directional Amplifiers). These devices should be considered on a case-by-case basis depending on the coverage needs for the location.

Coverage testing is included in the Motorola proposal; this is a process whereby they will assemble a testing team with radio coverage measurement equipment, and "drive the county" measuring the signal levels and digital Bit Error Rate (BER) in 1-mile grids throughout the county. BER testing is much more structured than the typical "Can you hear me now" process that has been used with previous testing. Motorola will provide a full report on the results of this testing process.

A final note is that Motorola (or any vendor) does not "guarantee" coverage for the whole county; what they will stand behind is the system coverage shown in these maps. If there is an area showing less than 95% and field testing shows no coverage, which is to be accepted by the customer.

C. Tower and Water Tower Site Work Required for the Radio System

The new radio system as planned will require a total of nine (9) tower sites for the installation and operation of the repeater and network equipment. A goal of the new system was to use of as many existing tower and water tower sites as possible, to avoid spending money on the development of new sites. When designing a new system, some compromises may be necessary to make the project possible. One example of this is often tower site selection: To state the obvious, towers are expensive and challenging to fund and build, especially with the growing concerns of environmental and visual impact, wildlife, Native American and local historical sites, and related issues. ***As such, it is usually best when existing tower sites can be used for a new system.***

This is the approach taken with the proposed Cass County/Fargo 800 MHz subnetwork as much as possible. Nine sites are needed for the new system; the current plan will utilize a combination of existing and new sites:

Existing sites to be reused:

1. 45th St. water tower (Fargo)
2. 64th Ave. water tower (Fargo)
3. Amenia tower (Cass County)
4. Kindred tower (Cass County)
5. US Customs & Border Patrol (USCBP – Cass County)

Note that some of the existing site will need upgrades and work for use with the new radio system.

New Sites:

6. Downtown water tower (Fargo)
7. 32nd Ave. water tower (Fargo)
8. Buffalo tower (Cass County)
9. Alice tower (Cass County)

This section of the plan provides a detailed overview of the work needed for each site. Refer to the Phase 1 report for more specific details about the existing sites. Note that some of the other existing sites not listed here may be retained for VHF paging and siren control.

Review of Existing sites to be reused:

1. 45th St. water tower (Fargo): The existing 45th St. water tower is a key site for the existing Fargo VHF radio system. This site is equipped with a prefabricated radio equipment shelter, along with an emergency generator housed in an attached but separate room. The water tower provides a good platform for the radio system antennas, and has adequate space on the top of the tank for additional antennas. The existing 6-ft microwave dish now

installed on the tank for the link to the Amenia site may be reused with the new system.

The existing radio equipment shelter houses the current VHF system's repeater, RF filtering, fiber optic and microwave radio equipment. However, there should be space within the equipment room for new 800 MHz repeater and network equipment if some of the existing equipment can be moved into a temporary location within the room, until the new system equipment is online and fully operational, at which point the VHF equipment can be removed.

2. 64th Ave. water tower (Fargo): The existing 64th Ave. site houses VHF and microwave radio equipment, and is a key site for providing coverage in the southern areas of Fargo, where most of the suburban development is taking place. This site is equipped with a prefabricated radio equipment shelter, along with an emergency generator housed in an attached but separate room. The water tower provides a good platform for the radio system antennas, and has adequate space on the top of the tank for additional antennas.

   The existing radio equipment shelter houses the current VHF system's repeater, RF filtering and microwave radio equipment. This shelter is rather small, and will not have room for the installation of new 800 MHz radio system equipment without the removal of existing VHF equipment. Because this is not logistically feasible, a new larger shelter will be needed at this site.

   A new shelter could be placed closer to the water tank structure than the existing shelter is located, however care needs to be taken not to locate the shelter directly below the top edge of the tank, where ice and water will be falling on anything directly beneath it. New cabling conduits will be needed between a new shelter and the water tank, along with AC electrical service.

   The existing shelter could be reused at another Cass County or Fargo site, such as Buffalo or the "new" 32nd Ave. water tower.

3. Amenia tower (Cass County): This tower site is currently a "hub" for connectivity between the sites in the Fargo area and the sites located in the western areas of the county for the existing VHF system. This site is leased by Cass County from Prairie Public Broadcasting, with a monthly fee of $1,000. This fee covers the use of the tower for the VHF and microwave antennas, space within the equipment building for the county's radio equipment, and AC power with generator backup.

   This site will continue to be used for a new system, and will provide a key RF site in central Cass County. This tower site is also the tallest site within the system; the overall structure is 1,000 feet high, and the county's VHF antennas are mounted at the 300-ft level on the tower. The new 800 MHz

antennas are proposed to be located at the 320-ft and 340-ft levels on the tower. It is not known at this time if any VHF antennas will be retained for use at this site.

Changes will be needed to the microwave antennas at the site (upgrading the unlicensed equipment to licensed), but there may not be any change in the total number of antennas at the site.

The new 800 MHz repeater system equipment will require more space within the radio building at the site, but there is quite a bit of open space within the building, and no issues are expected in this area, but will require coordination with the site's owner. The 800 MHz system equipment will use more AC power than the VHF equipment currently does; this along with the additional space needed for the new equipment and antenna changes may result in a higher monthly rental cost.

4. Kindred tower (Cass County): This tower is located in south central Cass County, and is owned by a local power utility. Cass County pays a monthly rental fee of $550 for use of the site. The existing VHF system equipment is housed in a prefabricated shelter adjacent to the tower; this shelter is equipped with an emergency power generator in a separate room of the shelter.

   This existing shelter and generator will be used to house the new 800 MHz radio and microwave equipment for the project. Some logistical planning will be needed to allow the existing VHF equipment to operate while the new equipment is being installed.

   The tower structure should be capable of supporting the two 800 MHz antennas needed for the new system, and a structural analysis will be done to validate the integrity of the tower.

5. US Customs and Border Patrol (US CBP): The existing US CBP tower site is a very old tower structure, of unknown age, and is not capable of supporting the new 800 MHz and microwave antenna equipment required for a new system. The existing radio equipment shelter is also very old, with no space for new equipment. Cass County is using this site at no cost.

   As such, a new tower structure and equipment shelter will be needed for this site. At this time, it is not known whether Cass County will partner with the US CBP for the replacement of the tower and shelter at this site, or Cass County will work to develop a new site on their own for this area of the county. There do not appear to be any other good tower site leasing options in the general geographic area that could be used for the new system.

