SIRN 20/20 VHF FREQUENCY SURVEY AND ANALYSIS REPORT

11.3 FINAL REPORT SUPPLEMENTAL DOCUMENT

Contract Deliverable # 7

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EXECUTIVE OVERVIEW

In support of the Statewide Interoperable Radio Network (SIRN) Feasibility Study, an analysis was performed to determine the availability of VHF frequencies. Using conservative assumptions, frequencies supporting five paired trunked channels per site were assigned to 108 sites in a Preliminary Network Design (PND) indicating that adequate VHF frequencies are available.

As with any extensive network of this nature, the analysis suggests that successfully finding frequencies to support the SIRN will not be without its challenges. Frequency planning is a sequential process where the choice of available frequencies is highly dependent on the status of current assignments. Success will be highly contingent on the management of the project and particularly on the goodwill of local public safety partners throughout the State. A viable SIRN will require maximizing contributions of existing on-site public safety sites' frequencies for incorporation into SIRN; establishing SIRN frequency separation policies; and disciplined assignment and licensing of frequencies in phases, addressing the riskiest phases first.

The SIRN frequency plan is contingent on cooperative incorporation of a significant percentage of the existing onsite transmitters currently used by public safety agencies. Therefore, SIRN must be perceived as an adequate replacement for local networks with a governance that provides transparency and responsiveness to local partners while nurturing local goodwill. One critical step in enabling this process is also implementing the 800 MHz systems in the major metropolitan areas. This step must be coordinated with local partners with the understanding that existing VHF resources in these communities will be freed up for incorporation into SIRN. Canadian frequency coordination – a potentially challenging and lengthy task – may also be mitigated by close collaboration with local communities for a gradual migration of those frequencies to SIRN.

The assignments of frequencies should be performed in phases where the riskiest assignments are performed first. This approach will alleviate the largest risks early while quickly building confidence in project success. This successful rapid reduction of risk and building of confidence will help build momentum toward the successful completion of the project.

Frequency planning for SIRN can be expected to take 18 to 24 months, but significant site construction can go on in parallel. Common site infrastructure that is not dependent on frequency assignments can begin as soon as a site is selected as long as there is confidence that SIRN frequencies will be successfully assigned to a site.

DOCUMENT CONTENT OVERVIEW

The documents chronicles the initial survey, design and process, identifies and discusses prospective risks; and outlines a set of technical and procedural policies and recommendations to guide SIRN frequency planning and deployment.

Spreadsheets including frequency surveys, and preliminary assignment plans are provide separately.

FREQUENCY SURVEY AND DESIGN PROCESS

FREQUENCY SURVEY OVERVIEW

The FCC Code of Federal Regulations (CFR) identifies both Public Safety (PS) and Industrial and Business (IB) VHF frequency pools. The frequency pools together include frequencies from 150.775 MHz to 161.61 MHz, and some of the frequencies are included in both pools. VHF frequencies do not have a structured band plan, where transmit frequencies are paired with receive frequencies all with a fixed frequency offset. Instead, prospective licensees supporting trunked applications that require paired frequencies are required to pair frequencies during the licensing process. Little opportunity exists for establishing any kind of frequency plan structure in this process due to the fact that there are many incumbent licensed frequencies.

The CFR lists 489 frequencies in the PS pool and 655 frequencies in the IB pool of which 66 frequencies are listed in both pools[1]. Since the PS listed limitations for the common frequencies are generally less constraining and the PS frequencies are not subject to the proof of need oversight of the IB frequencies, these common frequencies will all be considered PS frequencies, making the effective total number of unique frequencies:

- 489 PS Frequencies
- 589 IB Frequencies
- 1078 total unique frequencies

FCC LIMITATIONS ANALYSIS

The VHF frequency pools are selectively subject to various restrictions ranging from use as national interoperability channels only to maximum transmit power limitations. An analysis was required to determine the significance of the various limitations.

Significant limitations eliminated 22 of the 489 PS frequencies leaving 467 PS frequencies available. Likewise, limitations eliminated 149 of the 589 IB frequencies leaving 440 IB frequencies available.

Total Pool of 7.5 kHz VHF Frequencies		
	Public Safety	**Industrial & Business**
Pool Total without Limitations	489	589
Frequencies Limited	20	26
Total Frequencies Available	469	563

The FCC regulations assume that frequencies are separated by 7.5 KHz. This is inconsistent with the preeminent Project 25 (P25) public safety standard that supports channel bandwidths of 12.5 KHz. P25 transmissions assigned to frequencies separated by 7.5 KHz will experience significant in-band interference. To avoid this, one approach is to limit SIRN use to those frequencies separated by 15 KHz.

The current FCC 7.5 KHz spacing is the result of a narrowbanding effort of what used to be 15 KHz channel bandwidths. As a result, the majority of existing PS and IB VHF frequency assignments are in increments of 15

[1] See Frequency Survey and Plan Database.

KHz. By adopting these same 15 KHz frequencies bandwidths, the majority of co-channel interference issues can be avoided.

	Public Safety	Industrial & Business	Combined
Total Frequencies Available	469	563	1030
Interstitial Frequencies	-234	-277	-511
Total 15 KHz Spaced Freqs Available	235	286	521

These selected frequencies formed the pool of frequencies used to make frequency assignments to the Preliminary Statewide Interoperable Radio Network Design (PND) that included 116 sites.

Survey of Existing Frequencies

A database of all existing frequencies licensed within a 120 mile range of the North Dakota State border was developed using RadioSoft's Comstudy 2.0 tool. The RadioSoft data indicated that many licenses had separate entries for both the transmission and reception for a given frequency. For expedience, where this redundancy was present the transmit information was selected as representative of both the transmit and receive information. A list of statewide frequencies was also provided by RadioSoft and was incorporated.

A "Site List" Worksheet of VHF frequencies within the spectrum pool and geographical area of interest was assembled including:

- 10,242 frequencies
- 5,282 licensed site locations
- 83% of existing licenses comply with 15 KHz channel spacing

The survey information was consolidated into a "Site List" worksheet serving as the database of existing transmissions that could then be used to determine whether frequencies were in use within a given range of any selected proposed site.

