

## COMMUNICATIONS SYSTEM UPGRADES HISTORY

This report provides a history of, and additional information on, the upgrades to the radio communications systems for the Fire, Police and Public Works Departments.

### **Federal Communications Commission**

The FCC published a Notice of Inquiry in 1991 seeking comments on narrowbanding. In 1992, a Notice of Proposed Rulemaking was released, and in 1995, the original narrowbanding rules were adopted. In 2004, the Final Deadline was adopted requiring Land Mobile Radio Services, including the frequencies used by the Norwich Fire, Police and Public Works Departments, to change to narrowband by January 1, 2013.

There is a limited amount of radio spectrum available in the Land Mobile Radio Service which includes public safety, and by requiring narrowband, the FCC is making more channels available. This change to narrowband means an estimated 3 dB<sup>1</sup> reduction in signal strength at receivers. The impact of this reduction is very terrain dependent.

### **Norwich Mobiles, Portables and Pagers<sup>2</sup>**

Starting in 1997, all mobile and portable radios purchased new for Fire, Police and Public Works Departments were narrowband-capable. At that time, there were no narrowband-capable pagers available. The narrowband-capable Motorola Minitor V pager was released in late 2005 and since that time, the Fire Department has only purchased Minitor V pagers. Using local monies and grants, all of the fire, police and public works mobile and portable radios and pagers are now narrowband-capable.

### **Dispatch Services**

Historically the Norwich Fire and Police Departments were dispatched by Hartford Public Safety Dispatch using transmitters and receivers on Hurricane Hill in Hartford.

Hartford Public Safety Dispatch has changed to narrowband digital for the police frequencies and our Police Department is now narrowband digital for normal operations. Under an agreement we have, Hartford will maintain the wideband analog system until we have completed our transition to the narrowband digital radios which we now have.

As a result of the Communications Study discussed below, fire dispatch was moved to Hanover Public Safety Dispatch in August 2011 using a transmitter and receiver on Hayes Hill in Hanover (Etna). The propagation studies showed moving fire dispatch to Hayes Hill would improve radio coverage since Hayes Hill looked up Norwich valleys while Hurricane Hill in Hartford looked across the ridges, reducing coverage in the valleys.

Hanover Public Safety is in the process of changing to narrowband analog and should complete the change by the end of September 2012. Norwich Fire is in the process of reprogramming

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<sup>1</sup> The decibel (dB) is a logarithmic unit that indicates the ratio of a physical quantity (usually power or intensity) relative to a specified or implied reference level. A change of 3 dB is a change in power or intensity of 1.995. A 3 dB reduction is a reduction in received power or intensity of 50%.

<sup>2</sup> Mobile radios are fixed radios in Fire, Police and Public Works vehicles. Portable radios are hand-held units used extensively by the Fire Department at an incident and used by the Police Department when they are out of their vehicle. Pagers are used to notify Fire Department members of a call.

mobile and portable radios and pagers for narrowband which should be complete by the end of September.

Norwich Public Works does its own dispatch from an antenna on the Public Works garage at 26 New Boston Road. It will narrowband all of its radio equipment by November 15, 2012, before the start of winter operations.

### **Communications Study**

In October of 2008, the then Interim Town Manager developed a Request for Proposals (RFP) for a communications study. This RFP was provided to the new Town Manager along with a transition memorandum on November 5, 2008. The RFP was issued in March 2010 and four proposals for the study were received. A contract was signed in May 2010 with Communications Design Consulting Group (CDCG), a firm with extensive public safety and municipal communications system experience, and its draft report was completed in October 2010.

A number of propagation studies of radio waves were done since May 2010. Radio propagation is the study of how radio waves travel from a transmitter site to a receiver site through the atmosphere. Radio signals are affected by terrain and elevation between the sites, and obstructions, including trees, buildings, etc. that may be in between the two sites. The propagation studies for Norwich included studying transmissions from the known radio towers in the area as well as from existing Fire, Police and Public Works locations in Norwich. It became clear during these studies that a new tower would be needed in Norwich to have adequate coverage before narrowbanding was required as of January 1, 2013.

Consequently, the original system design was to rely on the Hayes Hill tower in Hanover in combination with one new tower in Norwich to address the expected reduction in signal strength. It also became clear during these studies that a location looking up the valleys would be the most efficient method of providing radio communications coverage with the lowest tower possible. VHF signals (used by Fire and Public Works) tend to be line-of-sight and even more so with UHF (used by Police). A tower that would look across the ridges would need to be high enough for the signal to also reach the valley floors (the location of our major roads) and would require a very tall tower.