Review of New sites needed:

6. Downtown Fargo: As identified in the Phase 1 report, the existing Fargo High Rise site is planned for either demolition or sale at some point in the future, and will not be suitable or available for use as a radio site. Also, the existing radio equipment shelter located at the top of the building is now full with radio system equipment, and has no room for the installation of new 800 MHz system equipment.

   The City of Fargo has been planning for the construction of new water tower in downtown Fargo, near the intersection of 5th Ave. and 5th Street, on city-owned property. The Cass County/Fargo radio system project team has been working with the City staff to plan for the use possible use of this new water tower as the primary local site for the new 800 MHz radio system. The new water tower, as currently planned, is expected to be built to a height of 120 to 140 feet, which is appropriate for the antennas needed for the system. A radio equipment shelter of some type will be needed at this site, and the option of erecting the structure with an internal radio room is being considered.

   The construction of this water tower is included in the city's capital expense budget, and is expected to occur within the next one or two years.

7. 32nd Ave. water towers (Fargo): As noted earlier, there are two 32nd Ave. water tower locations in Fargo. The site now being used for VHF system equipment is located east of I-29, and this site will be decommissioned once the new 800 MHz system is online. The "new" 32nd Ave. site is located west of I-29, between 42nd and 43rd streets. This site is not currently being used for radio system operations, but is a newer structure and better situated to provide radio coverage for both Fargo and West Fargo.

   This site will require the purchase and installation of a new radio equipment shelter on the property to house the proposed radio system equipment. It is not known if the top of the tank structure was designed with any antenna support mounting hardware, so this will need to be reviewed prior to any antenna installation work. AC power, fiber optic connectivity, antenna cabling conduits other resources will be needed for this site.

8. Buffalo tower (Cass County): A local grain elevator is currently used in Buffalo for the operation of the existing VHF and microwave radio equipment at this site. The equipment is housed in a small outdoor cabinet, with a small emergency generator adjacent to the cabinet.

   This site will not be suitable for the installation and operation of the new 800 MHz radio system equipment, due to the very limited space at the site, and the somewhat limited height of the structure.

A new 180-ft self supporting tower is being planned for purchase and installation at the Cass County Highway Maintenance facility, which is located about ¼ mile directly east of the elevator site, in Buffalo.

This site will require a new tower structure, radio equipment shelter, electrical power, security fencing, and all other items needed for a complete site installation. A NEPA environmental study will be needed prior to the construction of the tower.

9. Alice tower (Cass County): The existing (and former) Alice tower site was an 80-ft self-supporting structure located at the city of Alice fire station. The tower was situated adjacent to the fire station, and the VHF and microwave radio equipment was located inside the fire hall.

   This tower was damaged and collapsed during a windstorm in the fall of 2016, and is damaged beyond repair. A new tower structure will be needed at this site for the new 800 MHz and microwave equipment planned for the system. Similar to the Buffalo site, a new 180-ft self supporting tower is planned for this site, along with a new prefabricated equipment shelter, generator, electrical power, security fencing, and all other items needed for a complete site installation. A NEPA environmental study will be needed prior to the construction of the tower.

In addition to the above specific work and equipment required at the sites, Cass County and Fargo will be responsible for addressing the following general issues and requirements for the project:

- Verifying the structural analysis of existing tower sites, to support the new antenna equipment being installed for the project.
- Conducting or contracting NEPA (environmental) reviews for any sites where new tower structures are to be built
- Obtaining and/or preparing drawings of site locations for the installation of equipment and antennas
- Planning for and/or ensuring that commercial AC power is available at the sites for operation of the new radio system equipment
- Contracting with local construction vendors for utility, excavating, concrete, and other services needed for the development of new sites

The estimated costs associated with the work and equipment needed for these sites has been incorporated into the cost budget established for the project.

Some of the other existing tower and water tower sites not listed above may be retained for the operation of VHF/UHF paging and siren systems.

D. 700/800 MHz Mobile and Portable Radios

The conversion from VHF to a new 800 MHz Trunked Radio system will require the purchase, programming and installation of new mobile and portable radios for all Cass County, Fargo and West Fargo agencies. The following estimated quantities of new 800 MHz radios will be needed for the various user groups:

Agency	Mobiles	Portables	Ctl Stns
Fargo Police	100	235	
Fargo Fire	32	111	
Fargo Public Works	96	61	6
Fargo Utilities	59	13	
West Fargo Police	34	62	
West Fargo Fire	13	30	
West Fargo Public Works	70	16	2
Cass County Sheriff	70	70	4
Cass County Highway	54	12	1
Cass Co. Rural Fire/EMS	156	321	18
Totals	**684**	**931**	**31**

As shown, an estimated total of 1,646 radios will be needed to equip all Cass County, Fargo and West Fargo agencies with the new radios needed for the 800 MHz system. The above quantities include a variety of different models of radios, with various features, options, and associated pricing.

A proposal from Motorola will include the programming and installation of all radios being purchased for the project. The installation will be accomplished by a local Motorola subcontractor or radio shop of the customer's choice.

The cost of these radios is shown in Section 4.F. of this plan.

E. Other Work Needed for the Project

Motorola will be the primary equipment and services vendor for a Cass County/Fargo 800 MHz system project, and though they will provide the majority of the radio system equipment and services needed for the project, there are many other elements that will be needed for completion of the project, which are the responsibility of Cass County:

1. **General project management:** The main radio system project proposal is from Motorola, and they will be responsible for the installation, optimizing, testing and overall management of the new system installation.

   However, a final proposal from Motorola will include a long list of tasks and responsibilities for Cass County/Fargo, needed for completion of the project. This includes the following and more:

   - Tower site development (noted below)
   - FCC licensing
   - Connectivity between sites (microwave radio, fiber optic, leased circuits, etc.)
   - Mobile and portable radio programming template development for new radios
   - Ongoing coordination with the Motorola Project Manager assigned to the project
   - Participate in the final testing and inspection of all system equipment
   - Participate in the final performance testing of the new system

2. **Tower Site Development:** As noted in Section 4.C. of this plan, there is a significant amount of tower site improvement and development work that will be needed to prepare the tower and water tower sites for the installation and operation of the new radio system equipment. Cass County/Fargo has the option of handling this work on their own, in conjunction with an outside consulting firm (such as RFCC), or incorporating the work into the overall radio system proposal from Motorola. We recommend that the customer handle this work independently of Motorola, which will result in a significant cost savings.

