Radio Communications System Analysis & Recommendation Report

Presented to:

Town of Sherman, CT.

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RCC Consultants, Inc.

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1.0 INTRODUCTION

First Responders in the Town of Sherman currently utilize the Litchfield County Dispatch ("LCD") communication system which operates on VHF spectrum for responding to emergency dispatch calls for service.

Several difficulties in the existing radio system configuration render Sherman's First Responder operations unacceptable for public safety standards. System operation issues include the following:

- **Inadequate Radio Coverage** – hilly terrain variations make it very difficult for radio signals to cover the entire landscape in Sherman from a single radio transmission site.
- **Ineffective Simplex Operation** – simplex communication systems can make it impossible for users to communicate directly with users inother parts of Town, sometimes even in a neighboring valley.
- **No Backup Operations or System Redundancy** – no backup operations exist if LCD were unable to process emergency calls for service, or if LCD became overwhelmed with calls for service caused by large storms and other disasters; no equipment hardening to overcome power outages or equipment malfunctions.

RCC Consultants Inc. was retained to study the Town's radio system concerns and to examine system options moving forward. We report the findings of our study in this report and present alternatives to resolve the existing shortcomings.

RCC's methodology for this project focused its efforts first on collecting as much information as possible which describes the existing system configuration and operation. To this extent, the following tasks were performed:

1. FCC licenses authorized to the Town of Sherman were inventoried.
2. LCD leadership was contacted to gather data describing the LCD system as it pertains to the Town of Sherman.
3. Radio equipment inventory records were retrieved from the Town.
4. Radio transmission and reception system parameters were retrieved from Northeastern Communications and from LCD.
5. Potential radio communication sites were inventoried and surveyed throughout the Town
6. User operations descriptions were retrieved from the Town.
7. Preliminary radio propagation simulation analyses were performed to depict existing coverage areas and deficiencies.
8. Town of Sherman user and steering committee meeting was held to discuss all radio system issues at hand
9. Alternative engineering solutions were analyzed which would address the existing system issues.

2.0 FCC LICENSE AUTHORIZATIONS

RCC inventoried and analyzed FCC licenses authorized to the Town of Sherman. Three (3) FCC licenses have been granted to the Town. Examination of the licenses showed that all of Sherman's licenses have been modified for narrowband operation. A summary of the licensure is depicted in Table 1 below. Reference copies of the licenses are included in Appendix A.

OPERATION	CALL SIGN	FREQUENCY				SITES			
		Tx	Rx	ERP	Station Class	SVFD			Comments
						STRUCTURE HT		GROUND ELEVATION	
Town RPTR	WPIY661	154.1675	158.9475	100	FB2	42'		732'	**Not Deployed**
TBD	WQIJ777	153.7400	153.7400	35	FB	68'			**Not Deployed**
TBD	WQIJ777	153.7400	153.7400	35	MO				**Not Deployed**
Fire Gnd	WPIY661	154.1675	154.1675	45	MO				
Sherman TAC 1	WPIY661	154.4225	154.4225	45	MO				
Sherman FIPO	WPIY661	154.7475	154.7475	45	MO				**FIPO =** Fire/Police
Not used	WPIY661	33.8600	33.8600	110	FB	42'		732'	
Not used	WPIY661	33.8600	33.8600	110	MO				
Not used	WPYA960	45.2800	45.2800	110	FB	42'		732'	
Not used	WPYA960	45.2800	45.2800	110	MO				

Table 1 Summary of FCC licenses granted to the Town of Sherman

Analysis of Sherman's licenses shows that the Town is authorized to transmit from four fixed base facilities (FB), as denoted by the "Station Class" column. Two of the four FB's are low band channels that have not been in operation for quite some time. The FB authorizing transmission of the first channel in the list is actually licensed for repeater operation, as denoted by "FB2." This channel is also not in operation at the present time. As discussed later in this report, RCC has recommended substantial deployment of this very useful repeater channel resource.

Also of interest is the simplex channel – 153.7400 MHz -- authorized under license WQIJ777. This channel also has not been implemented by the Town. Depending on funding availability, Sherman may wish to pair this transmitter with a receiver frequency and modify the license for repeater (FB2) operation. RCC can provide guidance and assistance to the Town in performing this task.

With regard to the VHF low band channels – 33.860 MHz & 45.280 MHz – the Town has no further use for these licenses. The Town may wish to consider surrendering the licenses back to the FCC for use by other entities.

Another FCC related matter surrounds the use of LCD channels as well as all of the interoperability channels programmed in the existing fleet of Sherman subscriber radios. These channels are frequencies that are licensed to other organizations, but have been added to the Sherman subscriber radios for main system operation as well as interoperability. For example, Sherman radios have programmed within them two repeater channels licensed to the Town of New Milford – EMS (159.3525) and FD (154.3475). Although many interoperability entities consider it a formality, FCC rules do require that the entity to whom the radios belong have in their possession a formal "Letter of Agreement" for all transmit channels programmed into radios, for which the license is held by the interoperability partner. Accordingly, the Town of Sherman should solicit such a Letter of Agreement from the following organizations:

- LCD -- for dispatch and command channels; for Scene 4 through 15 channels; and for LCD Interops channel.
    - NOTE that Sherman has the LCD "scene 3" (AKA Sherman Fireground Channel) channel included in license WPIY661, therefore, a letter of agreement for use of this frequency from LCD is not needed.
- New Milford for EMS and FD channels.
- Gaylordville -- for FD and Scene channels
- New Fairfield – for FD 1 and FD 2 channels
- Patterson -- for FG 1 & 2 channels
- Putnam Lake -- for FG channel
- Brewster -- for FG 1 & 2 channels
- Roxbury -- for FD channel
- Washington -- for FD channel

- State of CT -- for STOCS 1 through 5.

3.0 EXISTING SYSTEM DESCRIPTION

The existing system utilized by Sherman First Responders is actually owned and licensed by Litchfield County Dispatch ("LCD") which provides dispatching and emergency communications services to the Town of Sherman. The Town of Sherman has equipped the SVFD with mobile and portable radios, as well as pagers and control station radios[1] which are programmed to access the LCD system for primary communications.

The LCD territory consists mostly of Litchfield County, but not all towns in Litchfield County subscribe to the LCD services. The Town of Sherman, which is obviously in Fairfield County, does subscribe to the LCD dispatching and radio communications services.

3.1 LCD System Configuration

Sherman relies upon the use of three simplex channels – labeled by LCD -- for Dispatch Operations, Command Operations, and Scene Operations. Shown in Table 2 below are the corresponding frequencies for each operational function:

OPERATION	FREQUENCY
Dispatch	155.1075 MHz (Tx/Rx)
Command	155.1225 MHz (Tx/Rx)
Fireground	154.1675 MHz (Tx/Rx)

Table 2 LCD channels assigned for each Sherman operation.

Fixed infrastructure installed by LCD is for only the Dispatch and Command channels. There is no fixed equipment, except for a desktop control station radio, in application of the Fireground channel. The Fireground channel is programed into all of the Town's subscriber radios for use as a fire ground channel.

Three sites are used by LCD for the fixed infrastructure as follows:

1. Chapin Road tower in New Milford.
2. Spooner Hill tower in Kent.

[1] Control Station radio is a mobile radio that has been supplied with a power supply and desktop microphone for use in a stationary desktop operation.

3. Sherman Volunteer Fire Department facility in Sherman (SVFD)

All three sites are used to simulcast the Dispatch channel. Two of the three sites – Chapin Rd. & SVFD -- are used to simulcast the Command channel. Spooner Hill has been deployed as a satellite receive-only site during operation of the Command channel. It is not clear why Spooner Hill is not configured to simulcast the Command channel.

Simulcast systems are implemented in a "prime" (or "main") and "remote" site configuration. The prime site – which is located at the LCD dispatch center – is the centralized location where all transmission sources in the system originate and are received. Prime site transceiver equipment is the same as that deployed at remote sites, but the difference is that the prime site will be equipped with a voting comparator set up for each channel in the system. The voting comparator is a collection point for all inbound transmissions on a specific channel, where the audio from the best received signal is selected, or "voted" for input to the dispatch console. Outbound transmissions are routed from the dispatcher through synchronized channel banks to all the transceivers on a specific channel with special timing delays needed to transit the signal with tightly controlled phase angle and amplitude characteristics.

Major components in the Remote sites – which in the case of Sherman will include Chapin Rd, Spooner Hill, and SVFD -- will include the following:

- Motorola Quantar Base Station
- IMACs channel bank to establish T-1 link from each site back to LCD dispatch
- TRAK Systems GPS timing equipment.
- Antenna System which includes both VHF antennas and GPS antenna.
- Equipment rack, primary power, UPS, and surge suppression.

Shown in Figure 1 Is the LCD equipment rack located in the radio equipment closet at the SVFD. The equipment in this rack is for the Sherman system, which is typical of the equipment racks installed in the Chapin Road and Spooner Hill tower sites. Not shown, of course, is the antenna system and the power systems which are also required.

Perhaps a note of importance in the simulcast equipment required to configure a site is in the fact that very little floor space is needed, as can be seen from the photograph, to equip a site with remote simulcast.

Figure 1 LCD equipment rack installed in equipment closet on second floor of new SVFD facility

Shown in Figure 2 below is a geographic location of the sites used in the LCD system with an embedded block diagram showing the LCD system configuration. All three radio transmission

sites are shown in the figure: Chapin Road, Spooner Hill, and the SVFD. Each site includes two Motorola Quantar base stations (black outline boxes), one IMACS channel bank (blue outline box), TRAK GPS timing system (not shown), antenna system (not shown), and ancillary equipment.

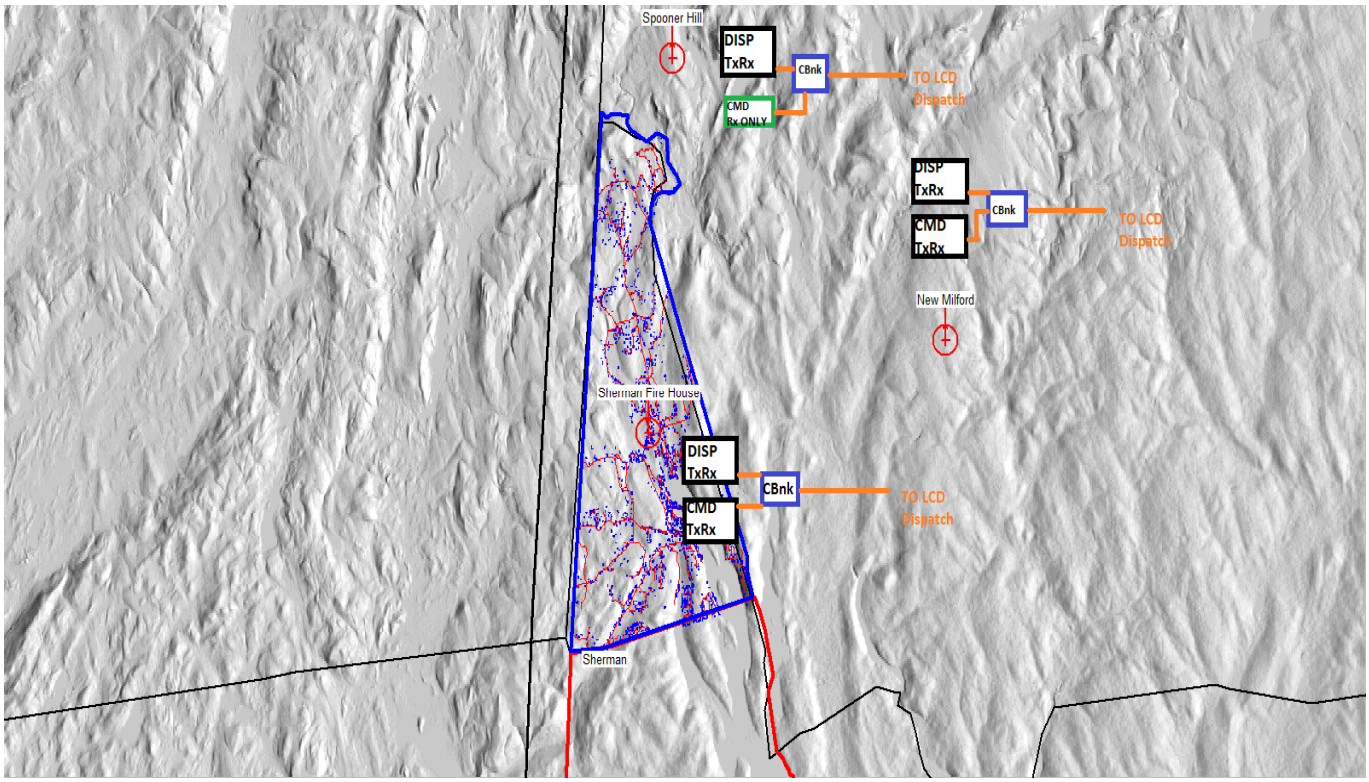

Figure 2 LCD System configuration for services to the Town of Sherman

Note that the Spooner Hill site has only one Quantar base station operating on the Dispatch channel. There is no transmitter on the Command channel at this site, only a Quantar satellite receiver (shown in green outline box). Each site is controlled by the LCD dispatch center through the IMACS channel banks via leased line T-1 services.