Frequency Planning Design Considerations

Capacity and Frequency Planning

Network capacity is determined by the number of sites and the number of channels per site. The number of sites was determined by coverage analysis. To ensure timely development of the Frequency Plan, the frequency activity employed the 2015 preliminary SIRN design (PND) of 116 sites as the basis for the site constellation.[2] Several sites

[2] Frequency development and coverage design are inherently linked and iteratively performed. However, while the Final SIRN Coverage Plan includes sites different from the PND, a majority of the PND and SIRN sites are identical or proximate to each other. This vicinity is typically with the search radius of the VHF assignment process and considered sufficient for the preliminary assignment process. Additionally, it should be noted that of the 145 planned SIRN sites, 20 – 25 sites would be designed as receive-only, leaving 120 sites requiring Transmit/Receive frequencies.

were located in the Cass/Fargo area, where an 800 MHz trunked network is planned.[3] This area uses a significant number of VHF frequencies currently, and these frequencies will likely be freed up or made available when the 800 MHz system is brought online. With these considerations, 8 of the 116 PND sites located in the Cass/Fargo vicinity were excluded from the frequency assignment process.

The Preliminary Site-Frequency Plan (PSFP) is designed for five (5) frequency pairs at each of the PND sites. The channel count assessment to date suggests that sites in 42 of North Dakota's 53 counties will be well served by just three traffic channels. Since there are more than two sites for each county, over 84 sites will require only three traffic channels. At the other extreme in the more metropolitan areas, it was determined that the channel count will rarely exceed four talk channels. Therefore, as a conservative assumption, the assessment exercise assumed that all sites would have one control channel and four traffic channels and that none of the existing onsite transmitters would be available for use in the PND. However, the original assignment process also did not accommodate ongoing coexistence of any existing on-site VHF transmitters.

TX-RX FREQUENCY SEPARATION AND INTERMODULATION CRITERIA

Frequency planning for network sites requires establishing guidelines. Adopting the appropriate frequency isolation guidelines reduces the likelihood of interference, and can significantly reduce the cost of sites by reducing the cost of transmit combiners[4] and other supporting equipment. The following site frequency guidelines were used under the assumption that separate antennas are used for transmit and receive signals and that:

Description	Recommendation
Pre-selector bandwidth	4 MHz
Minimum Rx to Rx separation	50 KHz
Minimum Tx to Tx separation	100 KHz
Minimum Tx to Rx separation	1.5 MHz
Intermodulation products	Clear to 7th order

In addition, in the absence of a specific frequency plan, a general guideline was adopted for the frequency assignment process where talk-in frequencies are lower than talk-out frequencies. Frequencies were assigned to sites in a manner consistent with the recommended frequency separations and reuse ranges listed above as well.

Separate Tx/Rx antennas and Frequency Constraints

In addition to being a technical best practice, deviations from the guidelines tabulated above also have financial and structural ramifications. Essentially, as the separation or isolation between Tx and Rx frequencies at a site gets smaller, the cost becomes significantly more expensive and requires substantially more rack space. Excessive

[3] The principal SIRN Architecture recommendation is a hybrid VHF-800 Network comprised on a statewide VHF system with 800 MHz augmentation in six Urban Areas.

[4] Radio Frequency (RF) combiners, combine multiple transmit repeaters onto a single transmit antenna, namely, to economize space on a radio tower.

insertion losses on both the Tx and Rx contribute to degraded performance. Sample costs and sizes for different scenarios are tabulated below:

Range/Category	Description	Size	Cost
Best Case	Separate antennas for Tx and Rx; **sufficient** spacing between Tx-Tx, Rx-Rx and Tx and Rx	1 Rack	$15k
Mid	Separate antennas for Tx and Rx; **tight** spacing between Tx-Tx, Rx-Rx and Tx and Rx	2 Racks	$23k
Bad Case	Single Tx-Rx antenna; **sufficient** spacing between Tx-Tx, Rx-Rx and Tx and Rx	4 Racks	$70k
Worst Case	Single Tx-Rx antenna; **tight** spacing between TxRx, Rx-Rx and Tx and Rx	N/A	N/A

The Best Case and the Bad Case listed above illustrate the difference in cost and shelter space when going from a dual antenna solution to a single antenna. Four times as many racks are required and the cost is over four times greater. In these two cases the frequency separations are adequate and compliant with the policy.

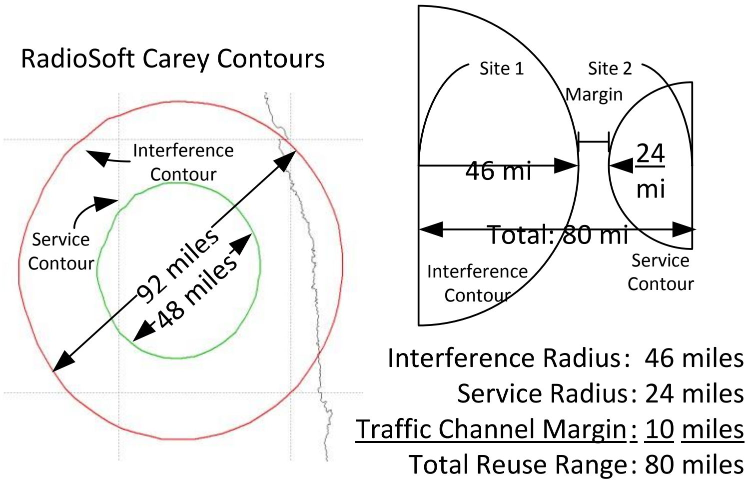
When frequency separations do not comply with frequency separation policy, combiner expense is increased by 50% and rack space is doubled. The Worst Case, while possible, would be significantly more expensive and requires substantially more rack space than even the Bad Case while supporting significantly degraded service.

It should be noted, to accommodate existing on-site frequencies or when there is limited space on towers, certain sites may require the use of more costly or space intensive combiner designs.

Geographical Separation and Reuse Criteria

A frequency geographical separation policy was adopted in the subsequent frequency assignment exercise. Adopting the appropriate frequency reuse range can affect the ease and cost of licensing as well as the reliability of the resulting network. Assuming that towers will be 400 feet tall or less and then determining the resulting service and interference contours, the minimum frequency reuse range was determined to be a total of 70 miles. For talk channels a margin of 10 miles was added, and for control channels, the added margin was 40 miles (See Figure below). This resulted in a talk channel reuse range of 80 miles and a control channel reuse range of 120 miles. No distinction was made whether the reuse is transmit or receive.