3. **Radio User Training:** All personnel who will be using the new radio system will be required to attend a formal radio user training class. This is not only a good practice, but will is required by all agencies connected to and using the Minnesota ARMER system. This is important because the new system has many new features, capabilities, technologies, channels (talk groups), and the radios are somewhat more complex than those now being used.

Training classes will be needed for:

- Dispatchers
- Law, Fire, EMS and EMA personnel using mobile and portable radios
- System administrator

This training can be accomplished through either an in-house program, or through the use of an independent Training services provider, such as On-Target Training (based in Minnesota):

http://ontargettc.com/node/10

The use of a local training service provides a more focused, customer-specific training program. On Target, for example, has provided training to over 50% of the counties in Minnesota now using the ARMER 800 MHz statewide radio system. We highly recommend consideration of this approach to training services.

In addition to the requirements for Cass County/Fargo identified throughout this plan, there is another element to be considered going forward with participation in the ARMER system, which is to remember that it is a shared system, with many users. The rules and requirements for use of the system are developed through the various User and Technical Committees which have been established for operation of the system.

RFCC will assist Cass County/Fargo as needed or desired with any and all of the tasks and responsibilities required for the project.

F. Cost and Pricing of the Proposed 800 MHz Subnetwork

Motorola is the selected vendor for the 800 MHz radio system equipment being planned for this project. They have provided Cass County/Fargo with a "Budgetary Proposal" for the equipment and services needed for the purchase and installation of a new radio system. A "Budgetary" proposal is a detailed proposal that addresses all of the technical and equipment requirements of the desired system, with the pricing based on nominal State Contract equipment and service rates. The pricing is typically higher than what the final cost would be once a formal and final proposal is received and negotiated with the vendor.

The proposal from Motorola is only for the core 800 MHz radio system equipment, and does not include any tower site upgrades or replacement. It also does not include any upgrades or replacement for the microwave radio or other connectivity systems between sites.

In addition to the proposal received from Motorola, RFCC and the Cass County technical staff have worked together to develop a proposed project budget, based on knowledge of the pricing and costs established with other similar radio system projects. Using the information developed in this process, a summary of the overall estimated costs for the project are provided below. A more detailed breakdown of the project's estimated costs are provided in Attachment B.

	Project Element	**Est. Cost**
1A	800 MHz system equipment (repeaters, antennas, network technology, software, installation services, etc.) for Fargo/West Fargo Simulcast network	$2,536,052
1B	800 MHz system equipment (repeaters, antennas, network technology, software, installation services, etc.) for Cass County ASR network	$1,316,113
1C	Master/Zone Controller (Optional, may not be needed)	$1,665,391
	1st Year Maintenance Services (Included)	
	Subtotal for 800 MHz System	**$5,517,556**

In addition to the primary project items and costs shown above, other items will be needed for completion of the project:

	Project Item	**Est. Cost**
1D	Microwave Radio Equipment	$ 625,000
1E	Fiber Optic Equipment	$ 299,870
1F	System Coverage Testing (Motorola)	$ 35,000
2A	Buffalo Site Tower, Shelter and Civil Work	$ 150,000
2B	Fargo Prime Site Shelter and Civil Work	$ 205,000
2C	32nd Ave Water Tower Shelter and Civil Work	$ 127,500
2D	64th Ave Water Tower Shelter and Civil Work	$ 90,000
2E	US CBP Tower, Shelter and Civil Work	$ 295,000
2F	Alice Tower, Shelter and Civil Work	$ 167,500
2G	Kindred Tower Structural Review	$ 2,500
3	800 MHz Mobile and Portable Radios	$6,158,442
4A	Training for Dispatchers and Radio Users	$ 20,000
4B	FCC Licensing	$ 10,000
4C	Consulting & Project Management	$ 150,000
	Project Contingency	$ 700,000
	Subtotal for Other Project Items	**$9,035,812**
	Subtotal for Motorola (from prev. page)	**$5,517,556**
	Grand Total for Project	**$14,554,000**

G. Maintenance Costs of the Proposed 800 MHz Subnetwork

The proposed 800 MHz subnetwork equipment for Cass County/Fargo will require ongoing maintenance and software updates, as is the case with any new radio and higher-technology system.

The proposal from Motorola includes the first-year maintenance costs associated with the new system. This one-year warranty period will begin once all of the system components has been fully installed, tested, and Cass County/Fargo agencies have began to use the system for daily operations.

The proposed costs from Motorola for full support and maintenance of the new subnetwork equipment in future years is as follows:

Period	System Cost	ARMER Mtc. Fees (note 1)	Optional Master Site Cost (note 2)
Year 2	$226,924	$31,000	$82,532
Year 3	$238,271	$32,000	$86,658
Year 4	TBD	$33,000	TBD

Note 1: This would be paid to Minnesota ARMER if they were to allow the new Cass County/Fargo 800 MHz system to be connected to the Zone 6 Master Site in Detroit Lakes.

Note 2: This would be paid to Motorola only if the new system cannot be connected to the ARMER Zone 6 Master Site, and Cass County/Fargo is required to purchase and maintain a Master Site for the new system.

It may be possible to obtain maintenance services from Motorola through the existing State of Minnesota ARMER network contract (with better pricing), depending on the outcome of the plan for ARMER connectivity discussed in Section 5 of this planning document.

Other ongoing radio system support costs will include tower site leasing for the 315 Main, Amenia, Kindred and AT&T Casselton tower sites (estimated to be $35,000 per year total for these locations). Some maintenance costs will also be encountered for the existing microwave radio links and VHF paging system.

5. Considerations for Use of the Minnesota ARMER Radio System Backbone

As outlined in the earlier sections of this plan document, Cass County/Fargo may have an option to consider in conjunction with the implementation of this new 800 MHz radio system. A system of this type requires a Master Site/Zone Controller, which can be considered the "host" or "server" of the system, and is used to operate and manage all functions of the network. This is a rather expensive device to purchase, with an estimated cost of $1.6 million (based on Motorola's budgetary proposal). It is also an expensive device to maintain, due to the ongoing software updates and general oversight required of the system. The cost of this device has been included as an option in the overall project budget.