3.2 Sherman First Responder Operation

Emergency 9-1-1 calls from Sherman are picked up by LCD dispatch and the event information is entered into the LCD computer aided dispatch (CAD) system. The CAD event is displayed before the LCD dispatcher assigned to process Sherman calls. The LCD dispatcher first

transmits the paging tones on the Dispatch channel, which is then followed by the dispatch of the event information over the same channel.

Responding units will use the Dispatch channel to alert the dispatcher that they are responding to the station, awaiting a crew, responding to the incident, or that they are at the scene of the incident. Once units arrive to the scene of the incident, the Command channel used only as follows[2]:

- "Used for CRITICAL AND IMPORTANT communication between LCD and incident commander and /or LCD and section officers."
- "Used for CRITICAL communication between a mutual aid chief officer while enroute to an incident and the incident commander."
- "Used for on scene command communications with sector chiefs or officers."
- "Used for ambulance enroute to EMS destination." (status)
- "Used for ambulance at EMS destination" (status)
- "Used for ambulance clear of EMS destination." (status)
- "Used for Department in service/available." (message)
- "Used for incident closed and completed." (status)

Upon arrival to the event location, fire and/or EMS operations are conducted though a "Fireground channel" which is a "talkaround" mode of communications. "Talkaround" is a term used to describe unit-to-unit communications wherein the transmissions are not processed by any of the base station receivers, therefore, nothing is heard by the dispatcher. Fireground channel or "talkaround" is used until the event is cleared.

3.3 Existing Subscriber Equipment

Available inventory records from SVFD were obtained and reviewed in order to determine the radio types comprising the existing subscriber fleet in Sherman. Shown in Table 3 is a summary breakdown of the equipment currently in use, which consists almost exclusively of Motorola manufactured radios.

[2] from "LCD RADIO SYSTEM: Operational Protocols", Revision 1/3/2007; p.12

TYPE	QTY.
Motorola HT1250 Portable Radio	45
Motorola CDM 1250 Mobile Radio	19
Motorola CDM 1250 Control Station	1
Motorola Minitor V Pager	51

Table 3 Summary of Sherman subscriber equipment inventory

Sherman representatives expressed contentment with the existing subscriber radios and no need to examine alternatives.

3.4 Sherman Interoperability

Interoperability in and out of the Town of Sherman is a staple operation, with numerous interoperability modes in place, including local interoperability, regional interoperability, and statewide interoperability.

Most of the interoperability operations engaged by Sherman are with neighboring towns and communities that also operate in the VHF high band spectrum. All entities which are accessible on VHF High Band channels are referenced in the FCC licensing section (see Section 2). All of these channels are programmed into the existing Sherman subscriber equipment. The complete list of interoperability channels was forwarded by Northeastern Communications, and can be found in Appendix B.

For interoperability with entities that operate in different spectrum bands, Sherman uses separate and dedicated subscriber equipment. The following are interoperability operations with non-VHF High Band entities:

1. ITAC / I-CALL -- used to interoperate with the State of Connecticut's DPS system, which is deployed on the 700/800 MHz band. Sherman has two ICALL/ITAC radios located in the SFVD dispatch room for use when needed.

2. Dutchess County, New York operates in the UHF band. Dutchess County has furnished six (6) portable radios for use by Sherman for interoperability if the need arises. The UHF portable radios are kept in the SVFD.

RCC will carefully consider any system upgrade alternatives by taking into account the large number of future interoperability relations that are in place on the VHF high band spectrum between the Town of Sherman and many of their neighboring First Responder communities.

3.5 Communications Issues & Needs

3.5.1 Poor RF Coverage

Several issues have been cited by Sherman representatives that have already been discussed in the introduction of this report. By far, the most compelling operational problem is the lack of reliable town-wide radio communications coverage for the Fireground channel, as well as for Command channel to a lesser extent. As correctly characterized by Sherman representatives, the terrain in Sherman is very hilly and irregular rendering signal penetration into all areas extremely difficult. The coverage issues experienced for the LCD Dispatch channel were very few; Command channel coverage was described as worse; and Fireground channel or fire ground coverage is unpredictable.

RCC analyzed the coverage problems by modeling the propagation that should be experienced from the LCD simulcast systems. Both the Dispatch channel and the Command channel systems were modeled, based on installed system operating parameters. The results were reviewed with members of the fire department who confirmed that these propagation models well represent the actual radio results experienced by its members.

Since radio communications systems are two-way (i.e. inbound and outbound), coverage surveys are performed for both inbound transmissions and outbound transmissions. The predicted results vary considerably between inbound and outbound coverage due to the power link budgets which contribute to both sides of the RF system. The link budget is greater for the outbound transmission than it is for the inbound transmission. This is largely attributable to the fact that there is a substantial disparity in transmitter power output level between the portable radio which contributes to the inbound link budget, and the base station transmitter, which contributes to the

outbound link budget. In the Sherman-LCD system, the portable[3] output power is 5 Watts, while the base station output power is 100 Watts.

Shown Figure 3 in is the predicted outbound coverage for the LCD Dispatch Channel Simulcast System in Sherman. Areas depicted inside the yellow circles represent poor coverage areas. For the most part, the Dispatch Channel Simulcast System provides good coverage in most of Sherman, but has problems reaching the southern part of the town. The south part of Sherman has reasonably good coverage outside in the street, but shows substantially detracting coverage inside of buildings. The only way to improve coverage in this part of Sherman is to supplement the vicinity of the poor coverage area with a transceiver site, which must be done under the auspices of LCD.

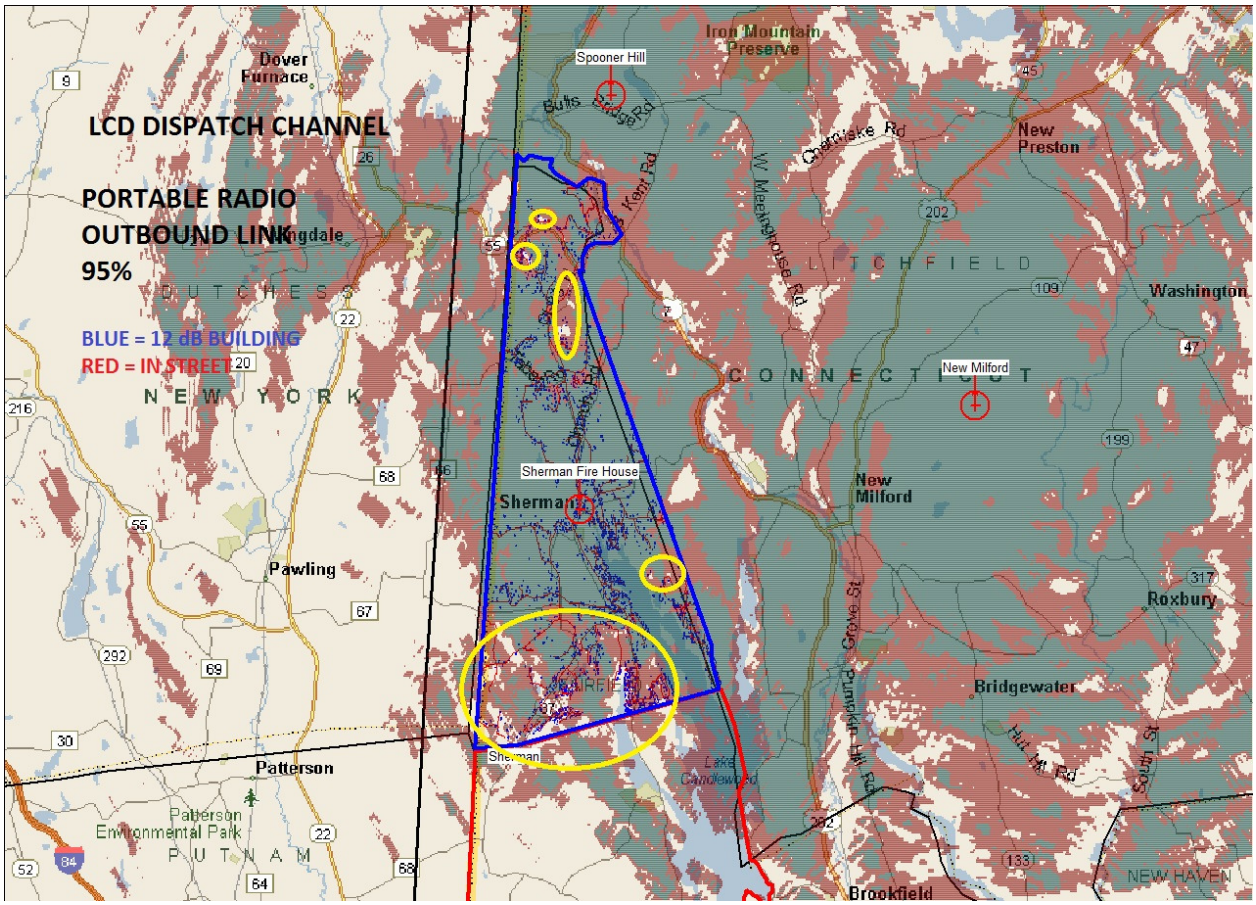

Figure 3 Coverage survey showing outbound (from dispatch to portable) propagation for LCD Dispatch Channel Simulcast System in Sherman.

[3] FYI, in mobile radio output power is variable, and determined through local programming. It is likely the power output ranges will be between 25W to 45W in Sherman.

Shown Figure 4 in is the predicted inbound coverage for the LCD Dispatch Channel Simulcast System in Sherman. Areas depicted inside the yellow circles represent poor coverage areas. By contrast, the inferiority of the inbound link to the outbound link is quite noticeable. Not only is the problem area in the southern part of the town substantially larger, but the inbound link shows several additional problem areas that are introduced in the northern part of Sherman.

From an operations perspective, what the outbound vs. inbound imbalance means is that in the areas marked by the yellow circles, it is quite possible that transmissions received by the portable radio operator from LCD dispatch, may not be heard by LCD dispatcher when responding units "talk back." The outbound vs. inbound link budget imbalance can be mitigated, or even eliminated with the addition of additional infrastructure equipment (under the auspices of LCD).

Please note that the label in Figure 4 states that this inbound coverage represents both the LCD Dispatch channel and the Command channel. The reason for this is because the Spooner Hill site is in fact equipped with a base station receiver on the Command channel. What it does not have is a transmitter on the Command channel, the effect of which is depicted in Figure 5.