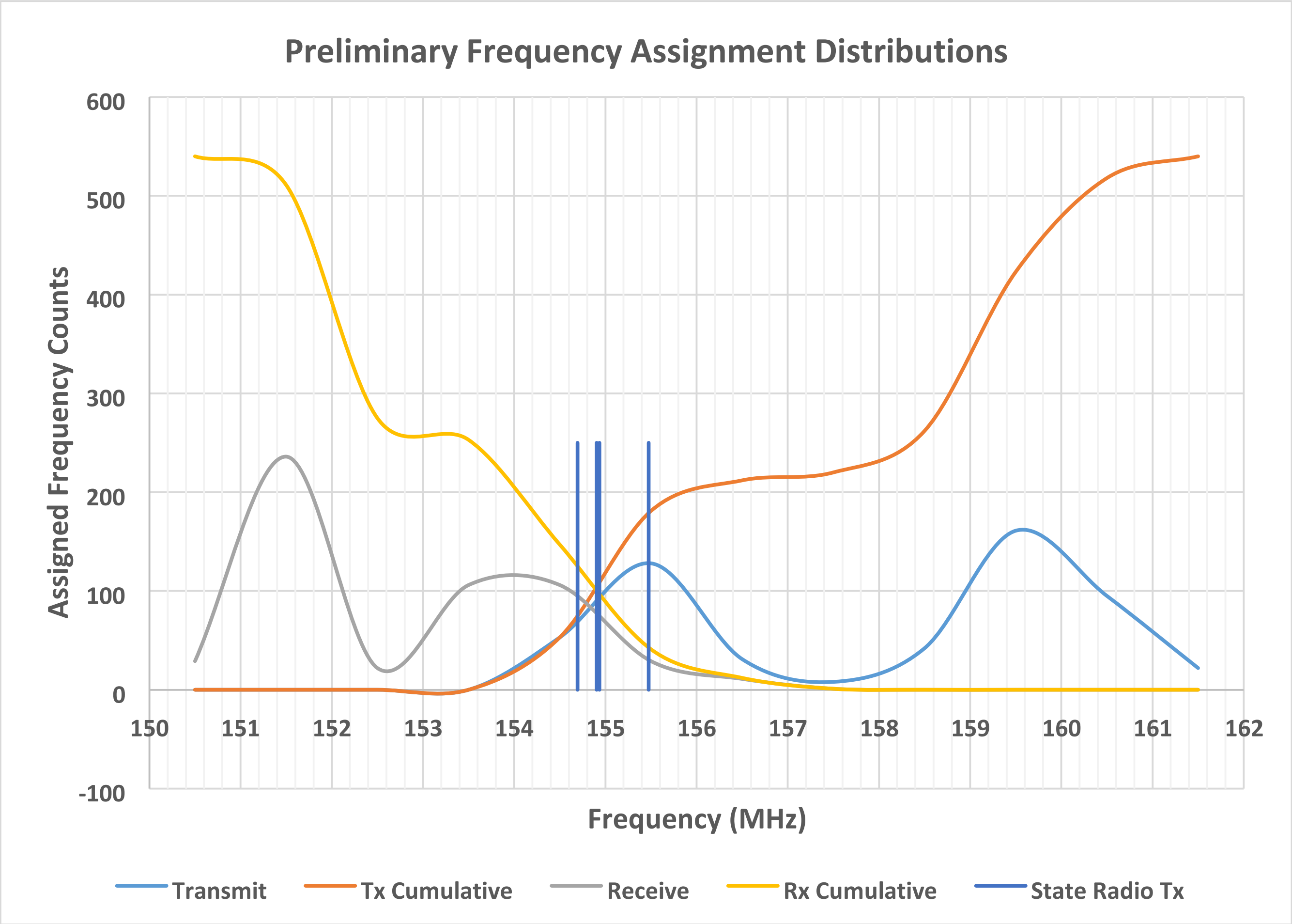
400 ft Tower Service and Interference Contours



TALK-IN/TALK-OUT FREQUENCY BOUNDARY

When frequencies were assigned, lower frequencies were assigned as talk-in, while higher frequencies were assigned as talk-out. For 108 sites 540 transmit frequencies and 540 receive frequencies were assigned. These frequency assignments assumed that none of the existing on-site VHF frequencies were available for incorporation into the SIRN, but the assignments also assumed that there were no existing on-site transmitters to be considered while assigning frequencies. The resulting frequency assignments were based completely on what frequencies appeared to be available at each site.

Below is a histogram of these frequency assignments showing the number of sites assigned for each frequency. The graph also shows cumulative site counts for both transmit and receive frequencies. Both the histogram and cumulative counts graph results show a dip in the middle of the graph, which suggests that it may be possible to establish a boundary frequency where all receive frequencies are below and all transmit frequencies are above. Establishing a boundary frequency will prevent a situation where a single frequency used as a transmit frequency at one site is used as a receive frequency at an adjacent site. In this scenario, a mobile subscriber's transmissions on the frequency will jam all nearby reception on the same frequency. The dip suggests that this frequency boundary can be established at a frequency just below 155 MHz.



Currently, statewide communications are supported by a total of 42 State Radio sites that host four statewide radio Tx/Rx frequencies. The 108 PND sites include these 42 State Radio sites, and one consideration is that these four existing frequencies will be maintained and supported at these sites even after the SIRN is built to support transition. The graph above shows the four statewide frequencies used at the 42 State Radio sites as four vertical blue bars. These frequencies are transmitted from these sites. Ideally the network boundary frequency would be compatible with these four statewide frequencies. The lowest of these four frequencies is 154.695 MHz, and as a placeholder, this frequency will be adopted as the lowest allowed site transmit boundary frequency for remaining analysis.

P25 Trunked Statewide Frequency Plan

Based on the guidelines and design criteria discussed above, the frequencies totals tabulated below were assigned to 108 sites of the PND. Assignments were successfully made to all 108 sites without incorporating any of the existing on-site frequencies into the SIRN.