There exists the potential option of utilizing the same device now being used within the State of Minnesota ARMER 800 MHz radio system. The ARMER system is the largest statewide radio network in the U.S., with the number of agency user radios on the ARMER network now approaching 100,000. Due to the size and capacity of the system, it has been implemented with six (6) Master Site Zone Controllers, located in diverse locations around the state. These locations include:

- Minneapolis/St. Paul area (2; Roseville and Golden Valley, Zones 1 and 2)
- Rochester (Zone 3)
- St. Cloud (Zone 4)
- Duluth (Zone 5)
- Detroit Lakes (Zone 6)

These units are located in different geographical locations and are configured to handle the radio traffic from the tower sites within their respective regions, as well the radio units and Talk Groups from the city, county and state user agencies within those regions. Though they are in diverse locations, they are linked together and share a common database. This allows agency radios from the various regions of the state to use the network regardless of specific location. This is especially important for agencies such as the Highway Patrol and DOT operations, who are by nature frequently on the move and roaming throughout different operating areas.

An important technical element to be considered throughout this discussion is the recent installation of new Motorola MCC7500 radio control consoles at the RRRDC facility in Fargo. These new consoles were implemented to replace the aging Centracom Gold Elite consoles which had been in service for over a decade, and had become an obsolete technology and product. The new MCC7500 consoles are an IP-based product, ***and are now connected directly to the ARMER Master Site in Detroit Lakes via microwave radio***. This provides the new consoles direct "network level" access into the ARMER 800 MHz network.

This is critical in conjunction with the planned conversion of Clay County and Moorhead public safety operations from VHF to the 800 MHz ARMER system, as it allows the RRRDC direct access to the local tower sites and talk groups planned for Clay County/Moorhead operations. It also allows direct access to the various Regional and Statewide Talk Groups being used by the public safety agencies in the northwest area of Minnesota, including State Patrol. Having access to these TG's greatly enhances communications interoperability for all agencies involved in public safety operations in the general area.

MCC7500 Radio Console Connectivity

An important point to be made is that MCC7500 consoles can only be connected to a single Trunked Radio network (such as ARMER). With the RRRDC consoles now connected to the ARMER network, they cannot be connected at the "network level" to any other system. If Cass County/Fargo were to implement a "Stand Alone" 800 MHz Trunked Radio system (not using the ARMER Master Site in DL), the RRRDC consoles would need to be disconnected from the ARMER system and reconnected to the new system. They would then loose access to much of the network functionality within the ARMER network (needed for daily dispatch operations with Clay County/Moorhead MN).

The only solution to this situation would be to implement a P25 system feature known as "ISSI" (Inter Sub System Interface). This is a network-level connection between two individual P25 Trunked Radio systems; an example would be between ARMER and another statewide system, such as Wisconsin's WISCOM VHF network, or a new stand alone 800 MHz system for Cass County/Fargo. The ISSI link allows many system-level functions to pass between the two networks. An MCC7500 console that is connected to one system will have access to talk groups and tower sites in the other system.

However, there are restrictions and limitations with this approach, including the number of talk groups, radios, and other features. There is also a significant cost, as the ISSI software application must be implemented on both systems, with a price of $50K to $100K, depending on the system types, features desired, and other technical factors. As such, this is not a preferred approach to console connectivity for primary use and operations.

Technical Considerations

From a technical approach, the connection and operation of a new 800 MHz multi-site subnetwork for Cass County/Fargo from the ARMER Zone 6 Master Site in Detroit Lakes is relatively simple, and has been done before for other subnetworks within Minnesota. Some examples are the 11-site simulcast subnetwork in Itasca County (Grand Rapids area), which operates through the Duluth Master Site. The Duluth area also has a Simulcast subnetwork, again operating through the Duluth Master site. The City of Rochester/Olmstead County subnetwork operates through

the Rochester Master Site. Within the Twin Cities metro area there are numerous city and county subnetworks operating through the Master Sites in the Roseville and Golden Valley locations.

Each Master Site/Zone Controller has a specific capacity for a number of tower sites, MCC7500 consoles, along with Talk Groups and radios on a system-wide basis. The Detroit Lakes Zone 6 Master Site is currently one of the least-utilized sites, with significant capacity to handle additional tower sites and radio traffic. Based on data provided by MnDOT and Motorola, the current usage statistics for the Detroit Lakes Master Site, along with projected Cass County/Fargo use, is as follows:

Parameter	Capacity	Current Use (est or avg)	Est. Cass Co. Use	Est. Cass Co. Use %	Remaining Capacity
System ID's (Note 1)	128,000	92,000	2,000	2%	34,000
Zone 6 Tower Sites	100	59	6	10%	35
Talk Groups (Note 2)	8,000	4,000	82	2%	3,920
Z6 Call Count/PTTs (note 3)	NA	2.4M	265K	11%	NA
Z6 User Airtime (hours)	NA	5,500	725	13%	NA
Z6 Console ID's (4)	50	6	Included	Included	44

(Note 1): The System ID capacity is planned for expansion to 256,000 through a future software upgrade via Motorola's SUA II program. The numbers shown are system wide, not just for Zone 6.

(Note 2): The Talk Group Capacity is system wide, not just for Zone 6.

(Note 3): The numbers shown are per month. The Cass County/Fargo estimates are based on existing traffic levels from similar subnetworks such as Duluth, St. Cloud and Olmsted.

(Note 4): The RRRDC consoles are already connected to the Zone 6/DL site. No further port use or expansion would be needed.

As shown, there exists significant available capacity within the Zone 6 Detroit Lakes Master Site and the ARMER system for future use and expansion. At this time, there are no additional tower sites planned in the Northwest/Zone 6 Region, but significant capacity remains available for future expansion within the Region.

Operational Benefits and Considerations

Regardless of the technical ease with which the ARMER Master Site in Detroit Lakes could be configured to operate and manage a new Cass County/Fargo 800 MHz subnetwork, the larger issue to be addressed is whether it is appropriate for a valuable radio system resource such as the Detroit Lakes Master Site to be used by a group of agencies geographically located outside of Minnesota. We believe a

key factor to again be considered in this discussion is the role of the RRRDC in providing 911 dispatch services for both Clay County/Moorhead, Minnesota and Cass County/Fargo, North Dakota. The RRRDC is a very unique operational model, and may be the only one of its type in the country, whereby a 911 PSAP located in one state provides primary 911 dispatch services for public safety agencies in two states, directly across the border from each other.