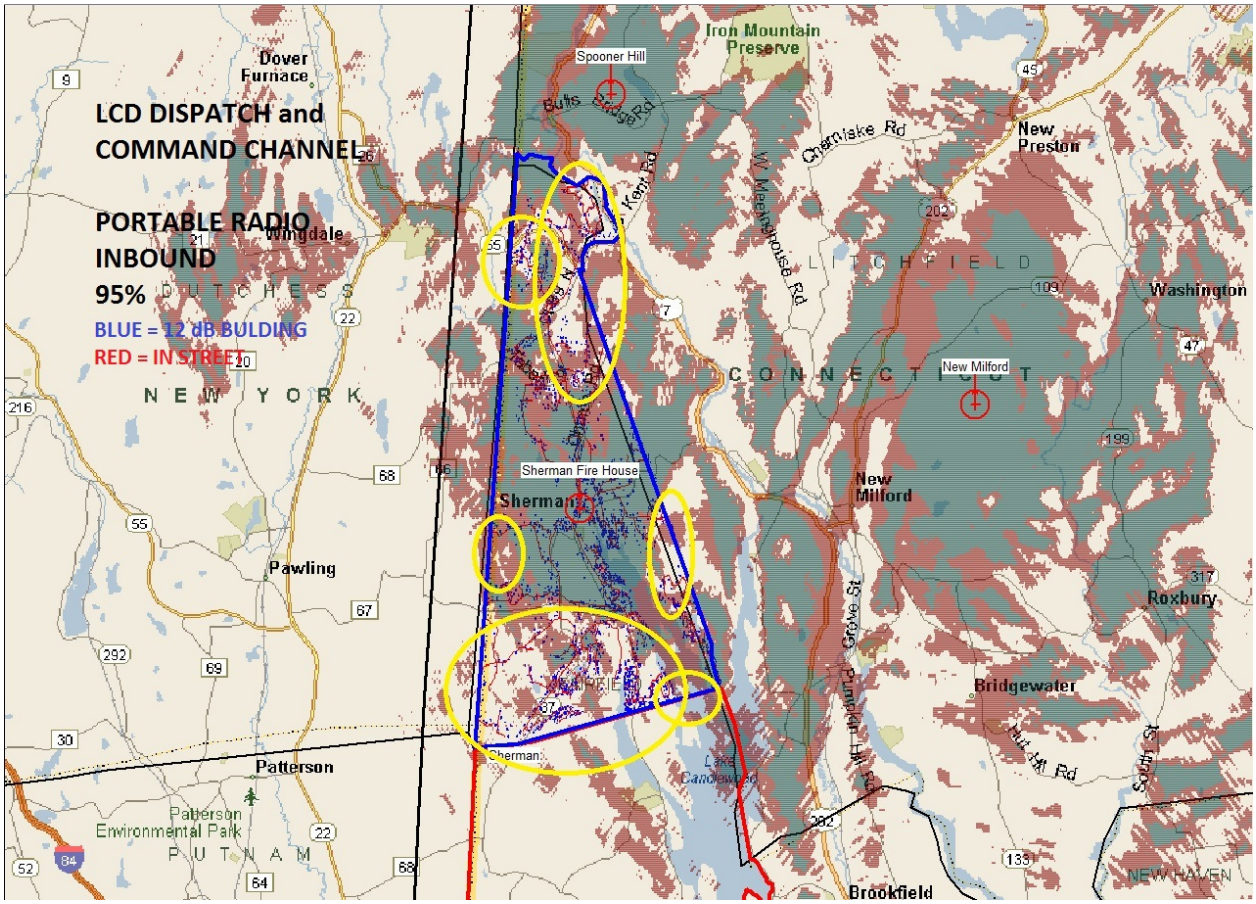

Figure 4 Coverage survey showing inbound (from portable radio to dispatch) propagation for the LCD Dispatch channel.

Figure 5 shows the predicted outbound coverage for the LCD Command Channel Simulcast System in Sherman. Command channel transmitters are located only at the Chapin Road tower site and the SVFD facility. There is no transmitter for the Command channel at Spooner Hill. Inspection of Figure 5, in comparison to simulcast coverage provided from three sites as provided for on the Dispatch channel shown in Figure 3, shows the impact of not having a transmitter on Spooner Hill in the northern sector of Sherman. The coverage gap in the north sector of town is substantially large.

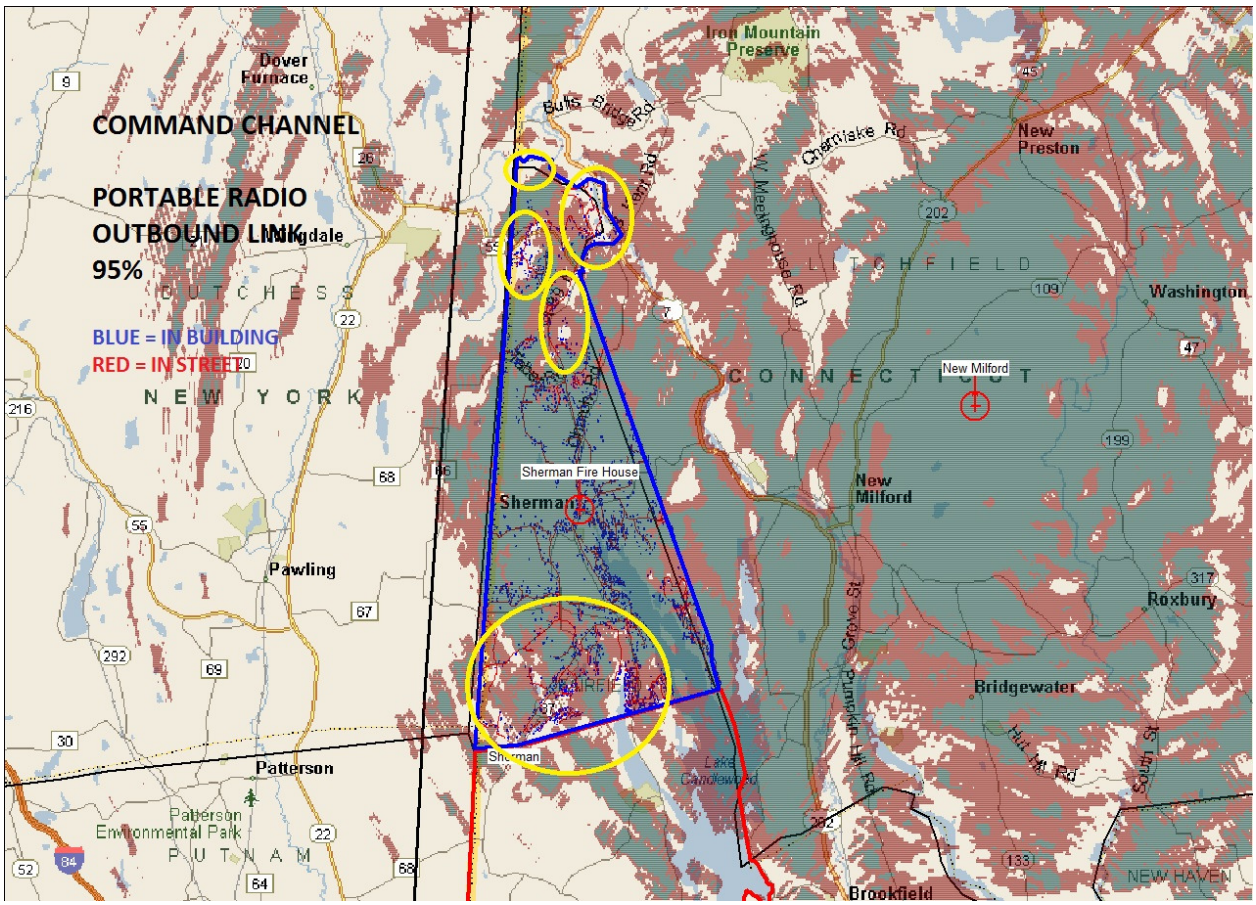

Figure 5 Coverage survey showing outbound propagation for the LCD Command channel

As stated earlier, inbound coverage for the Command channel is shown inFigure 4. In other words, the inbound transmission configuration for both the Command Channel and the Dispatch channel are identical. Only the outbound channel configuration is different in that the Command channel is not simulcast from Spooner Hill.

Coverage surveys for the Fireground channel are not shown in this report because there is no fixed base station resource on the fire ground. The Fireground channel can be in one part of town for one event, and in a different part of town for a different event. The coverage footprint for the fireground channel will be a function of the specific location of the event being serviced

because all communications between fireground radio equipment is direct (unit to unit) as opposed to a fixed repeater or broadcast station. For example, the fire ground channel may be used at an EMS incident location where one radio operator is communicating from inside the ambulance on a mobile radio, while the other radio operator is communicating from a portable or handheld radio inside someone's house. The coverage "footprint" of that communication link will be a function of the location of the ambulance, the location of the portable radio operator, the attenuation of the house, the terrain between the ambulance and the house, along with the transceiver parameters (power level; antennas; connecting cables; etc.) of the radios in use.

There is one additional existing operation in Sherman for which coverage was analyzed and that is the paging coverage. Over fifty (50) Sherman volunteer firefighters are equipped with Minitor V voice pagers. Paging alerts and messages are transmitted on the Dispatch Channel for every incident requiring emergency response. Shown in Figure 6 is the predicted coverage for a pager in Sherman. The coverage is obviously outbound (no transmitters on pagers) and the results are very similar to the coverage experienced for a portable radio.

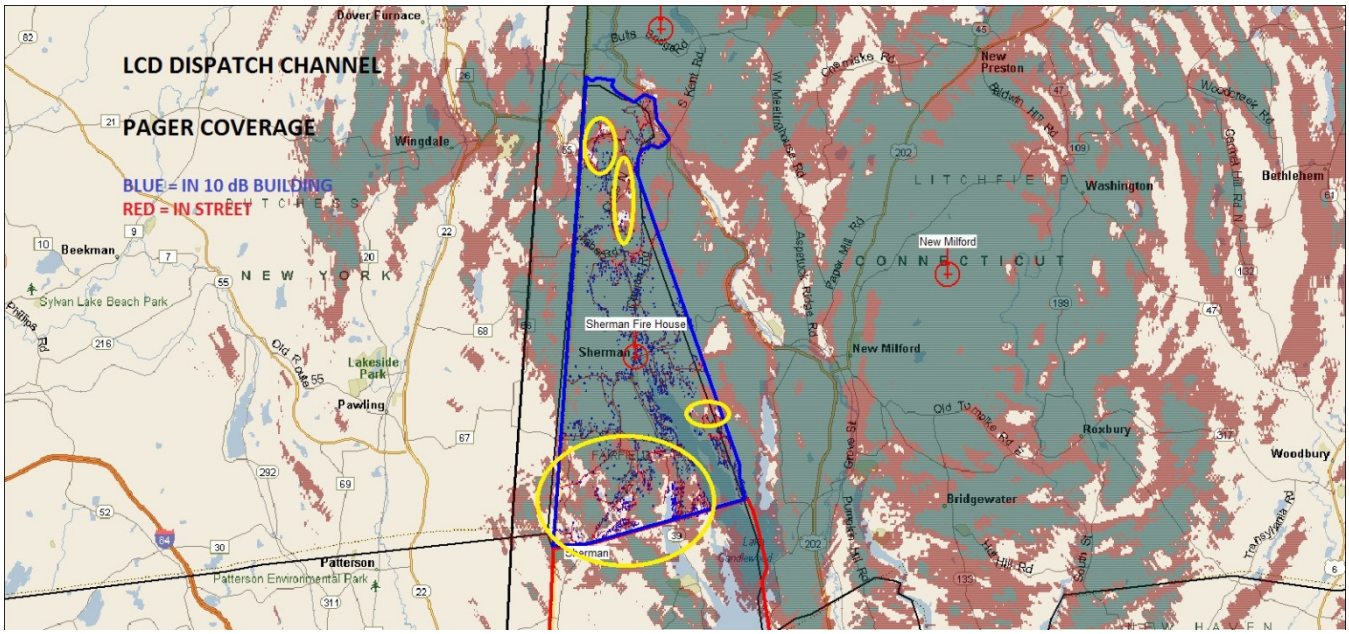

Figure 6 Coverage survey showing paging coverage from the LCD Dispatch Channel

3.5.2 Town-Wide Communications (Ineffective Simplex Operations)

Sherman First Responders consider it very important that radio channel access with the fire ground is necessary not only for units at the fire ground, but also for radio operations anywhere within the Town's boundaries who are trying to access the fire ground. In the existing configuration of channels, there are areas within the Town where transmissions from a portable

or mobile radio in one area cannot be heard by radio users in another area without dispatcher intervention. In these locations a dispatcher must relay the transmitting unit's radio traffic in order for the target recipient to hear the transmission. Of course, the LCD dispatcher can only serve to relay the received transmissions on the Command and Dispatch channels, not on the Fireground channel.