Preliminary Assignment Totals		
Total Number of Frequencies Assigned	1080	108 Tx Sites – 10 frequencies each
Public Safety Pool	697	
Industrial & Business	383	
Unique Frequencies	382	
Average Reuse	2.83	

A sample excerpt from the frequency plan deliverable appears as follows:

Site Name: SS-ARNGD			Site Name: McKenzie A1	
47.91166667	-103.45325		47.87008	-103.95083
Transmit	Receive		Transmit	Receive
Primary Control (Min Spacing 120 miles)			Primary Control (Min Spacing 120 miles)	
158.76	151.19		155.76	153.86
Traffic (Min Spacing 80 miles)			Traffic (Min Spacing 80 miles)	
155.64	153.89		155.535	153.59
155.79	153.965		158.22	153.665
156.135	154.025		160.23	153.725
159.18	154.13		160.485	153.995
Intermods:	Clr		Intermods:	Clr

I/B Pool	PS Pool

POTENTIALLY RESTRICTED FREQUENCIES USED IN FREQUENCY PLAN

The Preliminary SIRN Frequency Plan (PSFP) employed frequencies that may be restricted for use but could be available depending on the inclusion of state and local entities on SIRN or further coordination with other jurisdictions outside of the State. These frequencies include:

- Statewide/Countywide Frequencies – 6% of the 382 frequencies are currently licensed for mobile use across the entire state geography
- Continental US Frequencies – 15% of 382 frequencies are currently licensed for mobile use nationwide by the railroad industry.
- Canadian Frequencies – A subset of frequencies licensed by federal authorities in the Canada are not publicly available for search and licensing at this stage.

It should be noted that, conversely, the PSFP does not incorporate frequencies that will be vacated by entities migrating to 800 MHz where a significant number of VHF frequencies are currently licensed. Frequencies vacated and in turn contributed to SIRN by those "Urban Area" entities are expected to more than offset the loss of these restricted frequencies.

A sample set of the PSPF was selected for pre-coordination by APCO, an accredited licensing body for independent review and validation.

Mobile Area of Operations Considerations

The FCC database includes frequencies that are licensed for use within a jurisdictional Area of Operation (AoO) such as one or more counties, statewide or nationwide as opposed to a specific radius from a given point. Because these frequencies are typically licensed by a public sector entity, the original PSPF did not account for those restrictions. However, Televate has since developed a methodology for defining metadata polygons for the jurisdictions and can incorporate this methodolgy into future assignment processes. A more thorough survey of countywide and statewide licensed frequencies was conducted for North Dakota and the neighboring states of Minnesota, South Dakota and Montana.

Statewide/Countywide Frequencies

Summarizing just the North Dakota statewide licensed frequencies:

- ND has 91 statewide licensed frequencies ○ 54 licensed by State Radio, DoT and Forest Service
- Some of these will likely be incorporated into SIRN ○ 17 licensed by other commercial or federal entities
- These are not likely to be incorporated into SIRN
- 6% of the total pool of assigned unique frequencies (23 out of 382) were licensed statewide

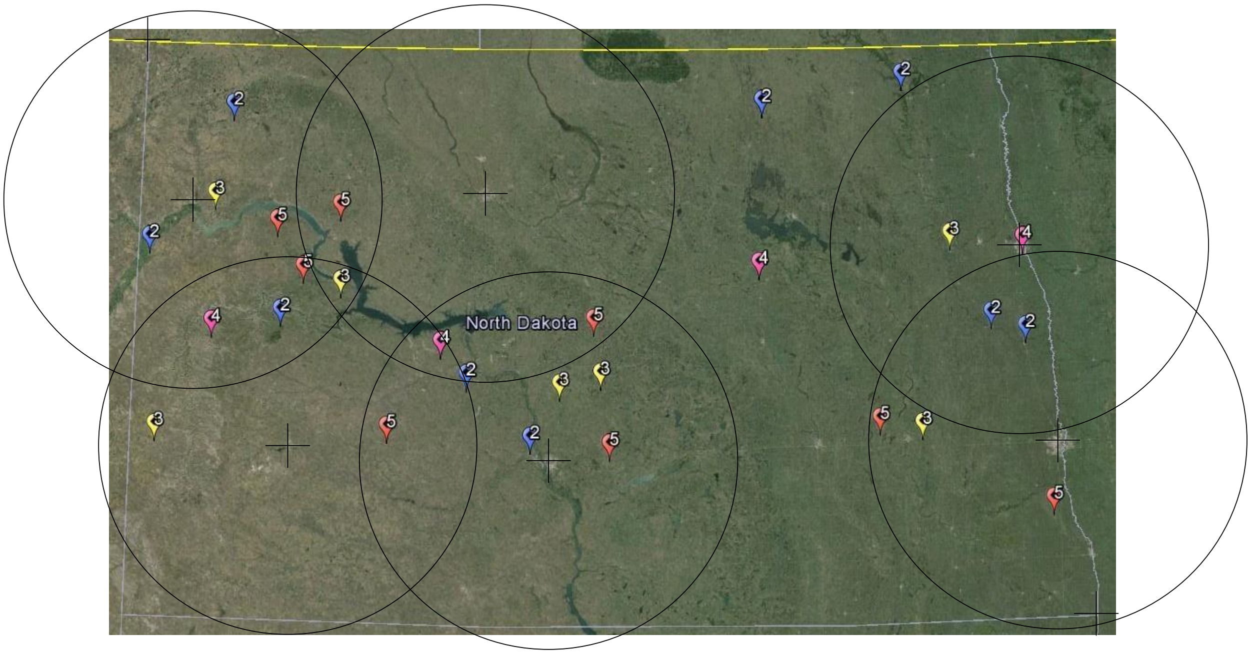
Continental U.S. Frequencies

Similarly, the railroad industry licenses frequencies nationwide. These frequencies are designated for "LR" use and extend from 160.215 – 161.610 MHz many of which tend to be protected from non-railroad use by the railroad frequency coordinators. However, the industry does not actually use all of those frequencies throughout the continental US. On a case-by-case basis use of those frequencies may be possible.