The RRRDC primary dispatch center, located in downtown Fargo, North Dakota, provides all 911 call taking and emergency dispatching services for all public safety agencies in the following jurisdictions:

- Clay County, Minnesota including Moorhead and other city agencies
- Cass County, North Dakota including Fargo, West Fargo and other cities

The RRRDC was established through a Joint Powers Agreement between Cass County, the City of Fargo, Clay County, and the City of Moorhead in 2001. A renovation of the building for the new dispatch center commenced in 2002, and the facility became fully operational in October 2003. As noted on their web site, the RRRDC was the first consolidated dispatch center to manage dispatch operations and personnel independently from the agencies it serves.

Website: www.rrrdc.com

As noted, the center now utilizes the Motorola MCC7500 console system, with nine (9) dispatcher workstations.

A primary benefit to allowing a new Cass County/Fargo 800 MHz subnetwork to operate from the ARMER Zone 6 Master Site is the seamless Interoperability that would be provided to the RRRDC, as well as ALL public safety agencies within Clay County/Moorhead and Cass County/Fargo areas.

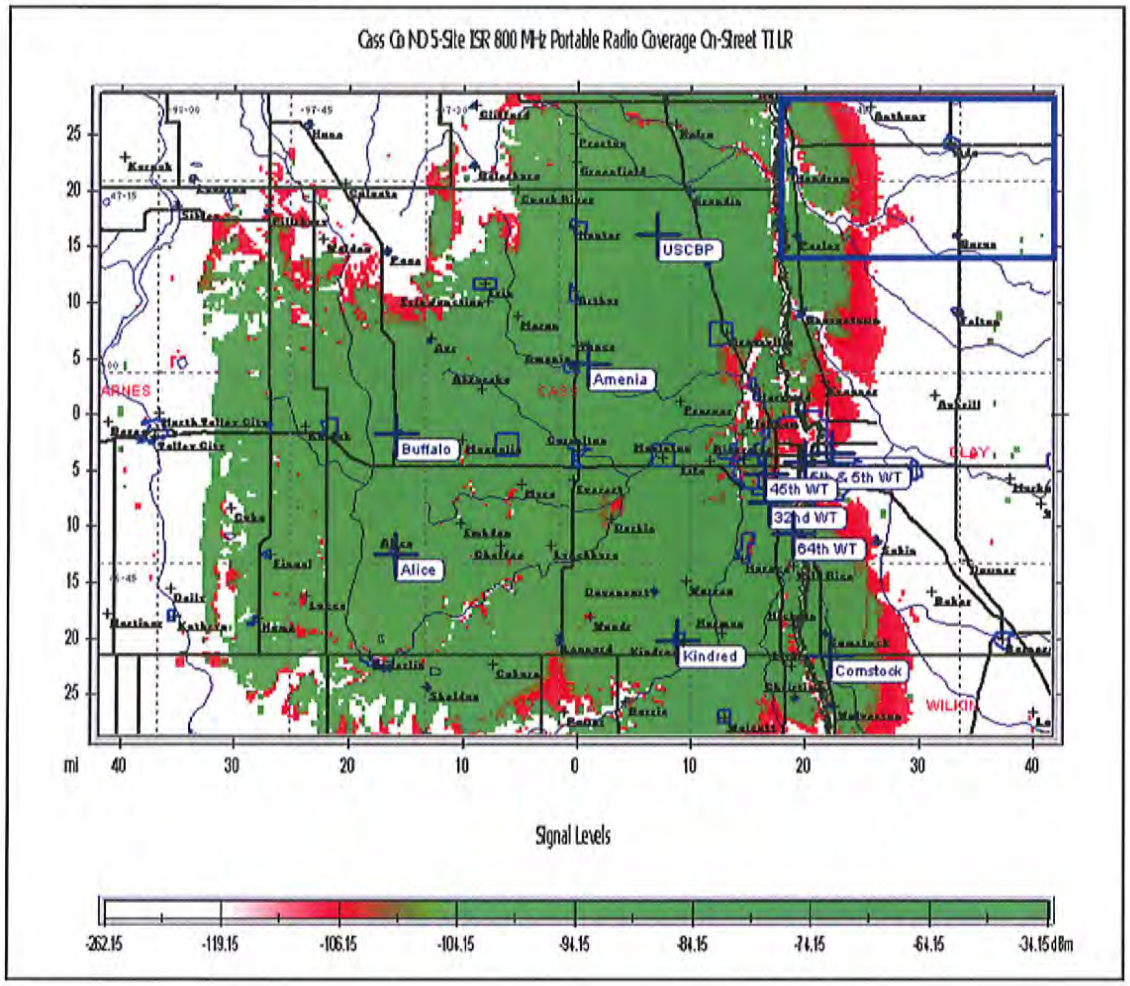
Knowing that all agencies will eventually be operating on an 800 MHz radio system, and that these groups of agencies work and function almost as a single, large public safety operation, it would be challenging to have them working from two independent radio networks. Even the existing VHF systems have been configured to allow overlap in coverage across the county and state borders.

Some specific operational benefits to be had for each user group are as follows:

- RRRDC: Seamless access to the networks, including Talk Groups (local, Regional and Statewide), radio user PTT ID's, and tower sites within both systems and subnetworks. Improved "Patching" capability within the two networks.
- Clay County/Moorhead MN agencies: Seamless access to the new Cass County/Fargo Talk Groups, radio PTT ID's, and tower sites for Interoperability. A new Cass County/Fargo 800 MHz system will also

expand radio coverage west across the border into North Dakota for selected Clay County/Moorhead Talk Groups.

- Cass County/Fargo/West Fargo ND agencies: Seamless access to the Clay County/Moorhead Talk Groups, radio PTT ID's, and tower sites for Interoperability.
- Norman County MN: The proposed US CBP 800 MHz Cass County tower site planned for the northern area of the county will provide on-street portable and some level of in-building coverage into Norman County, where ARMER coverage is currently somewhat limited. Refer to the coverage map below to see the level of portable coverage expected from the system. Norman County is shown by the blue box in the upper right hand corner of the map.



- ARMER system users in northwest Minnesota (State Patrol, etc.): A need for Interoperability also exists between Minnesota and North Dakota agencies. MN State Patrol radio users would be able to roam across the border into North Dakota (pursuits) seamlessly into the Cass County/Fargo subnetwork.