The cause of this problem is that the system is not currently configured for repeater operation – but rather simplex operation. In a simplex system, the transmitter frequency is the same as the receiver frequency. Signals received by the base station receiver are not retransmitted from the that site. Therefore, only users who operate in the "coverage footprint" of the simplex radio user will hear both– inbound and outbound – sides of the transmission.

In a repeater system, the transmit frequency is different from the receiver frequency thereby allowing both frequencies to operate in the same station without causing self-interference. Accordingly, in a repeater system as well as in a simulcast system, radio signals received by the base station receiver are not only routed to the dispatch console, but they are also retransmitted from the associated transmitter(s) at the same site(s) thereby significantly increasing the coverage footprint of the original signal.

Radio coverage problems related to town-wide transmission/reception will be largely resolved by deployment of a repeater radio infrastructure discussed later in this report.

3.5.3 System Redundancy & Backup Operations

It is an essential requirement for all public safety entities to harden their communications facilities and fortify their backup operations. By "hardening", we are referring to measures that facilitate backup power, spare or redundant components on hand, as well as supplemental equipment that would enable resumption of communications services, such as a dispatch controller. This would apply to any future infrastructure that Sherman may invest as well as negotiations with LCD to determine the degree to which they have implemented system hardening measures.

Any major impairment to any of LCD's system components could render communications inoperable for Sherman's first responders until service is either restored or the equipment is replaced. Restoration could take hours, or days, or even weeks depending on the severity of the failure or the availability of parts needed to service the existing equipment.

Backup operations are also necessary in case LCD dispatchers ever get inundated with calls for service and are unable to supply the necessary manpower resources to meet the demands for dispatching services.

Town representatives have made it clear that an alternate means to dispatch calls is important to Sherman in case anything happens to impair the LCD system, or render LDC dispatch services too busy to manage the workload. Sherman wants the "in-house" capability not only to dispatch incoming calls, but also to manage multiple situations over an extended period of time . (e.g. 50 different "wire down" situations in town, along with calls for help from the town's resdients). It is necessary to consider a backup dispatch center, within the town or perhaps from a neighboring location where E-9-1-1 calls and dispatching operations can be resumed in case of catastrophic failure at LCD.

4.0 CONCEPTUAL SYSTEM DESIGN CONSIDERATIONS & ALTERNATIVES

Any alternative technology considered for public-safety radio communication is predicated upon the availability foundational building blocks. These foundational elements include the following:

- Radio **spectrum** upon which public-safety communications will operate.
- The availability of radio facilities and **fixed infrastructure** that must propagate signal into the service area.
- A **communications center** where emergency calls are received, dispatched, coordinated, tracked, and closed.
- **Telecommunications** connectivity to link the fixed infrastructure with the communications center.
- Field **subscriber equipment** which will utilize the infrastructure to communicate with each other and with the dispatch center.
- **System management** to maintain all aspects of system operation.

For each alternative considered, provisions must be made to include each of these foundational elements.

One of the foundational elements that merit consideration prior to discussion of alternatives is the potential of supplementing radio sites which will likely have application to all solutions. We begin our discussion of design alternatives by first addressing the need for additional sites.

4.1 Radio Transmission Sites in Sherman

Sherman is clearly lacking sufficient coverage in many areas of the Town that can only be resolved by adding radio sites. The Town is also a blessed with a pristine landscape that many consider would be negatively impacted by the proliferation of towers. All agree with this stance.

With great sensitivity to mitigating the visual impact of towers to the landscape, a balanced alternative is presented for the Town's consideration. It is suggested that utilization of antenna

structures in remote areas that would no more detract the beauty of the landscape than would the installation of a common telephone pole. The LMR ("land mobile radio") and Cellular Industry refers to these types of sites as "low profile RF sites."

Figure 7 Low-profile telephone pole-type antenna structure (60') installed at Ball Pond VFD in New Fairfield

Potential antenna installation locations were surveyed within Sherman with a view to install a minimum number of low profile RF telephone pole type structures in higher elevation parcels of the Town. Higher elevation parcels would offset the need for the actual structures to be over extended above the landscape. If the land elevation was sufficiently high, then the actual structure height would only have to be high enough to clear the highest tree line in that location. Shown in Figure 7 is an example of a low-profile antenna structure that was installed behind the Ball Pond Volunteer Fire Department in New Fairfield.

Numerous sites were physically inspected for potential application. Sites that were deemed potential candidates for inclusion in the design were added to RCC's coverage prediction model to determine whether the Town's coverage goal could be met. Based upon the propagation simulation studies, it was concluded that the Town would need a minimum of three (3) low profile, unobtrusive radio transmission sites to meet Sherman's public safety coverage goal. One site would be needed in the north end of the Town, another in the central part of Town, and the last would be needed in the southern part of Town.

With regard to the central location, it is recommended that the SVFD facility continue to serve the coverage needs for the area. The SVFD site provides sufficient coverage, and will not burden the town with any site development cost impact.

The proposed areas at the northern and southern ends of town would be undeveloped, forested sites ("greenfield sites") for which the Town would install these telephone pole-type low profile structures. For the northern site, depending on which site the town selected, our design would call for a sixty (60) foot structure, and for the southern site, our design would call for an eighty (80) foot structure.

The resulting inbound and outbound coverage with deployment of these three sites is discussed in the following sections, as it is applied for each design alternative.

4.2 Conceptual Design Alternative One – One Channel Repeater Simulcast System

As alluded to in Section 3 of this report, the coverage provided by LCD on the Dispatch Channel, although not as good as it could be, was acceptable for paging and initial response purposes. To a lesser extent, especially in northern Sherman, Command channel operations provided by LCD can also be useful for incident response operations. What is unacceptable to the Sherman First Responders is effectiveness of simplex based unit-to-unit fire ground communications. To address Sherman's primary objective of improving radio coverage for their fire ground and EMS operations, the first alternative presented is implementation of a three-site, single channel repeater simulcast system that would used primarily for fireground operations.

4.2.1 Applied Spectrum

Very often, the most challenging resource to obtain when considering a radio system design solution is a FCC licensed radio channel. Without licensed spectrum, no Sherman enterprise system can be considered. Thankfully, Sherman already has a FCC licensed repeater channel – call sign WPIY661 -- upon which to build a solution. The authorized repeater transmit frequency is 154.1675 MHz and the complementary receive frequency is 158.9475 MHz

WPIY661 is currently authorized for 100 W effective radiated power (ERP) from the SVFD station. If the Town of Sherman adopts this design alternative, license modifications will have to be made to seek authorization of operation from the FCC to increase the number of sites from one to three as described herein. The process for this modification will require approval of the local frequency coordinators before it is presented to the FCC for final approval.

4.2.2 Fixed Infrastructure Design

4.2.2.1 Radio Coverage Design

Radio coverage for this alternative design was performed using a maximum ERP of 100 W, as currently licensed for the SVFD site. Numerous other parameters are determined for optimal system performance. Propagation parameters considered in the prediction model are as follows:

System:

- Antenna heights, antenna gains, and radiation patterns
- Transmitter output power
- Receiver sensitivity
- Transmission line, jumpers, and connector losses

Model and Environment:

- Longley Rice simulation model
- Topographic effects (mountains, valleys)
- Effects of vegetation
- Rayleigh and Lognormal fading
- Confidence factors (95% reliability)
- Physical structures
- Simulcast Effects
    - Minimum Capture: 15 dB
    - Maximum overlap propagation delay: 60 µS

Parameters used for the Sherman service area

- All repeater stations range in power between 28 W and 37 W
- Portable radios are 5 watts
- Portable radios transmit and receive at 3.5' (belt level) using a ¼ wave whip antenna and a speaker microphone. Body shielding/antenna efficiency included.
- All sites are transmit/receive
- 95/95% reliability

- 3 dB system loss was introduced for narrowband system operation.
- TSB-88 receive system offset loss was included to model 3.0 DAQ

Individual site coverage and composite coverage prediction maps were generated to analyze RF coverage for a portable radio unit "in-street" and “in 12 dB building” throughout the service area of Sherman. Sites utilized were the SVFD, Northern Site, and Southern Site.

Coverage is analyzed for both outbound coverage (base to subscriber) and inbound coverage (subscriber to base). Shown in Figure 8 below is the predicted outbound coverage for a three-site simulcast system.

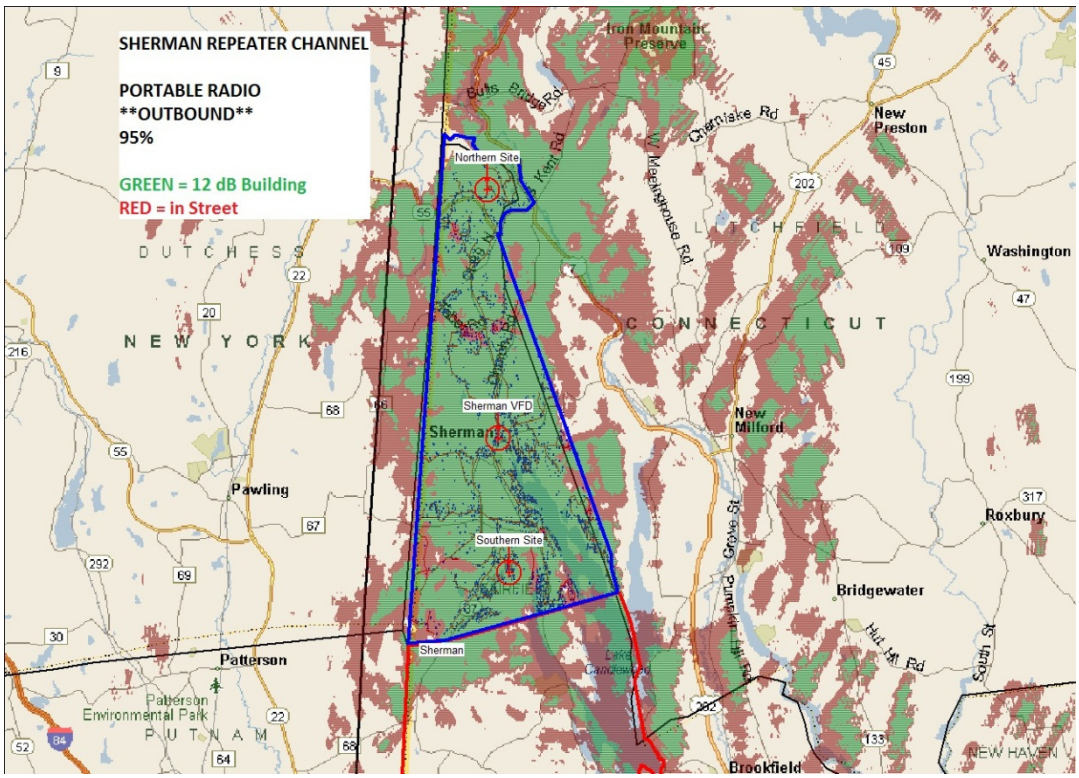

Figure 8 Sherman Coverage from 3 sites; 95% Portable-in-street (red) and in 12 dB building (blue) OUTBOUND.