- Summarizing nationwide railroad licensed or designated frequencies:

○ "LR" designated frequencies extend from 160.215 – 161.610 MHz ○
15.2% of total pool of assigned frequencies (58 out of 382) are LR

LR assignments were used as a last resort. It should further be noted that the PND sites using the most LR frequencies are predominantly located in the vicinity of the urban areas (See Figure below). Most of these areas will be migrating to 800 MHz which should free up significant VHF resources.



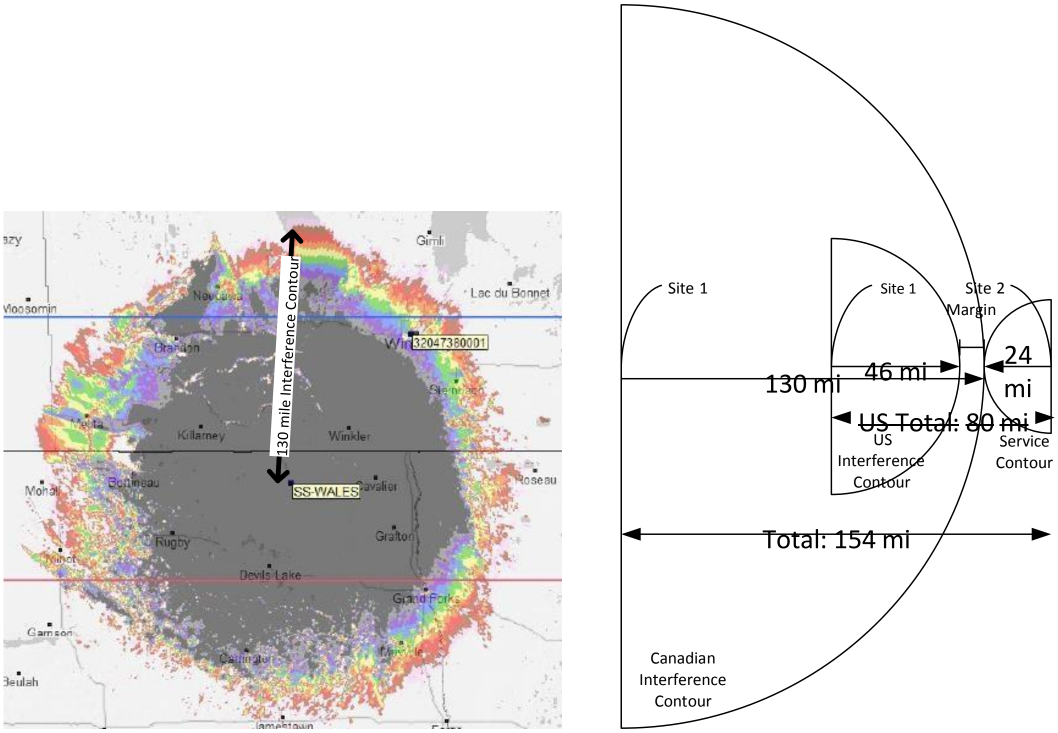
Site Railroad Frequency Counts and Proximity to Metro Areas

CANADIAN COORDINATION

There are two separate challenges in obtaining frequencies along the Canadian Border

1. Frequencies used within a distance of 70-miles of the Canadian border, referred to as Line A, require coordination with the Canadian authorities. While information on commercial frequencies in use by private enterprises is publicly available, information on frequencies in use by federal authorities is not disclosed until the actual licensing process. As noted later in discussion on mitigation strategies, one approach is to leverage the publicly available information on private or commercial enterprise frequencies. It is safe to assume that there are no Canadian public safety sites using the same frequency within the Canadian interference contour of the Canadian commercial site.

2. Canadian regulations have significantly more conservative interference contours than those in the U.S as depicted below. Canadian interference contours extend out to 130 miles for a 400 ft tall transmitter test case. If the service contour is 24 miles, the Canadian minimum reuse range is 154 miles. While the current PSPF uses the previously discussed 80 and 120 mile reuse ranges for site frequency assignments above Line A, future frequency assignment processes will incorporate the Canadian minimum reuse range for reusing existing Canadian assigned frequencies in SIRN.



Canadian 400 ft Tower Service and Interference Contours

Canadian Interference Radius:	130 miles
Service Radius:	24 miles
Minimum Total Canadian Reuse Range:	154 miles

ON-SITE TRANSMITTERS FOR SIRN SITES

There are a number of existing VHF transmitters providing critical communications services on the selected PND sites currently. Every attempt must be made for SIRN frequencies to co-exist with those legacy on-site transmitters at least during the transition period so that end users can smoothly transition from the legacy to SIRN channels.[5] The PSPF assignment results assure that the proposed frequencies can co-exist with the legacy State Radio sites at the State Radio towers. However, all SIRN frequencies cannot co-exist with all existing onsite transmitters at all remaining sites while complying with the SIRN frequency separation policy. Some accommodations must be made.

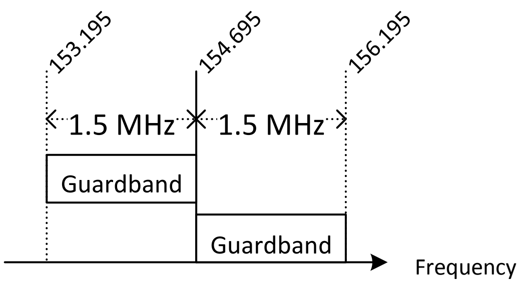
[5] For this analysis all licensed transmitters located within a mile of the PND site locations were considered on-site transmitters. This approach may overstate the actual number of transmitters, but it should not understate it.

ON-SITE STATE RADIO CHANNELS

The existing State Radio system provides statewide coverage hosted by 42 sites sharing four VHF frequencies licensed statewide. This system has the most extensive coverage and the most subscribers and will be essential in transitioning from the existing patchwork of local repeaters to the SIRN. The four frequencies supporting State Radio appear to be compatible with the SIRN Tx/Rx frequency boundary allowing easier integration and accommodation. The four frequencies are all within the high guardband range of the boundary frequency which provides the greatest limitations on the availability of receive frequencies, so SIRN frequency assignments to these State Radio sites will have to be performed early in the frequency assignment process to achieve success.