This created a circle-of-opportunity, if you will, to begin narrowing the options for the most effective location for a tower. We wanted a location that would look up the valleys in order to keep the tower as short as possible but provide adequate coverage. In addition, we looked for a site that would have easy access to utilities and be large enough so that, if the tower were to fall, it would stay within the property (meaning approximately 400 feet by 400 feet or 3.7 acres). In addition, if possible, we wanted a tower less than 200 feet to the top of the highest antennas so that the tower would not have to be painted red and white or require obstruction lights under aviation regulations. If the site was publicly owned, this was considered a plus in its favor. The circle of opportunity included the village area and the village ends of Beaver Meadow Road, Turnpike Road and New Boston Road.

There was consideration for the tower to be located at Huntley Meadows or at the site of the current fire and police stations. Huntley Meadows has a ground elevation of approximately 540

feet above sea level and the current fire and police stations are at approximately 530 feet. Using either of those locations would have required a tower that would have far exceeded 200 feet in height.

By process of elimination, it was decided to run propagation studies of a hypothetical tower at the Public Works site which has a ground elevation of 745 feet. This base elevation meant that the fire and police antennas on the tower would be approximately 925 feet above sea level, keeping the top of the antennas less than 200 feet above the ground. This elevation was also high enough to provide good coverage up the valleys, and combined with the Hanover Hayes Hill tower, narrowband coverage in Norwich would increase from 36% to 84%. When we later added coverage provided by the Hartford Hurricane Hill and Hanover Moose Mountain towers, the goal of 95% coverage of the Norwich land area 95% of the time was met. This level of coverage is the normal public safety standard.

The final Fire/EMS system design to provide coverage to Norwich and other towns served by Hanover Public Safety Dispatch includes seven transmitter sites and eight receiver sites.<sup>3</sup> The final Police system design includes three transmitter/receiver sites.<sup>4</sup> The final Public Works system design includes one transmitter/receiver.<sup>5</sup> Needing only one tower for Public Works keeps the cost down and still provides very good mobile radio coverage for the Public Works Department.

### **Cellular Versus Wide Area Radio System Coverage**

There is a significant difference between a cellular coverage system and a wide area radio system.

A cellular network looks like a honeycomb with each cell using multiple channels or different frequencies from neighboring cells to avoid interference and to provide the ability to reuse frequencies. When joined together, a network of cells provides coverage over a wide geographic area and enables a large number of portable transceivers (e.g., mobile phones) to communicate on a private channel with each other and with telephones anywhere in the network. As density of cellular phone use increases, the size of the cells decreases by use of directional antennas and reduction of the power and/or height of the antennas.

In contrast, wide area public safety systems, especially in rural areas, use the same frequency or frequencies over a wide area for interoperability. In our system, the same radio frequency pair will serve the Hanover, Plainfield, Enfield, Canaan, Lyme, Orford, Thetford, Strafford, West Fairlee, Vershire, Fairlee, Bradford and Norwich fire departments. In addition, with a simulcast system, all of the transmitters transmit on the same frequency and at the same time. In order for this to work, the timing and quality of the radio signals to overlapping portions of the coverage area is critical. In the overlap, non-capture area, the carrier center frequency must be within 1

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<sup>3</sup> Transmitters/Receivers on towers for Fire/EMS are designed to be at the Norwich Public Works site, Hurricane Hill (Hartford), Hayes Hill (Hanover), Hanover Town Hall, Hanover Public Safety, Moose Mountain (Hanover) and Rogers Hill (Bradford), with a Receiver at the Lyme Fire Station.

<sup>4</sup> Transmitters/Receivers for police are at Norwich Public Works, Hurricane Hill and Hayes Hill.

<sup>5</sup> A Transmitter/Receiver at Norwich Public Works.

hertz from all sites; recovered audio and recovered carrier tone-coded squelch system (CTCSS) sub-audible tones must be within 0.2 dB; and audio must be aligned within 40-50 microseconds.

### **Regionalization**

We have had ongoing discussions on the concept of regionalization for several years with area towns. Related to communications, we worked with Hanover Public Safety Dispatch to apply for an Assistance to Firefighters grant to upgrade their system to an analog simulcast system for Fire/EMS which would also work for Norwich. Hanover received the grant and a regional simulcast system is being designed and bids are planned to be solicited in September. This grant includes radio equipment and antennas for the Norwich tower.

Norwich will benefit from transmitters located at the Norwich Public Works site, four towers in Hanover (Hayes Hill, Hanover Town Hall (this site may be relocated to north of Norwich and west of the Connecticut River), Hanover Public Safety Dispatch on Lyme Road, and Moose Mountain) and one tower in Hartford (Hurricane Hill). This will improve our coverage and reduce our costs.