As can be seen from the coverage shown above, the three proposed locations for Sherman will produce virtually blanket coverage for the First Responders using the suggested repeater channel.

Inbound coverage using the same sites and parameters will show a slight degradation in coverage if each site were configured to function autonomously. However, in a simulcast system, the sites are configured with a receiver voting platform. Probabilities of inbound reception will improve considerably when applying receiver voting technology, thereby increasing the likelihood that the inbound signal will be received by as many factors as there are signals reaching the overlap

area. For example, if an inbound transmission is likely to be received by two sites at 80% probability, the resultant reliability of the composite signals will theoretically be 96%. Shown in Figure 9 is the predicted inbound coverage for a three- site receiver voting system.

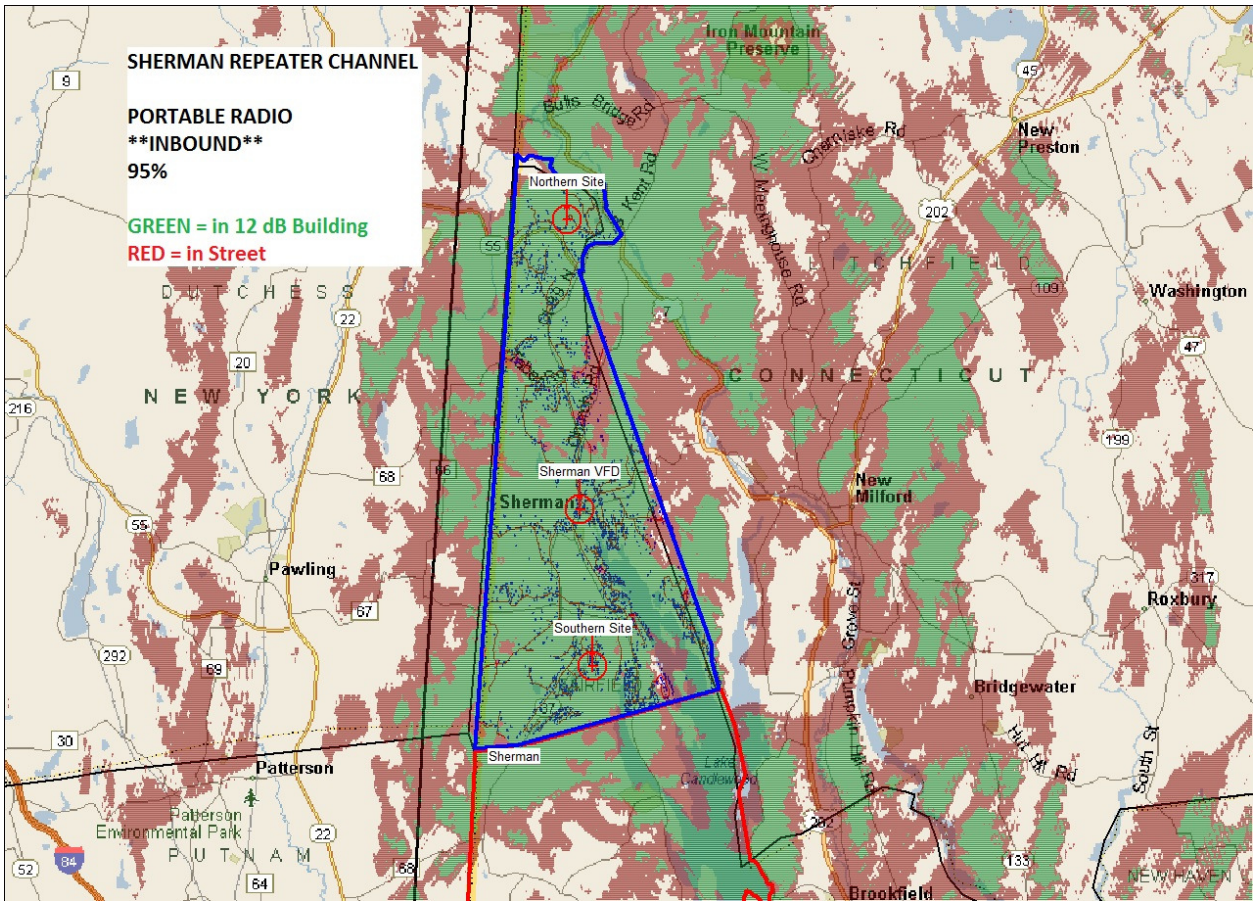

Figure 9 Sherman coverage; 3 sites; 95% Portable-in-street (red); Portable in 12 dB Building (green) INBOUND

4.2.2.2 Simulcast Equipment

Conventional simulcast system architecture will require specially designed components to maintain strict tolerances of transmission system parameters that would otherwise be less stringent in a non-simulcast system. When transmissions from two or more sites reach a subscriber radio without enough distinguishable signal level (i.e. RF capture), then all of the signals are received and processed by the subscriber radio in an attempt to accurately recover the transmitted voice message. The geographic areas where multiple transmission signals are available are called the overlap zones. Signal distortion which may occur in an overlap zone is usually caused by a number of contributors, including time delay interference (TDI), carrier difference interference, and modulation or deviation level distortion.

Parameters which must be kept in tight tolerance include:

- Modulation level of the voice message
- Phase angle of the audio (voice) component of the transmission (TDI control)
- Variance of the actual carrier frequency licensed.

Equipment tolerances include the following:

- carrier center frequency accuracy must not exceed +/- 1 Hz;
- audio phase angle must not be greater than +/- 30 degrees;
- modulation deviation must not exceed +/- 0.2 dB;
- system timing mechanism which performs synchronization of radio transmissions.

System equipment required to deliver quality simulcast communications which adhere to strict tolerances include the following major components:

1. Simulcast capable repeaters having uniformity of manufacturer as well as product line for deriving homogenous audio transmission characteristics
2. Very high stability frequency/time reference equipment with built-in distribution amplifier
3. Audio synchronization channel banks
4. T-1 transport
5. Receiver Voting System (Comparators)

4.2.2.3 Base Station Repeaters

Three low power base station repeaters are needed for this design alternative. The repeaters would be specified for conventional analog, narrowband operation, preferably with the capability to migrate to digital operation in the future if the Town opted to upgrade the system at a later date.

For budgetary purposes, this alternative conceptual design is based on the assumption that three (3) new repeaters will be required.

4.2.2.4 High Stability Frequency/Time Reference Equipment

Repeaters that will be configured for simulcast operation must derive its center frequency from a highly stable clocking source. The clocking source is an ultra-high stability oscillator with an external frequency reference input. The reference standard is a rubidium oscillator with a 5 MHz output. The 5 MHz output (the system can also use a 10 MHz clock) is delivered to each repeater

at the site through a built-in distribution amplifier. Each transmitter will lock its frequency synthesizer to the external 5 MHz (or 10 MHz) signal from the frequency/time reference. Once the synthesizer is locked, it will convert this frequency into the VHF center frequency the repeater will transmit, having the same stability as the frequency standard. The rubidium stability is supplemented by synchronizing its timing with GPS satellite network clocks.

The same timing source is used to generate an extremely accurate 1 pulse per second (1 PPS) signal needed to synchronize the clocks on the peripheral simulcast equipment, including the voting comparators and the T-1 channel banks.

One of these GPS-based reference oscillators is required at each simulcast transmitter site.

The conceptual design includes three (3) GPS based frequency/time reference sources for the system.

4.2.2.5 Audio Synchronization & Channel Banks

Distribution of the voice message to the input of each repeater in the system must be synchronized to launch all transmissions reaching the overlap area with precision to avoid TDI. This is accomplished by inserting an audio delay into the signal to be transmitted. Different technologies exist to manage this critical timing parameter, but use of dynamic synchronization channel banks is preferred for systems that have leased T-1 transports.

The timing correction and gain function for each site can also be controlled by an external Convex (or approved equal) Dynamic Audio Delay subsystem. The primary equipment included in the configuration will include a channel timing module located at the main site along with an audio PTT distribution amplifier, and automatic remote delay modules interfaced to every transmitter at the three RF sites in the system.

This conceptual design includes two (3) channel banks – one for each site in the configuration.

4.2.2.6 Receiver Voting System

The processing of receiver audio in a simulcast system is accomplished through the utilization of a voting comparator at a single collection point. One comparator is needed for every channel in the system. The comparator is a frequency independent component that collects all receiver audio signals on a specific channel, chooses or “votes” the best receiver audio signal, then redistributes that signal both to the dispatcher consoles as well as back to the transmission leg of the repeater system.

Included in this design for budgetary purposes is a single channel Raytheon SNV-12 voting comparator system. It will be necessary to interface the SNV-12 with the GPS frequency/timing 1 PPS signal.

4.2.3 Communications Center Equipment

In order to establish backup to LCD dispatching capabilities in Sherman, the system design must include a dispatching controller for installation in the SVFD communications center. The dispatch controller must be interfaced to the main simulcast repeater site in Sherman's configuration, which will be co-located at the SVFD.

Several varieties of dispatching controllers and workstations are available from different manufacturers. Features that are important for Sherman's application include the following:

- Multi-channel controller; four (4) transceivers (base stations, or control stations)
- Multi-controllers for additional operators; minimum of 4 operators.
- Tone, DC, or E&M signaling control format.
- Select and unselect speakers and desktop push-to-talk microphone
- Patch function for any input audio sources.
- Recording interface.
- Integrated Paging Encoder; programmable for individual or group paging with single button paging.
- Telephone instrument interface.
- Auxiliary inputs/outputs for supervisory control, voting receiver comparator interface, and form-C relay interfaces.

Not only must the dispatch controller be interfaced to the newly deployed Fireground Repeater System, but it must also be interfaced to the LCD repeaters installed at the SVFD. Local control of the LCD repeaters, which operate on the Dispatch and Command channels, is a requirement of the OEM in Sherman for performing initial dispatch functions and paging functions during times when LCD cannot provide dispatching services, for any reason. A memorandum of understanding for this interface must be reached with LCD before the interface from the newly deployed Sherman controller is made to the LCD repeaters for local control.

4.2.4 Sites' Transport & Connectivity

It is important in a simulcast system to control the timing and message integrity of the transmission audio source over a highly predictable (stable) transport. RCC recommends that the Town invest in equipping each site a high quality fractal T-1 service in order to avoid the cost of implementing an enterprise point-to-point link system such as microwave or fiber optics. Since leased T-1 or fractal T-1 services are recurring operating expenses, the cost for this service is not included in the budgetary for Sherman.

4.2.5 Paging

As discussed in Section 3, Sherman's pagers are alerted on the LCD Dispatch channel -- 155.1075 MHz. The existing paging operation works well enough, but it is important to have a backup ability to alert the Town's pagers in case of LCD system malfunction.

The Town can provide this backup functionality through use of the dispatch workstation described in Section 4.2.3, and utilization of the Town's newly deployed repeater simulcast system. The only modification that would have to be performed to enable this functionality is that the Towns existing inventory of Minitor V pagers will have to be reprogrammed to include a second paging channel to correspond to the transmit frequency of the Town's repeater channel – 154.1675 MHz.