All of the above examples are of course dependent on the proper programming and configuration of the radios and system access profiles, etc.

Financial Considerations and Benefits

Assuming the ARMER administration and various governing groups agree on the operational benefits to be realized, and are open to considering allowing Cass County/Fargo access to and the use of the Zone 6/Detroit Lakes Master Site from an operational perspective, there are financial issues that must be reviewed and addressed. It is obviously a financial benefit to Cass County/Fargo to allow the connectivity and operation of the proposed 800 MHz Trunked Radio System from the ARMER Zone 6 Master Site in Detroit Lakes, as it then eliminates the need for Cass County/Fargo to purchase a Master Site, with an estimated cost of $1.5 million, along with the ongoing maintenance and support fees.

Nonetheless, Cass County/Fargo would be willing pay ARMER for the use of this system component, but how should the cost or value of this usage be determined?

One approach might be calculate the percentage of the overall use of the Zone 6 Master Site by the Cass County/Fargo subnetwork, and apply this percentage to the annual costs associated with the Zone 6 Master Site. An example of that model might be as follows:

1	Annual Operating and Maintenance Costs for Zone 6 Master Site (based on Motorola SUA-II Service Contract)	$156,000
2	Motorola ST Technical Services (% of system total)	$ 27,200
2	Other MnDOT Zone 6 Maintenance and Operating Costs (est.)	$ 50,000
4	Total Estimated Yearly ARMER Zone 6 Maintenance Costs	$233,200
5	Cass Co/Fargo Zone 6 Site Usage (est. from previous table)	13%
6	$233,200 x 13% = (Cass County/Fargo Annual Usage Fee)	$ 30,316

In the table on page 2-55, Cass County/Fargo would use 10% of the overall Zone 6 tower site capacity (6 sites of a total of 65 being used). However, that same table shows the Cass County/Fargo subnetwork is projected to use 13% of the traffic capacity in Zone 6, so this higher number would be used to calculate the resulting cost sharing. This usage can easily be tracked, and adjustments made if the traffic levels are significantly higher or lower than the estimated numbers.

Cass County/Fargo also proposes to pay a one-time "Connection Fee" of $195,000 for use of the Zone 6 Master Site. This number is based on a Master Site cost of $1.5M x 13% (est. usage) = $195,000.

In the actual ARMER Plan document we state that Cass County/Fargo is open to a discussion regarding other operational usage parameters or criteria that could be used to calculate their use of the Zone 6 Master Site, and establish an equitable fee to be paid to ARMER for the use of this valuable resource.

Another important element to these calculations, usage considerations and cost determination is to establish an understanding and written agreement that if – at some point in the future – the Zone 6 Master Site approaches operational capacity, and requires expansion (with associated costs), Cass County/Fargo will be responsible for funding whatever changes are needed to that element of the system. Further, Cass County/Fargo would be required (by written agreement) to do the following:

- Maintain their 800 MHz Trunked Radio subnetwork at the same software levels being used by the ARMER system
- Provide funding for future maintenance and software upgrades associated with Zone 6 Master Site operations, based on whatever usage formula is established with ARMER

There would a financial benefit to ARMER as well with the proposed plan, as the funding provided by Cass County/Fargo would go directly to the operations and maintenance of the ARMER system. Because any actual incremental costs for the Zone 6 Master Site would be covered by Cass County/Fargo, the calculated usage fees paid by Cass County/Fargo would be a net benefit to ARMER.

Note that the costs discussed here are over and above the radio system maintenance costs identified in Section 4.G. of this plan document (page 2-50).

There are other technical considerations to be addressed, such as Tower Site permissions for Cass County/Fargo radios, which would be set to keep Cass County/Fargo agency radios affiliated with their home network, unless roaming into Clay County, when working with other agencies in that service area. However, the proposed Cass County/Fargo 800 MHz system would provide a significant coverage footprint into Clay County/Moorhead, and as a result Cass County/Fargo radios could remain on the Cass/Fargo system without using ARMER 800 MHz RF tower site capacity.

In summary, we believe that there are significant operational and financial benefits to be had by all agencies if a new Cass County/Fargo 800 MHz subnetwork were to be allowed to operate from the ARMER Zone 6 Master Site in Detroit Lakes.

6. Other Radio System Options to Consider?

The question has been asked whether there are any other public safety radio system options that should be considered before moving forward with the proposed 800 MHz radio system. There are a limited number of alternatives that could be considered for this purpose:

A. Retain VHF P25 digital operation with system expansions. The current VHF system uses P25 digital modulation, which continues to be used by agencies in North Dakota. The only potential options within VHF would be:

- Replace all existing system and infrastructure with new VHF P25 equipment, and retain the existing system configuration. This would address the issue of aging equipment, but would do nothing to expand the system operations for additional channel capacity and in-building portable radio coverage.

  - or -

- Replace the existing VHF system with a new VHF P25 Trunked Radio System, which is essentially the same type of system being proposed for 800 MHz, but without the in-building coverage and Interoperability benefits to be found with a new 800 MHz system.

  The lack of Interoperability with Clay County/Moorhead agencies would be a major issue with any VHF option. Much of the tower site work identified for the project would be needed as well. The cost of this option would be nearly identical to the cost of the proposed 800 MHz system, but without the same benefits.

B. Implement a stand-alone 800 MHz Trunked radio system from another vendor (non-Motorola). A county or other local government agency has the option of building their own 800 MHz Trunked Radio System. This type of system would not be connected to the ARMER network, and would create significant technology challenges for operation and connectivity with the RRRDC. Some potential cost savings may be realized with this option, but any savings would quickly be offset by the increased technical and operational complexity of such a system.

Based on our understanding of Cass County and Fargo's radio operational needs and history, along with technical and financial considerations, we do not believe any of the above options are a logical choice, and none provide an equivalent or better radio system than a conversion to an 800 MHz P25 Trunked Radio system, with connectivity into the ARMER network.

7. Summary of Proposed 800 MHz Radio System

The review of the 800 MHz radio system being proposed for Cass County, Fargo, West Fargo and associated agencies, with the technology, features and radio coverage provided by it, is expected to meet the growing needs of these agencies, and provide a reliable and high performance radio network for years to come.