LOCAL PUBLIC SAFETY TRANSMITTERS

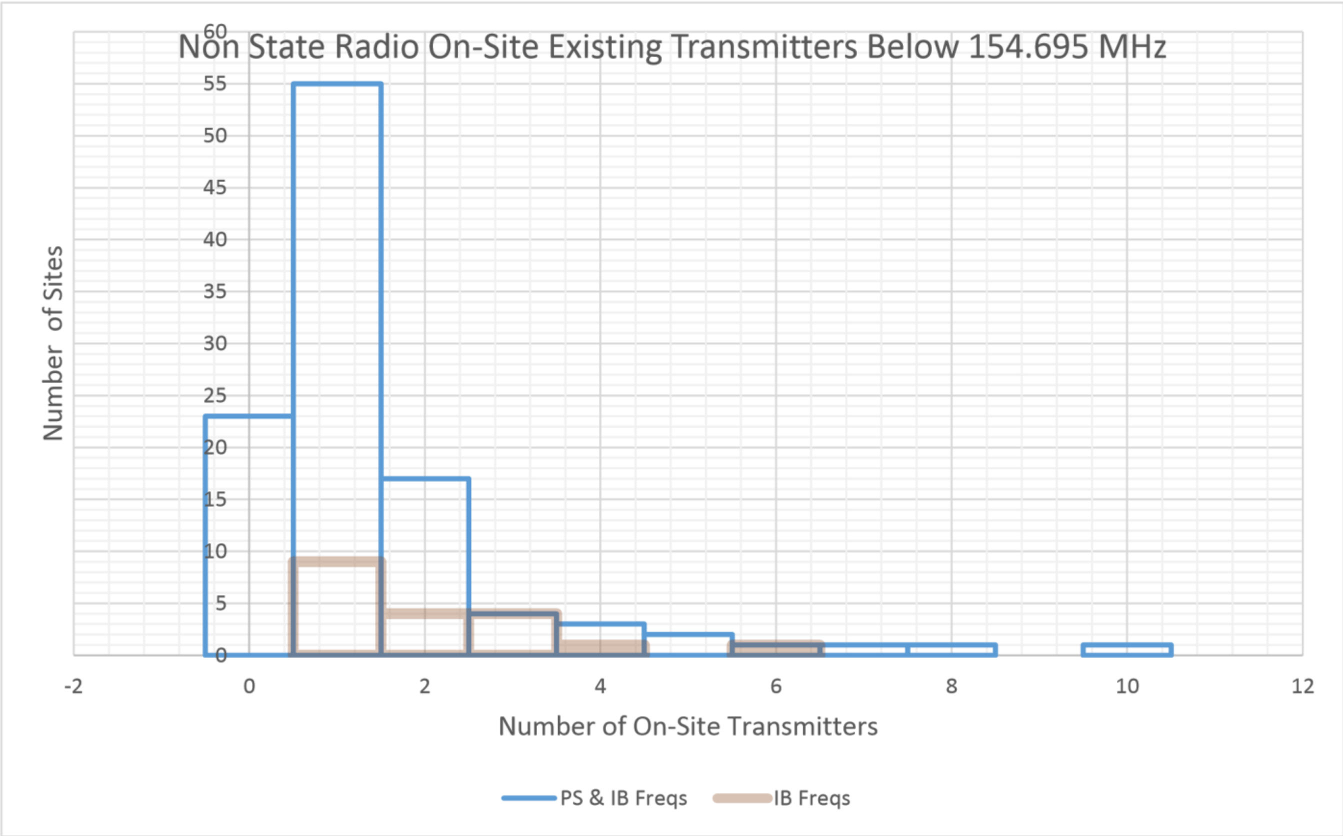
For the rest of the existing on-site transmitters, those transmitters that have frequencies 1.5 MHz above the Tx/Rx site boundary frequency (See Talk-in/Talk-Out Boundary discussion above) have the best chance of being preserved while complying with the frequency separation policy. This is because of the 1.5 MHz Tx/Rx separation requirement. SIRN-assigned receive frequencies can approach the boundary, but this will force all transmit frequencies at these site higher than the boundary frequency as shown below.



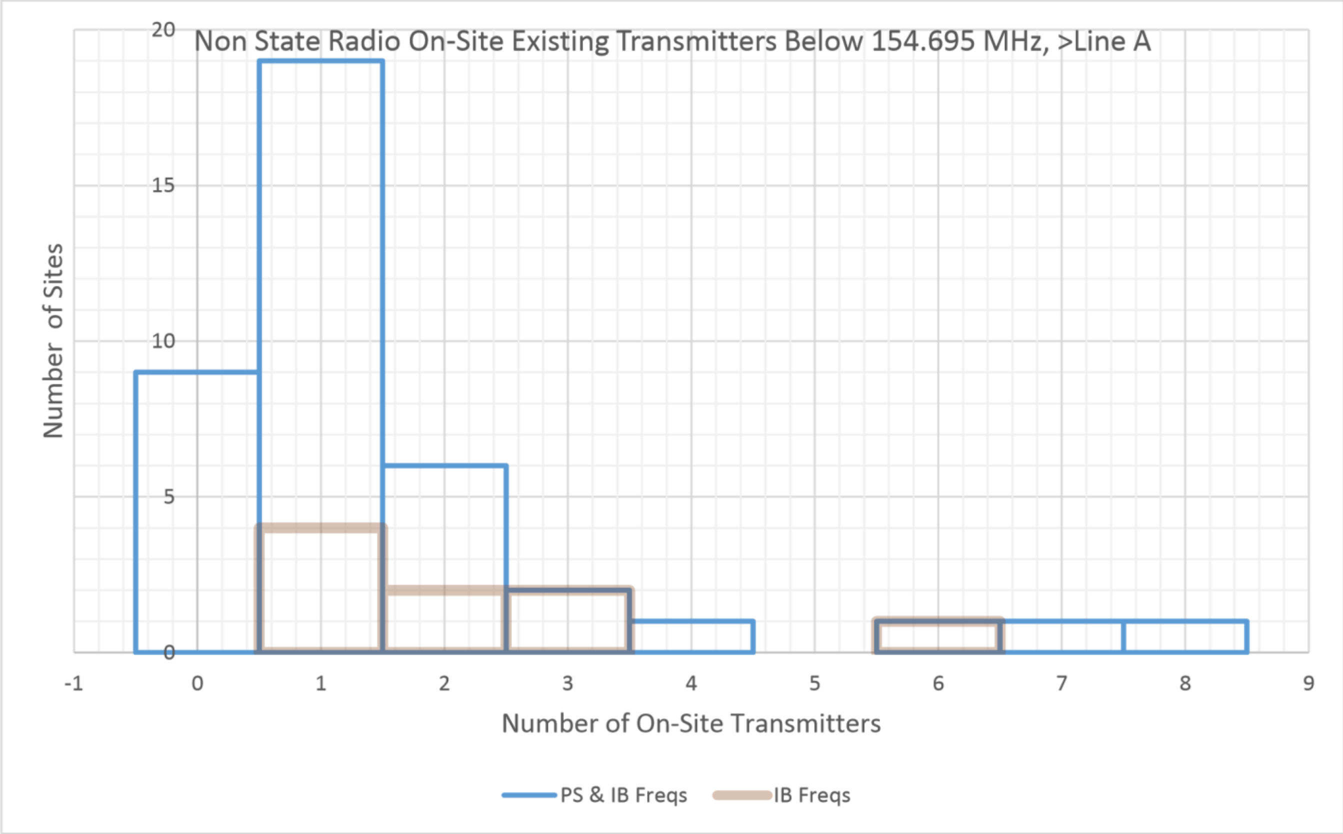
Existing high guardband range on-site transmitters that are within 1.5 MHz above the boundary have the next best chance of being accommodated and complying with policy, while those transmitters below the boundary will not comply with policy.