4.2.6 Subscriber Equipment

The conceptual system design solution offered in this alternative makes full use of the existing mobile radio, portable radio, and pager subscriber fleet in Sherman. All of the radios currently in operation will continue to function as always, with the exception that the radio fleet will be able to access the Sherman based repeater channel.

If the radio programming template forwarded by Northeastern Communication is accurate, the Town can even avoid the reprogramming costs for continued mobile and portable radio operation. Radio users can simply turn their Zone 1 radio switches to position 3 to access the new repeater simulcast system.

As mentioned in the previous section, the Town's Minitor V pagers will have to be reprogrammed to add an additional paging frequency to the LCD Dispatch channel currently included in the receivers. Costs to reprogram the pagers are included in the budgetary estimate.

4.2.7 Conceptual Design Alternative One -- Budgetary Estimate

RCC has calculated a budgetary cost estimate to deploy the system described in the conceptual design. The estimate is shown in Table 4 below in summary form.

Table 4 also includes further estimated FCC license modification costs in order to add the three sites to the Town's license.

Capital Cost Item	Unit Cost	Qty	Net Cost
Base Station Repeaters	$10,000	3	$30,000
GPS Frequency / Time Reference	$10,000	3	$30,000
Channel Bank	$20,000	3	$60,000
Antenna / Installation (including cabling)	$3,000	3	$9,000
Receiver Voting System (1 Channel)	$8,000	1	$8,000
Site Upgrade (existing SVFD site - electrical, HVAC, UPS, grounding, etc.)	$5,000	1	$5,000
Low Profile Tower Site (incl. outdoor eqt. shelter and backup power; does not include civil work or utility company costs).	$30,000	2	$60,000
FCC Relicensing Work	$2,000	1	$2,000
Dispatch Controller @ SVFD	$10,000	1	$10,000
Pager Reprogramming	$35	51	$1,785
Installation / Program Mgmt. / Training (20%)		1	$43,157
Contingency (10%)		1	$25,894
Total Cost Estimate			**$284,836.00**

Table 4 Town of Sherman simulcast repeater system budgetary cost estimate

4.2.8 Phased Procurement & Implementation Alternatives

Stakeholders in the Town should understand a few determining factors which may drive procurement decisions of the concept repeater system described in this section.

1. Of regulatory importance to the FCC is that the WPIY661 license authorization obligates the licensee to construct and operate the class FB2 (repeater) station at Sherman Town Meadows within one year of the grant. Obviously, the FCC is lax in enforcing license construction deadlines and Sherman has not been called to task, but the fact is that Sherman remains non-compliant with this FCC regulation. At the very minimum, in

order to remove the risk of non-compliance, Sherman should make the investment to install and operate a repeater in this location, or at the SVFD with a license modification.

The relevant potential risk to Sherman is that there may be some other entity or organization in the vicinity of Sherman that is in need and was searching for a very nice, clean VHF channel pair. It is conceivable that the FCC could ultimately revoke the license from Sherman and grant it to another entity if they reached the conclusion that Sherman was not truly in need of the channel. A FB2 channel resource like this is very difficult to obtain, and Sherman should take every reasonable measure they can to construct and operate the channel in order to protect their authorization, even if it's only at one site.

2. Sherman can procure the system in phases, as funding become available. The following sequence can be deployed in as many as six (6) phases, and is one possible scenario for rolling out this simulcast system:

    a. Construct one repeater station at SVFD. Since the FCC requires a control point for the repeater, Sherman should purchase the recommended dispatch wire line controller that is connected to the repeater for control from the SVFD communications center. Configure the workstation to process Sherman paging tones. Reprogram Sherman's fleet of Minitor V pagers to include the repeater transmits frequency as the second receiver channel. Test paging operation.

    b. Construct the Southern Antenna Structure.

    c. Purchase and install Southern Site outdoor equipment cabinet, electrical work, backup power system, repeater equipment, channel bank, GPS clock and leased fractal T-1 to SVFD. Also purchase channel bank and GPS clock for the or SVFD site. Integrate, optimize, and test the SVFD Site and the Southern site to function in simulcast mode.

    d. Construct the Northern Antenna Structure.

    e. Purchase and install Northern Site outdoor equipment cabinet, electrical work, backup power system, repeater equipment, channel bank, GPS clock and leased fractal T-1 to SVFD. Also purchase channel bank and GPS clock for the SVFD site. Integrate, optimize, and test the Northern Site, SVFD Site, and the Southern site to function in simulcast mode.

4.2.9 Strategy to Offset Greenfield Site Construction Costs

If the structure heights at White Silo Farm, or Happy Acres Farm, are amenable to cellular carriers providing service in Sherman, then it's quite likely that similar structure heights in the

North and South end of Sherman may also be attractive. This will especially be true in the South end of Sherman, where the population center is greater.

In many circumstance, cellular carriers who are invited to discuss their interest in adding BTS (Base Transceiver Station) resources to a particular service area are also willing to burden the expense of developing the site. Alternatively, if there is Cellular carrier interest in either the Northern or Southern sites, the Town may wish to engage the carriers in leasing antenna space on the structure as well as shelter space on the ground.

If the Town of Sherman has interest in doing this, and if the Carriers are willing to lease antenna space, shelter space, or otherwise build out the entire site, the Town can use the funding from their participation to offset costs in implementing their own simulcast system.

Cellular carriers should be engaged as early as possible to understand their level of interest. If they are interested, they will want to perform their own propagation surveys to analyze the benefits of building additional BTS equipment at these sites. The Town can either take a rigid stance with regard to the maximum structure height, or they may wish to allow a nominal increase in height, depending on the feedback received from the carriers.

The income received from cellular carrier participation can range anywhere from $25,000 to $50,000 (or even higher) per year, depending on the number of carriers that the Town succeeds in engaging.

The collateral benefit to the Town, of course, will also serve to significantly improve cellular coverage provided to its resident taxpayers.

4.3 Conceptual Design Alternative Two – Shared Use of Connecticut Department of Public-Safety Network

The Connecticut Department of Public Safety (DPS) currently own and operate a statewide 800 MHz Motorola SmartZone 4.1 Digital Trunking system that was implemented in the year 2000.

The network has an infrastructure which includes 49 simulcast sites comprising 9 simulcast subsystems. In addition, there are three (3) Intelli-Repeater fill-in sites for coverage in less congested areas of the State. Of the nine (9) simulcast subsystems, no system has more than six (6) RF channels. The exact distribution of RF channels within each simulcast subsystem has not been disclosed by the DPS.

The DPS network supports over 4000 subscriber units distributed among a variety of state agencies including CSP, DPS, DMV, DEP, DEMHS as well as Resident Trooper Towns.

The 49 site network is interconnected with DPS owned and operated microwave network as well as leased T-1 services. This telecommunications backbone is used not only to link the RF sites, but also a host of dispatch operator positions in various locations. DPS has 50 Motorola Centracom Gold Elite dispatch operator positions to support daily public-safety operations. Centracom Gold Elite uses a Computer Display Terminal user interface in lieu of older generation "button-and-LED" user interface.

In 2011, DPS entered into contract with Motorola, Inc. to upgrade their entire system from SmartZone 4.1 to an ASTRO 25 network. This network will conform to APCO 25 Phase 1 (12.5 KHz, FDMA) when complete. This conversion will be implemented in phases over a considerable period of time with utilization of a "black box" technology developed by Motorola to enable migration from SmartZone system platforms to ASTRO 25 system platforms called "Smart X."

There are many differences between SmartZone network platforms and ASTRO 25 platforms. Perhaps the biggest difference lies in that SmartZone is circuit switched architecture while ASTRO 25 is packet switched, or Internet Protocol (IP) based architecture. Another important difference between SmartZone technology platforms and ASTRO 25 lies in the control channel data rate. SmartZone systems operate a control channel rate of 3600 BPS and ASTRO 25 systems operate a control channel rate of 9600 BPS. 9600 BPS data rate is APCO 25 Phase II compliant.

In order to migrate SmartZone subscriber equipment operating at 3600 BPS to the ASTRO network operating at 9600 BPS, Motorola makes use of the SMART X interface at the Master Site Control point enabling SmartZone subscriber equipment to communicate with an ASTRO 25 network switch. The SMART X "box" is essentially a protocol converter to emulate 3600 BPS protocol at 9600 BPS, and vice-versa.

It was not disclosed how long it will take DPS and Motorola to convert the entire statewide network from SmartZone 4.1 to ASTRO 25.

The DPS changed leadership during the past 2 years. Under the previous direction, DPS was not open to allowing non-state governed entities access to their network. This posture has changed under the newer leadership, with several additional factors motivating shared network utilization.

DPS recently completed a shared system use venture with the Urban Areas Security Initiative (UASI) region in lower Fairfield County. Six RF channels in the 700 MHz band were constructed for use by the UASI region by adding these channels onto the DPS system at six (6) sites in lower Fairfield County. The add-on territory covers 14 towns in lower Fairfield County. The added cost of infrastructure was borne by UASI, but that cost was leveraged by existing infrastructure already owned by DPS. UASI would not have to purchase some of infrastructure components (i.e. towers, shelters, microwave, or a network control switch, etc.). Once implemented, the infrastructure equipment would be turned over as the property of DPS. UASI would pay DPS any incremental annual maintenance costs for the added infrastructure equipment, as well as any subscriber related costs, such as capital equipment costs and on-going maintenance costs. Subscriber access would fall under the control of DPS. Network maintenance, and upgrade responsibilities would belong to DPS. Although DPS is not charging any subscriber access charges, it may be a possible in the future for the State to assess a reoccurring fee in order to help offset ongoing network maintenance, management, and upgrade costs that would be incurred by DPS.

It is not expected that DPS will allow shared use of their 800 MHz network. Rather, it is expected that the Memorandum of Understanding for utilization of the DPS system for the Town of Sherman would be similar to that for UASI. In essence, the town of Sherman would very likely be required to bear at least some of the expense for the purchase and installation of new Motorola trunked ASTRO-25 700 MHz equipment to extend the DPS' 700 MHz network footprint. It's possible that this equipment expense can be leveraged if other neighboring towns in the Litchfield County (or northern Fairfield County) area also invested interest in joining the DPS 700 MHz network. The purchase of new infrastructure equipment would then be signed over to the DPS for inclusion in the State's inventory, ongoing maintenance, and upgrades in the future. The Town of Sherman would also be responsible for replacing their fleet of mobile and portable radio equipment.

Although DPS has not disclosed their RF sites, it is believed that the sites that would contribute most to coverage in the Town of Sherman are the same sites – with the exception of the SVFD -- as those in use by LCD for the current system. In other words, it is believed that the State has 800 MHz equipment located at the Chapin Road and Spooner Hill tower sites. These sites would likely be the targets for installation of 700 MHz infrastructure, especially if Sherman were to contribute their resources for augmenting the DPS network.

Although there are many benefits for the Town of Sherman if they were allowed to enter into a shared network agreement with DPS, there are several bigger liabilities. The pros and cons are listed below. First the pros:

- The DPS network currently boasts 98% statewide mobile coverage that Sherman can access if permitted.
- The DPS trunked radio network offers public safety radio features and functions that are "as good as they get."
- The DPS network is meticulously monitored, hardened, secured, maintained, and backed up. It's very unlikely DPS network users will experience communications outages.
- Sherman will have instant interoperability with all Connecticut State agencies.
- DPS will responsible for on-going network maintenance.
- DPS will be responsible for on-going network upgrades. Some of these costs will probably be passed along to end-users like Sherman, but it would only be to the portions of the network utilized by Sherman.
- Sherman will not have to secure any 700 MHz licensing. All licensing needs would be the responsibility of DPS.