The implementation of the 800 MHz subnetwork, and potential operation with the State of Minnesota ARMER radio system, will provide excellent radio communications coverage, capacity, reliability and performance for customer agencies. This new system will also greatly improve communications interoperability with neighboring public safety agencies adjacent to Cass County/Fargo (specifically Clay County and Moorhead), who are also moving to 800 MHz Trunked Radio system operations.

The cost of this implementation is not inexpensive, but the price of new advanced technologies and associated performance is greater than previous generations of equipment. A significant amount of work will be needed by the Cass County/Fargo project team to complete the tower and water tower site work needed for operation of the system, along with the programming and installation of new mobile and portable radios for use by the member agencies.

The radio system data incorporated into this planning document will now be used to prepare an ARMER Participation Plan for Cass County/Fargo, and eventually be presented to the various ARMER groups and committees for review and approvals, including the following:

- ☐ ARMER Executive Steering Committee
- ☐ ARMER SECB Finance Committee
- ☐ State of Minnesota ECN staff
- ☐ MnDOT
- ☐ Northwest Minnesota RAC and ECB

Attachment A: Draft Fleetmap for new Cass County/Fargo 800 MHz System

Law	TG Alias
Cass County LE Announcement TG	CS LAW ANNCE
Cass County Sheriff Primary	CS SO MAIN
Cass County Sheriff Alternate Encrpted	CS SO2E
Cass County Sheriff Alternate	CS SO3
Cass County Sheriff Alternate- Car to Car	CS SO C2C
Cass County Sheriff Investigations	CS INV1E
Cass County Sheriff Investigations	CS INV2E
Cass County Jail	CS JAIL1
Cass County Public Safety Roam	CS PS ROAM
Cass County Law Emergency Button	CS EMER LAW
Fargo PD Primary	CS FGO PD1
Fargo PD Alternate	CS FGO PD2
Fargo PD Alternate	CS FGO PD3
Fargo PD Alternate Encrypted	CS FGO PD4E
Fargo PD Alternate- Car to Car	CS FGO PD C2C
Fargo PD Investigations Encrypted	CS FGO INV1E
Fargo PD Investigations Encrypted	CS FGO INV2E
West Fargo PD Primary	CS WF PD1
West Fargo PD Alternate	CS WF PD2
West Fargo PD Alternate Encrypted	CS WF PD3E
West Fargo PD Alternate- Car to Car	CS WF PD C2C
West Fargo PD Investigations Encrypted	CS WF INV1E
West Fargo PD Investigations Encrypted	CS WF INV2E
NDSU PD Primary	CS NDSUPD1
NDSU PD Alternate Encrypted	CS NDSUPD2E

Fire and EMS	TG Alias
Cass County FIRE & EMS Announcement TG	CS FIRE ANNCE
Cass County Fire/EMS Primary	CS F/E MAIN
Cass County Fire/EMS Alternate 2	CS F/E 2
Cass County Fire/EMS Alternate 3	CS F/E 3
Cass County Fire/EMS Alternate Encrypted	CS F/E 4E
Fargo FD Primary	CS FGO FD1
Fargo FD Alternate 2	CS FGO FD2
Fargo FD Alternate 3	CS FGO FD3
Fargo FD Alternate 4 Encrypted	CS FGO FD4E
West Fargo FD Primary	CS WF FD1
West Fargo FD Alternate	CS WF FD2

Cass Co Fire Truck to Truck	CS FR C2C
Fargo Fire Truck to Truck	CS FGO FDC2C
West Fargo Fire Truck to Truck	CS WF FDC2C
Cass County Fire Emergency Button	CS EMER FIRE
Cass County FIRE & EMS Announcement TG	CS EMS ANNOUNCE
Cass County FM Ambulance Dispatch	CS FMA DSP
Cass County FM Ambulance Primary	CS FMA 1
Cass County FM Ambulance Alternate E	CS FMA 2E
Cass County Public Health	CS P HLTH 1
Cass Emergency Mangement	CS CO EM1
Fargo Emergency Mangement	CS FGO EM1

Public Works, Transportation and Schools	**TG Alias**
Cass County PW Announcement TG	CS PW ANNOUNCE
Cass County Highway Department	CS HWY1
Cass County Highway Department ALT	CS HWY2
Fargo Street	CS FGO PW1
Fargo Street	CS FGO PW2
Fargo Street	CS FGO PW3
Fargo Water/Wastewater	CS FGO WW1
Fargo Solid Waste	CS FGO SW1
West Fargo Street	CS WF PW1
West Fargo Street	CS WF PW2
Fargo Schools-Emergency	CS FGO SCH 911
West Fargo Schools-Security	CS WF SCH SEC
West Fargo Schools-Emergency	CS WF SCH 911
Fargo Schools-Security	CS FGO SCH SEC
Cass County School Future	CS SCH1
Cass County School Future	CS SCH2
Cass County PW 1 Future	CS PW 1
Cass County PW 2 Future	CS PW 2
Matbus-Metro Transit	CS MATBUS

Pooled-Metro/County Public Safety	Talkgroup Alias
Cass County Announcement TG	CS ANNOUNCE
Cass County Calling/Hailing TG	CS CALL
Cass County Operational TG	CS 1
Cass County Operational TG	CS 2
Cass County Operational TG	CS 3
Cass County Operational TG	CS 4
Cass County Operational TG	CS 5
Cass County Operational TG	CS 6
Cass County Operational TG	CS 7
Cass County Operational TG	CS 8
Cass County Operational TG	CS 9
Cass County Operational TG	CS 10
Cass County Operational TG	CS 11
Cass County Operational TG	CS 12
Cass Cass Common Encrypted	CS 13E
Cass Cass Common Encrypted	CS 14E