Ideally all existing on-site transmitters will gradually be incorporated into SIRN. However, at least during the transition, those that are above the site specific guardband can be incorporated as SIRN site transmit frequencies, while those below the site specific guard band can be incorporated as SIRN site receive frequencies. Barring incorporation, where the existing on-site transmitters do not comply with policy, they may be accommodated as they are with extra and costly combiner equipment. However, in some cases, they may not be able to be accommodated at all depending on how close the transmit frequency is to the receive frequencies. As this gap tightens, the cost and the rack count increase considerably.

The histogram below quantifies the number of existing on-site transmit frequencies below the Tx/Rx boundary frequency at the PND sites. 85 sites have one or more existing frequencies which SIRN has to accommodate, navigate around or incorporate. The good news is that 55 of those sites have only one on-site transmitter. The histogram also breaks out the transmitters for 19 sites with frequencies that are allocated from the IB frequency pool. A total of 9 of these sites have a single IB frequency.



The histogram below shows a subset of the histogram above that separately depicts the number of existing onsite transmit frequencies below the Tx/Rx boundary frequency for sites above Line A. As noted later, to circumvent lengthy licensing procedures with Canada, these frequencies are ideally incorporated into SIRN at the outset; however, this approach does have to be balanced with the transition plan and operational needs of the affected jurisdictions. The graph shows that 31 of 40 sites are affected, and while 19 sites only have one frequency, there are four sites that have between four and six frequencies each. Meanwhile 9 sites use frequencies from the IB frequency pool. Four of these site have a single IB frequency.



OTHER CONSIDERATIONS

TIMING FOR DESIGN AND BUILD OF THE 800 MHZ SYSTEMS

Major metropolitan areas within North Dakota currently employ a significant number VHF frequencies at multiple sites in these areas. At a single State Radio site in Bismarck, the FCC database shows that there are 35 unique VHF frequencies licensed within a mile of the site. Of course, there are multiple VHF sites in each of these metropolitan areas providing critical communications services.

With the introduction of 800 MHz networks in these metropolitan areas, their critical communications services will be better supported.

Six metropolitan areas[6] within the State of North Dakota are currently recommended for 800 MHz service for the following reasons. A primary benefit will be that a significant number of the VHF frequency resources will be freed up to support the SIRN. The freeing up of these resources can play a crucial role in successfully assigning frequencies to SIRN, but only if the 800 MHz systems are deployed before the SIRN. In addition, 800 MHz:

- Delivers critical in-building portable coverage to major urban areas

[6] Include Fargo/West Fargo Metropolitan area, Bismarck/Mandan, Minot, Grand Forks, Dickinson, and Williston.

- Supports better interoperability with their counterparts for cities along the Minnesota border
- Release upgradeable VHF radios to be provisioned for use by Rural/County users

- Supports a pilot phase as the legacy VHF networks and 800 MHz networks can co-exist to further validate SIRN

SUMMARY OF RISKS, MITIGATION STRATEGIES AND RECOMMENDATIONS

The SIRN system is currently in early stage planning, and the selection of sites is still fluid. Any frequency analysis exercise must be based on a snapshot of site selection, as this analysis is. This early frequency analysis process provides vital insights into the viability of planning the network, however, frequency planning, coordination and licensing will be subject to a range of on-going variables that pose latent risks and hence require strategies to overcome them.

The actual frequency planning process will require a final selection of sites in order to minimize rework. Rework during the actual frequency planning process can have a considerable impact on both the schedule and cost of assigning frequencies. Some rework is expected in navigating frequency coordination with Canada, accommodating on-site frequencies, and other examples noted in this report.

EXISTING VHF ON-SITE TRANSMITTERS

The cooperation of existing VHF licensees at SIRN sites is critical to the success of the network. Particularly for sites north of Line A, successfully incorporating the existing licenses into SIRN will have a tremendous impact on the overall network deployment. Incorporating then in SIRN will avoid the majority of the FCC and the Canadian coordination, and these resources may be adequate enough to bring up the SIRN network at reduced capacity in the early stages of the process.

A lack of cooperation may introduce on-site transmitter combiner issues which may compound the FCC and Canadian coordination challenges.