The Hartford Hurricane Hill tower site was added to the Hanover system and will improve radio coverage to the Mitchell Brook valley area in Norwich which drains into the White River (which includes Mitchell Brook Road, Tiger Town Road, Chapel Hill Road and portions of Beaver Meadow Road). Other portions of Norwich drain more directly into the Connecticut River. These different drainage basins create a north-south ridge on the west side of Norwich. Hartford Public Safety Dispatch has already changed to narrowband analog and, after conducting field tests in this area, we found very reliable mobile radio coverage from Hartford's Hurricane Hill tower to the Mitchell Brook valley area. This is an improvement over the existing wideband coverage from Hayes Hill in Hanover.

### **Public/Private Partnership**

During the communications study, it was suggested that we consider the possibility of a public/private partnership to reduce the cost of the Norwich tower. Pete Webster contacted VTel because they had a Rural Utility Service grant from the USDA to provide broadband coverage to most of Vermont. When I became manager, I contacted Verizon Wireless and AT&T. I never received a response from Verizon Wireless but AT&T discussed the tower location with their radio frequency engineers and told me that their priority was cellular coverage for major transportation arteries like Interstates 91 and 89 and they were not interested in the Norwich tower site at this time.

I followed up on Pete's contact with VTel with a letter dated March 28, 2012 and had some subsequent discussions with their engineers about the location and proposed height of the Public Works tower. On July 11, 2012, they sent me an email that they were interested in partnering with Norwich and building the tower if they could put their 700 MHz LTE system on the tower. This would provide broadband access for a portion of Norwich.

On August 15, 2012, the Selectboard authorized me to sign a Letter of Intent<sup>6</sup> with VTel for VTel to build the tower, and it was fully executed by both parties on August 22, 2012. I found VTel very cooperative in making certain that the communications needs of Norwich were given first priority. They agreed to give Norwich the same space at the locations we need on the tower to provide service to Fire, Police and Public Works that we would have had if Norwich were to build and own the tower.

VTel also preferred to build a monopole tower. I discussed this with our radio consultant and the company that maintains the Hanover and Hartford radio systems. VTel will be using sector (directional) antennas that each provide about 120 degrees of coverage and three antennas will provide 360 degrees of coverage. We will be using omnidirectional antennas that provide 360 degrees of coverage. A monopole would create a shadow of reduced coverage on the side of the monopole away from the antenna. In addition, the company that currently maintains the Hartford and Hanover radio systems told me that monopoles are very difficult to work on in ice and snow conditions. After obtaining that information, I told VTel that we needed a lattice tower and not a monopole, and they readily agreed.

### **Fiber**

During discussions of the tower on the Public Works site, it was suggested that using fiber to connect multiple and lower towers would accomplish the needed coverage at a lower cost. I requested a budget quote for a site with a 60 foot tower, equipment shed, backup generator, simulcast transmitter/receivers for Fire, Police and Public Works with the necessary timing equipment. The quote for the master control site was approximately \$237,000 and for each controlled site, approximately \$220,000. These estimates did not include the costs of linking the sites, acquiring private property for the new tower sites or the necessary easements for access for utilities and maintenance, nor extending utilities to the sites.

A preliminary estimate of this proposal using lower towers required approximately 10 tower sites for an aggregate cost of \$2,271,000. In the unlikely event that the number of sites could be reduced to 5 (one for each major valley) and still maintain adequate coverage, the cost of the towers and radio equipment was estimated to be \$1,117,000. Again, these estimates did not include the cost of site acquisition and utility or maintenance access that would be needed from private property owners. In addition, the annual cost of ongoing maintenance using this technology would be higher and the technical difficulty of timing the radio signals from different locations (which travel at the speed of light) would be significantly increased.

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<sup>6</sup> The "Definitive Agreement" still need to be negotiated.

**Summary**

The proposed simulcast system seven transmitter/receiver sites and one receiver site for Fire/EMS, simulcast system three transmitter/receiver sites for Police and one transmitter/receiver site for Public Works will provide significantly improved communications capabilities for our Public Safety and Public Works Departments and meet the requirements for changing to narrowband channels. The one tower in Norwich has been located on public property in a location that looks up the valleys and provides very good coverage for Norwich Departments and has kept the height to less than 200 feet to the top of the top antenna so that painting and obstruction lights are not required. The cooperation with neighboring communities has improved coverage and reduced our costs. The partnership with VTel on the tower has further reduced to costs to Norwich.

Neil Fulton

September 4, 2012