County Interop	Talkgroup Alias
ND SR2 C2C	
VLAW31-Cass	

Attachment B: Detailed Budget for new Cass County/Fargo 800 MHz System

Item No	Equipment and Services	Orig Budget	Motorola Budget
1	**800 MHz Trunked Radio System**		
1.1	800MHz 4-site RF Trunking System Simulcast (Fargo)	$ 1,100,000	$ 1,765,213
1.2	Prime Site Equipment	$ 300,000	Incl.
1.3	Master Site/Zone Controller (optional)	**$ 1,000,000**	**$ 1,665,391**
1.4	Motorola Services	$ 500,000	$ 770,839
1.5	Antennas, Lines and Installation	$ 140,000	Incl.
	Subtotal - Fargo Radio System Infrastructure	**$ 3,040,000**	**$ 4,201,443**
1.5	800 MHz 5-site ISR Trunking System - Cass County	$ 1,138,667	$ 1,019,100
1.6	Motorola Services	$ 500,000	$ 297,013
1.7	Antennas, Lines and Installation	$ 175,000	Incl.
	Subtotal - Cass Co Radio System Infrastructure	**$ 1,813,667**	**$ 1,316,113**
	Grand Total - Motorola System Equipment	**$ 4,853,667**	**$ 5,517,556**
1.8	Master Site Licenses - ARMER Detroit Lakes	$ 25,000	$ 25,000
1.9	Microwave Radio Links - to ARMER DL	$ 100,000	$ 100,000
1.10	Microwave Radio Links to Cass Co Sites	$ 500,000	$ 500,000
1.11	Fiber Optic for Fargo 64th St site	$ 162,470	$ 162,470
1.12	Fiber Optic for Fargo 32nd Ave site	$ 66,660	$ 66,660
1.13	Fiber Optic for Fargo Prime site	$ 58,740	$ 58,740
1.14	Fiber Optic Multiplexers	$ 12,000	$ 12,000
	Other Options		
1.15	Field Coverage Testing	$ 40,000	$ 35,000
1.0	**Total - Radio System Equipment**	**$ 5,818,537**	**$ 6,477,426**

(cont. on next pages)

2	Tower Site Project Costs		
2.1	Buffalo Site: 180-ft Self Supporting Tower	$ 90,000	$ 90,000
2.2	Buffalo: Geotechnical (soil) testing	$ 2,500	$ 2,500
2.3	Buffalo: Civil and Environmental work for new tower	$ 15,000	$ 15,000
2.4	Buffalo: Shelter relocation (reuse existing from 64th ?)	$ 15,000	$ 15,000
2.5	Buffalo: Slab foundation, Fencing	$ 20,000	$ 20,000
2.6	Buffalo: Emer Generator (from 64th St), Elec work	$ 7,500	$ 7,500
2.7	Fargo Prime Site: Shelter (delivered, installed)	$ 65,000	$ 65,000
2.8	Fargo: 50 KW Emergency Generator, Elec work + R56	$ 50,000	$ 50,000
2.9	Fargo: UPS for Prime Site	$ 50,000	$ 50,000
2.10	Fargo: Antenna TX line mounting system (wtr tower)	$ 20,000	$ 20,000
2.11	Fargo: Slab foundation, Fencing	$ 20,000	$ 20,000
2.12	32nd Av Water Tower: Shelter (delivered and installed)	$ 65,000	$ 65,000
2.13	32nd Av: Slab foundation, Fencing(?)	$ 20,000	$ 20,000
2.14	32nd Av: Underground conduit for antenna lines	$ 15,000	$ 15,000
2.15	32nd Av: Water tower Engineering Svcs for Ant install	$ 2,500	$ 2,500
2.16	32nd Av: 25KW Emergency Generator, Electrical work	$ 25,000	$ 25,000
2.17	64th Av Water Tower: Shelter (delivered and installed)	$ 75,000	$ 75,000
2.18	64th Av: Slab foundation for new shelter	$ 15,000	$ 15,000
2.19	45th St Water Tower: No work needed	$ -	$ -
2.20	USCBP Tower: New 225-ft guyed tower	$ 160,000	$ 160,000
2.21	USCBP Tower: Civil & Enviromental work	$ 40,000	$ 40,000
2.22	USCBP Tower: Shelter (delivered, installed)	$ 50,000	$ 50,000
2.23	USCBP Tower: Emer Generator, Electrical Work	$ 25,000	$ 25,000
2.24	USCBP Tower: Slab foundation, Fencing	$ 20,000	$ 20,000
2.25	Alice Site: 180ft Self Supporting Tower	$ 90,000	$ 90,000
2.26	Alice: Geotechnical (soil) testing	$ 2,500	$ 2,500
2.27	Alice: Shelter (delivered, installed)	$ 50,000	$ 50,000
2.28	Alice: 25KW Emergency Generator, Electrical work	$ 25,000	$ 25,000
2.29	Kindred Tower: Structural review and Engineering	$ 2,500	$ 2,500
2.0	**Total - Tower Site Equipment**	**$ 1,037,500**	**$ 1,037,500**

3	Mobile/Portable Radio Costs		
3.1	Fargo Police - 800 MHz Mobile & Portable Radios	$ 1,732,595	
3.2	Fargo Fire Dept - 800 MHz Mobile & Portable Radios	$ 468,875	
3.3	Fargo P.Works - 800 MHz Mobile & Portable Radios	$ 412,590	
3.4	Fargo Water Dept. - 800 MHz Radios	$ 191,815	
3.5	West Fargo PD - 800 MHz Mobile & Portable Radios	$ 448,283	
3.6	West Fargo FD - 800 MHz Mobile & Portable Radios	$ 138,054	
3.7	West Fargo Public Works - 800 MHz Radios	$ 234,770	
3.8	Cass Co. Sheriff - 800 MHz Mobile & Portable Radios	$ 847,590	
3.9	Cass County Highway - 800 MHz Radios	$ 81,770	
	Subtotal - Mobile/Portable Radio Costs	**$ 4,656,342**	**$ 4,656,342**
3.10	Cass Co Rural Fire/EMS Depts - 800 MHz Mobile Radios	$ 499,200	
3.11	Cass Co Rural Fire/EMS Depts - 800 MHz Port Radios	$ 930,900	
3.12	Cass Co Rural Fire/EMS Depts - 800 MHz Base Radios	$ 72,000	
3.0	**Total - Mobile/Portable Radio Costs**	**$ 6,158,442**	**$ 6,158,442**

4	Other Project Costs		
4.1	Project Management (consulting)	$ 150,000	$ 150,000
4.2	Dispatch and Radio User Training	$ 20,000	$ 20,000
4.3	FCC Licensing	$ 10,000	$ 10,000
	Project Contingency (10% of $7M, excludes mobile/ports)	$ 700,000	$ 700,000
4.0	**Subtotal - Other Project Costs**	**$ 880,000**	**$ 880,000**
5	**Est. Grand Total Project Costs**	**$13,894,479**	**$14,553,368**