Some disadvantageous also should be considered:

- Sherman will still have to retain their paging operations on the existing VHF band, due to the fact that there are no 700 MHz tone and voice pagers manufacturers. Paging operations must obviously continue in Sherman.
- Sherman must purchase very expensive 700 MHz trunked radio infrastructure equipment, probably in range of $500-700K per site – depending on site related work needed -- if

these costs are not leveraged by other towns or cities that also join the network in the same vicinity as Sherman. Including the Spooner Hill and Chapin Road towers, Sherman will likely need at least four (4) sites to provide the required signal penetration in the Town.

- All infrastructure equipment must be transferred to the DPS inventory.
- Sherman must replace their fleet of mobile and portable radios with trunked 700 MHz mobile and portable radios. Depending on the types of radio options purchased, 700 MHz trunked radio costs can vary from $2700 to $6000 per unit. At $3,000 per radio, Sherman would have to bear the burden of over $195,000 in subscriber replacement costs.
- Sherman will not have complete control over subscriber access parameters. System access priorities, which will not be a factor unless "busy conditions" are encountered, will be under the control of DPS.
- If Sherman migrated to the 700 MHz, an interoperability plan will have to be designed to continue mutual aid communications with neighboring jurisdictions that remain in VHF high band.

Although this alternative is presented in this report for Sherman to contemplate, it would seem that the cost to Sherman to pursue such an alternative would be prohibitive.

4.4 Conceptual Design Alternative Three – Future Use of Public-Safety LTE Broadband Network

On February 22, 2012, Congress passed a bill, H.R. 3630 called the "Middle Class Tax Relief and Job Creation Act of 2012". Under Title VI of H.R.3630 -- Public Safety Communications and Electromagnetic Spectrum Auctions -- provisions were given to allocate an additional 10 MHz of 700 MHz spectrum (AKA "D Block") for development and deployment of a wireless nationwide public-safety broadband network. 10 MHz of 700 MHz spectrum were added to 12 MHz of 700 MHz spectrum that had been previously allocated to public safety by the FCC, rendering a total of 22 MHz of 700 MHz spectrum. Shown Figure 10 in is a spectrum chart showing the frequency allocation.

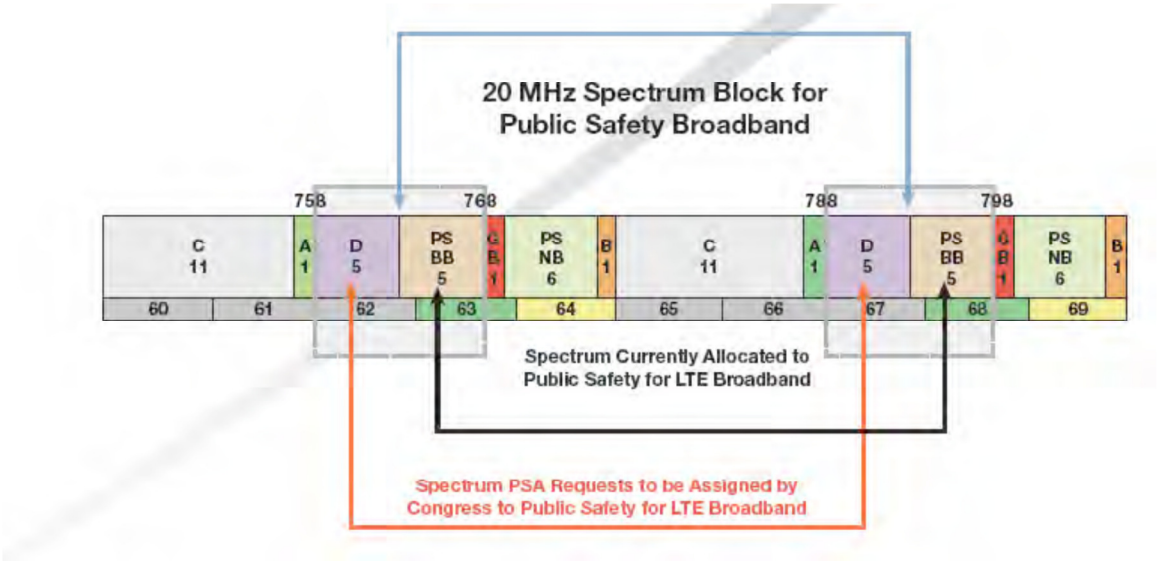

Figure 10 Public Safety Spectrum allocations in 700 MHz

In addition to allocation of the D Block spectrum, Title VI also provisioned $7.2B in funding to build the nationwide network. Two groups – the National Telecommunications Industry Association ("NTIA") and First Responder Network Authority ("FirstNet") -- were designated as the responsible parties for administering and deploying the nationwide network.

At present, the plan for rolling out the network is complex, incomplete, and with unspecified completion deadlines. In the end, the public safety community will have access to a nationwide network using LTE (Long Term Evolution, or 4G) architecture. Each state is responsible, by the 2nd quarter of 2013 to decide ("Op-in or Opt-out") if they will embrace the FirstNet deployment for a LTE network, develop their own compatible LTE network, or make supplemental provisions for the FirstNet deployment. Once the BB network is deployed, the Town of Sherman can purchase subscriber equipment for accessing this system for a monthly subscriber fee typical of a commercial cellular subscription.

Initial deployment of the network will enable first responders to access the network for high speed ("4G") wireless data applications. It is hoped that applications will eventually evolve and support VOIP (Voice Over Internet Protocol) for first responders. There is tremendous promise inherent to such a network, but here are a few of the potential applications:

- Wireless video surveillance.
- Aerial video from a helicopter over a scene fed to personnel below.

- Video-based training to remote emergency workers.
- Real-time license plate recognition.
- Testimony based on video transmitted from an emergency-services vehicle or command post.
- Sending and receiving high-resolution pictures.
- In-field biometrics (such as iris and fingerprint identification).
- Automated vehicle location and navigation.
- Medical applications such as telemedicine, patient records, and high-resolution video to enable medical services performed at a scene of an accident.
- VOIP and Interoperability (later)

RCC does not know whether the State of Connecticut will Opt-in or Opt-out of the FirstNet plan. There are pros and cons to both options. If Connecticut opts out, the NTIA requirement is for the State to plan and issue an RFP for their own LTE solution, which must be compatible with the FirstNet LTE solution, within 180 days of their decision. Beyond these dates, there are no further requirements specified under Title VI, other than the fact that the broadband issued by the FCC to the Public Safety Trust licensee – FirstNet – will be up for renewal in February of 2022.

Unfortunately the national public safety broadband network plan has many unanswered questions for local government entities such as the Town of Sherman. When will the network be completed? How much will it cost to access the network? What LTE devices will be available? How much will the LTE radios cost? How will they be used? Will the network have VOIP? Can Sherman do away with their existing LMR? What are the best practices of other entities? Perhaps the most important question revolves around radio coverage. How much signal penetration can Sherman expect? Where will the LTE sites be?

Future use of the national public safety LTE network is certainly worthy of consideration by the Town of Sherman, but there are more questions about this alternative at the present time than there are answers. If the Town can wait several years for this technology to be deployed and matured before decisions are made, then that's what it will likely take. Given the current coverage challenges, RCC cannot recommend that Sherman wait this long to act on their public safety communications problems.

5.0 RCC RECOMMENDATIONS

RCC recommends the following for the Town of Sherman:

- Adopt Concept Design Alternative #1 as a Town resolution.
- Begin process to modify FCC license WPIY661 to see if the simulcast system can be coordinated at the proposed locations.
- As soon as possible, construct and operate the repeater station authorized under WPIY661, at the SVFD. Further, the license must be modified to reflect transmissions from this site.
- As soon as possible, construct and operate the FB simplex base station authorized under WQIJ777 (154.7400 MHz) at SVFD. In order for this license to be compliant, the Town may wish to deploy a very inexpensive base station (even a used or borrowed base station) on this channel.
- Determine a timeline for deployment of the fixed base simulcast repeater infrastructure.
- Allocate funding and begin phased deployment.
- Engage cellular carriers in discussions that would invite them to lease antenna structure space from the Town for use of the Northern and Southern low profile sites. If any of the carriers are interested, they will analyze the potential benefits of deploying a BTS to the sites and specify the minimum structure height on which they will require their antenna equipment. If their structure height requirements exceed the structure heights recommended in this conceptual design, the Town may wish to consider nominal structure height increases (i.e. 10'-30') Monthly income from the carriers can be used to offset simulcast system procurement costs.
- Meet with LCD to develop a memorandum of understanding that allows the Sherman dispatch controller to be interfaced to the two LCD repeaters installed at the SVFD, for being able to provide local control Dispatch and Command channel communications during anytime that LCD is unable to perform this service. This will be required during

extreme LCD busy conditions and/or during equipment LCD malfunction conditions. As long as the LCD repeaters in SVFD are operating, then Sherman should be able to assume dispatch control over these stations, especially for performing paging functions, or for directing SVFD personnel to change from the Dispatch channel over to the Sherman Repeater Channel.

- Meet with LCD to reach an understanding as to what they feel it will take to improve Dispatch and Command channel communications performance in the Town.
- Meet with LCD to develop a memorandum of understanding of how dispatch protocol will be handled in Sherman during extreme busy conditions and during equipment malfunction conditions.
- Establish relationships with State DPS representatives to determine how Sherman can be kept "in the loop" relating to updates and plans for the national public-safety broadband LTE deployment in the State of Connecticut.
- FCC License WPIY661 included authorization to operate low band channel 33.860 MHz and; and WPYA960 authorizes operation of 45.280 MHz. Sherman's subscriber inventory did not include any equipment that would operate on either of these low band channels. Accordingly, the Town should confirm that these channels are no longer in use, and consider surrendering the license to operate these low band channels.
- For all interoperability channels programmed in the Sherman subscriber fleet, in addition to channels licensed to LCD, Sherman should obtain Memoranda of Understanding (MOU) with the Licensee that showed concurrence with these Licensees for operation of their channels by Sherman first responders for mutual aid or for primary first response use, as appropriate.

APPENDIX A – RADIO STATION AUTHORIZATIONS

REFERENCE COPY
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Federal Communications Commission
Public Safety and Homeland Security Bureau

RADIO STATION AUTHORIZATION

LICENSEE: SHERMAN, TOWN OF

ATTN: EMERGENCY MGMNT DIR GUIDO J TINO
SHERMAN, TOWN OF
SVFD RTE 39 N
PO BOX 39
SHERMAN, CT 06784-0039

Call Sign	File Number
WQIJ777	
Radio Service PW - Public Safety Pool, Conventional	
Regulatory Status PMRS	
Frequency Coordination Number	

FCC Registration Number (FRN): 0004092730

Grant Date	Effective Date	Expiration Date	Print Date
02-29-2008	02-29-2008	02-28-2018	

STATION TECHNICAL SPECIFICATIONS

Fixed Location Address or Mobile Area of Operation

Loc. 1 **Address:** SVFD RTE 39 N
City: SHERMAN **County:** FAIRFIELD **State:** CT
Lat (NAD83): 41-35-50.5 N **Long (NAD83):** 073-29-54.3 W **ASR No.:** **Ground Elev:** 233.0

Loc. 2 **Area of operation**
Operating within a 16.0 km radius around fixed location 1

Antennas

Loc No.	Ant No.	Frequencies (MHz)	Sta. Cls.	No. Units	No. Pagers	Emission Designator	Output Power (watts)	ERP (watts)	Ant. Ht./Tp meters	Ant. AAT meters	Construct Deadline Date
1	1	000153.74000000	FB	1		11K2F3E 20K0F3E	25.000	35.000	20.0	56.1	02-28-2009
2	1	000153.74000000	MO	2		11K2F3E 20K0F3E	25.000	35.000			02-28-2009

Conditions:
Pursuant to §309(h) of the Communications Act of 1934, as amended, 47 U.S.C. §309(h), this license is subject to the following conditions: This license shall not vest in the licensee any right to operate the station nor any right in the use of the frequencies designated in the license beyond the term thereof nor in any other manner than authorized herein. Neither the license nor the right granted thereunder shall be assigned or otherwise transferred in violation of the Communications Act of 1934, as amended. See 47 U.S.C. § 310(d). This license is subject in terms to the right of use or control conferred by §706 of the Communications Act of 1934, as amended. See 47 U.S.C. §606.

Licensee Name: SHERMAN, TOWN OF

Call Sign: WQIJ777 **File Number:** **Print Date:**

Control Points

Control Pt. No. 1

Address: 43 RTE 39 N

City: SHERMAN **County:** FAIRFIELD **State:** CT **Telephone Number:** (860)355-0846

Associated Call Signs

Waivers/Conditions:

NONE

Reference Copy

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Federal Communications Commission
Public Safety and Homeland Security Bureau

RADIO STATION AUTHORIZATION

LICENSEE: SHERMAN, TOWN OF

ATTN: FIRST SELECTMANS OFFICE FCC LIC
SHERMAN, TOWN OF
PO BOX 39
SHERMAN, CT 06784

Call Sign	File Number
WPYA960	
Radio Service PW - Public Safety Pool, Conventional	
Regulatory Status PMRS	
Frequency Coordination Number	

FCC Registration Number (FRN): 0008513624

Grant Date	Effective Date	Expiration Date	Print Date
07-14-2003	07-14-2003	07-14-2013	

STATION TECHNICAL SPECIFICATIONS

Fixed Location Address or Mobile Area of Operation

Loc. 1 **Address:** 43 RTE 39 N
City: SHERMAN **County:** FAIRFIELD **State:** CT
Lat (NAD83): 41-35-50.5 N **Long (NAD83):** 073-29-54.3 W **ASR No.:** **Ground Elev:** 147.0

Loc. 2 **Area of operation**
Operating within a 28.0 km radius around fixed location 1

Antennas

Loc No.	Ant No.	Frequencies (MHz)	Sta. Cls.	No. Units	No. Pagers	Emission Designator	Output Power (watts)	ERP (watts)	Ant. Ht./Tp meters	Ant. AAT meters	Construct Deadline Date
1	1	000045.28000000	FB	1		20K0F3E	110.000	110.000	12.0	-42.0	07-14-2004
2	1	000045.28000000	MO	25		20K0F3E	110.000	110.000			07-14-2004

Conditions:
Pursuant to §309(h) of the Communications Act of 1934, as amended, 47 U.S.C. §309(h), this license is subject to the following conditions: This license shall not vest in the licensee any right to operate the station nor any right in the use of the frequencies designated in the license beyond the term thereof nor in any other manner than authorized herein. Neither the license nor the right granted thereunder shall be assigned or otherwise transferred in violation of the Communications Act of 1934, as amended. See 47 U.S.C. § 310(d). This license is subject in terms to the right of use or control conferred by §706 of the Communications Act of 1934, as amended. See 47 U.S.C. §606.

Licensee Name: SHERMAN, TOWN OF

Call Sign: WPYA960 **File Number:** **Print Date:**

Control Points

Control Pt. No. 1

Address: 43 RTE 39 N

City: SHERMAN **County:** FAIRFIELD **State:** CT **Telephone Number:** (860)350-5514

Associated Call Signs

Waivers/Conditions:

NONE

Reference Copy

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Federal Communications Commission
Public Safety and Homeland Security Bureau

RADIO STATION AUTHORIZATION

LICENSEE: SHERMAN, TOWN OF

ATTN: FIRE CHIEF
SHERMAN, TOWN OF
1 RT 39 NORTH
PO BOX P.O. BOX 249
SHERMAN, CT 06784

Call Sign	File Number
WPIY661	
Radio Service PW - Public Safety Pool, Conventional	
Regulatory Status PMRS	
Frequency Coordination Number	

FCC Registration Number (FRN): 0004092730

Grant Date	Effective Date	Expiration Date	Print Date
10-08-2005	10-08-2005	12-08-2015	

STATION TECHNICAL SPECIFICATIONS

Fixed Location Address or Mobile Area of Operation

Loc. 1 **Address:** RT 39
City: SHERMAN **County:** FAIRFIELD **State:** CT
Lat (NAD83): 41-34-44.3 N **Long (NAD83):** 073-29-49.4 W **ASR No.:** N/A **Ground Elev:** 155.0

Loc. 2 **Area of operation**
Operating within a 24.0 km radius around fixed location 1

Loc. 3 **Address:** 32 RT 37 E
City: SHERMAN **County:** FAIRFIELD **State:** CT
Lat (NAD83): 41-34-57.7 N **Long (NAD83):** 073-28-52.8 W **ASR No.:** **Ground Elev:** 207.0

Loc. 4 **Area of operation**
Operating within a 16.0 km radius around fixed location 3

Antennas

Loc No.	Ant No.	Frequencies (MHz)	Sta. Cls.	No. Units	No. Pagers	Emission Designator	Output Power (watts)	ERP (watts)	Ant. Ht./Tp meters	Ant. AAT meters	Construct Deadline Date
1	1	000033.86000000	FB	1		20K0F3E	110.000	100.000	12.0	0.0	
2	1	000033.86000000	MO	30		20K0F3E	110.000				

Conditions:
Pursuant to §309(h) of the Communications Act of 1934, as amended, 47 U.S.C. §309(h), this license is subject to the following conditions: This license shall not vest in the licensee any right to operate the station nor any right in the use of the frequencies designated in the license beyond the term thereof nor in any other manner than authorized herein. Neither the license nor the right granted thereunder shall be assigned or otherwise transferred in violation of the Communications Act of 1934, as amended. See 47 U.S.C. § 310(d). This license is subject in terms to the right of use or control conferred by §706 of the Communications Act of 1934, as amended. See 47 U.S.C. §606.

Licensee Name: SHERMAN, TOWN OF

Call Sign: WPIY661 **File Number:** **Print Date:**

Antennas

Loc No.	Ant No.	Frequencies (MHz)	Sta. Cls.	No. Units	No. Pagers	Emission Designator	Output Power (watts)	ERP (watts)	Ant. Ht./Tp meters	Ant. AAT meters	Construct Deadline Date
3	1	000154.16750000	FB2	1	100	11K0F3E	75.000	100.000	13.0	27.6	08-03-2006
4	1	000154.16750000	MO	100		11K0F3E	45.000	45.000			08-03-2006
4	1	000154.42250000	MO	100		11K0F3E	45.000	45.000			08-03-2006
4	1	000154.74750000	MO	100		11K0F3E	45.000	45.000			08-03-2006
4	1	000158.94750000	MO	100		11K0F3E	45.000	45.000			08-03-2006

Control Points

Control Pt. No. 1

Address: 49 POPLAR STREET

City: NEW MILFORD **County:** LITCHFIELD **State:** CT **Telephone Number:** (860)355-3133

Associated Call Signs

Waivers/Conditions:

NONE

Reference Copy

APPENDIX B – SHERMAN SUBSCRIBER PROGRAMMING TEMPLATE, INCLUDING INTEROPERABILITY CHANNELS

Zone 1 Sherman			
Dept.	Frequency	PL	Bandwidth
1. LCD Dispatch	155.1075	82.5	12.5kHz
2. LCD Command 3	155.1225	532	12.5kHz
3. Sherman FD RPT	154.1675 RX	712	12.5kHz
	158.9475 TX		
4. Sherman Fire Grnd	154.1675	712	12.5kHz
5. Sherman TAC 1	154.4225	712	12.5kHz
6. Sherman FIPO	154.7475	712	12.5kHz
7. New Milford Amb	159.3525 RX	226	12.5kHz
	155.8575 TX		
8. New Milf Amb T/A	159.3525	226	12.5kHz
9. New Milford FD	154.3475 RX	445	12.5kHz
	150.805 TX		
10. NMFD Fire Grnd	154.3475	445	12.5kHz
11. Gaylordville FD	155.875	251	12.5kHz
12. GVFD Scene 1	154.7175	251	12.5kHz
13. New Fairfield FD	155.6775 RX	051	12.5kHz
	151.4075 TX		
14. New Fairfield FD2	158.7975 RX	131	12.5kHz
	153.8225 TX		
15. LCD AirTAC 14	150.790	203.5	12.5 kHz
16. Marine 16	156.800	CSQ	25.0 kHz
Zone 2 Mutual Aid			
Dept.	Frequency	PL	Bandwidth
1. LCD Dispatch	155.1075	82.5	12.5kHz
2. LCD Command 3	155.1225	532	12.5kHz
3. Sherman FD RPT	154.1675 RX	712	12.5kHz
	158.9475TX		
4. Sherman Fire Grnd	154.1675	712	12.5kHz
5. New Fairfield FD	155.6775 RX	051	12.5kHz
	151.4075 TX		
6. New Fairfield FD2	158.7975 RX	131	12.5kHz
7. PATTERSON FG 1	159.405	114.8	12.5 kHz
8. PATTERSON FG 2	156.105	114.8	12.5 kHz
9. Putnam Lake FG	159.240	271	12.5 kHz
10. Putnam Lake Rptr	159.240 RX	271	12.5 kHz
11. BREWSTER FG 1	154.370	123.0	12.5 kHz
12. BREWSTER FG 2	170.150	123.0	12.5 kHz
13. Roxbury FD	153.980	365	12.5 kHz
14. Washington FD	158.775 RX	343	12.5 kHz
	153.920 TX	343	12.5 kHz
15. LCD InterOps 15	154.665	141.3	12.5 kHz
16. Weather 16	162.500	CSQ	12.5 kHz

Zone 3 LCD			
Dept.	Frequency	PL	Bandwidth
1. LCD Dispatch	155.1075	82.5	12.5kHz
2. LCD Command 3	155.1225	532	12.5kHz
3. Sherman FD RPT	154.1675 RX	712	12.5kHz
	158.9475TX		
4. Sherman Fire Grnd	154.1675	712	12.5kHz
5. LCD Scene 4	155.8125	072	12.5kHz
6. LCD Scene 5	155.8275	025	12.5kHz
7. LCD Scene 6	156.0075	051	12.5kHz
8. LCD Scene 7	155.8125	172	12.5kHz
9. LCD Scene 8	155.8275	125	12.5kHz
10. LCD Scene 9	156.0075	152	12.5kHz
11. LCD Scene 10	155.8125	271	12.5kHz
12. LCD Scene 11	155.8275	205	12.5kHz
13. LCD Scene 12	156.0075	244	12.5kHz
14. LCD Traffic 13	158.3025	532	12.5kHz
15. LCD AirTAC 14	150.790	203.5	12.5 kHz
15. LCD InterOps 15	154.665	141.3	12.5 kHz
Zone 4 STOCS/ Marine			
Dept.	Frequency	PL	Bandwidth
1. LCD Dispatch	155.1075	82.5	12.5kHz
2. LCD Command 3	155.1225	532	12.5kHz
3. Sherman FD RPT	154.1675 RX	712	12.5kHz
	158.9475TX		
4. Sherman Fire Grnd	154.1675	712	12.5kHz
5. Sherman TAC 1	154.4225	712	12.5kHz
6. Sherman FIPO	154.7475	712	12.5kHz
7. Marine 9	156.450	CSQ	25.0 kHz
8. Marine 16	156.800	CSQ	25.0 kHz
9. New Fairfield FD	155.6775 RX	051	12.5kHz
	151.4075 TX		
10. New Fairfield FD2	158.7975 RX	131	12.5kHz
	153.8225 TX		
11. New Milford FD	154.3475 RX	445	12.5kHz
	150.805 TX		
12. STOCS 1	154.4525	156.7	12.5kHz
13. STOCS 2	158.7375	156.7	12.5kHz
14. STOCS 3	159.4725	156.7	12.5kHz
15. STOCS 4	158.7375	156.7	12.5kHz
16. STOCS 5	159.4725	156.7	12.5kHz