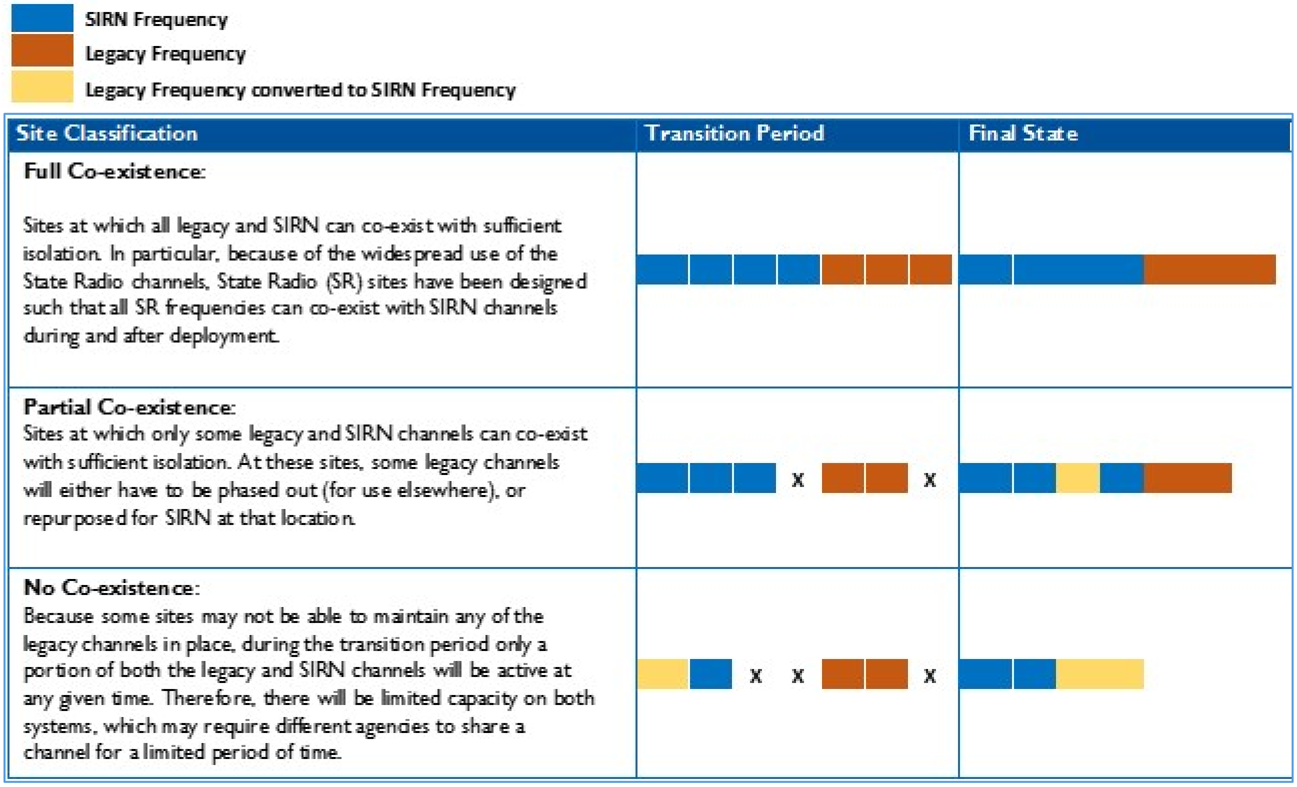
Managing Transition – Co-existence with On-Site Transmitters

In general a migration strategy for each SIRN site with existing public safety transmitters should be put in place. The State must maintain operational readiness during the transition to SIRN. Transition requires upgrading, programming and exchanging subscriber equipment while coordinating network deployment. Some existing channels must continue to be in place during transition providing continuity of communications. The capacity of these transition configurations must be monitored carefully as subscriber equipment is evolving. Any transition strategy must carefully nurture the goodwill of local communities by tactfully maintaining and then retiring their local communications resources.

An additional consideration includes the existing on-site transmitters that are allocated from the IB frequency pool. While some of these will be used for public safety, in other cases they may be used by commercial entities.

The risk is that these commercial entities may not be cooperative in either contributing or vacating their frequency assets. In some cases, this consideration may require consideration another site nearby or possibly even construction of a new site altogether.

The figure below illustrates three different scenarios for managing, transitioning and/or incorporating SIRN and existing on-site transmitters.



Mobile Area of Operations

A similar strategy may be pursued to incorporate and/or maintain the statewide mobile only frequencies. As several of those are operated by the State's public safety and other public sector agencies, many of them would gradually be incorporated into the SIRN frequency plans.

Coordination with Canada

Commercial Canadian Frequencies

Coordination with Canada can be minimized by maximizing the incorporation of existing currently coordinated VHF on-site transmit frequencies in the SIRN. Where coordination is necessary, candidate frequencies can be determined by identifying existing Canadian commercial frequency assignments just beyond the Canadian reuse range from the selected SIRN site. These frequencies can be assumed to be free of Canadian public safety within the interference contour of the Canadian commercial site.

Maximize Assignment of Existing Frequencies to SIRN

Maximizing assignment of existing frequencies to SIRN is especially important for sites north of Line A. Where existing on-site transmitters cannot be incorporated and where they cannot be cost effectively accommodated, they may have to be vacated. Incorporation or modification of existing frequencies may be done in phases rather than on day 1 to better support transition.

MANAGING FCC LICENSE EXPIRATION

Implementation of the SIRN network will take several years and include many phases of frequency planning. The time it takes to perform frequency coordination will vary significantly based on PS versus IB or U.S. versus Canadian coordination. There are many scenarios where frequencies licensed early in the process are not built out in time before they expire with the FCC. Consider if early licensing is performed for sites below Line A followed by licensing efforts above Line A. The above Line A frequencies that ultimately can be licensed may not be compatible with the earlier assignments, thus resulting in rework delays. There are real concerns for licenses expiring before the system is implemented.

OTHER RISK MITIGATION STRATEGIES

Other Risk Mitigation Strategies are available to overcome issues that may surface during the project.

Using 7.5 kHz Channel Spacing

Although the CFR allows frequencies to be used at 7.5 KHz increments, most current licenses use only frequencies at 15 KHz increments. Using the intermediate or interstitial frequencies will more likely require coordination with three frequencies rather than just one. This becomes even more critical when coordinating frequencies with Canada where all frequencies are assigned in 15 KHz increments. With their considerable interference contour restrictions, using interstitial frequencies may make Canadian coordination substantially more difficult. However, the use of 7.5 kHz Channel Spacing effectively doubles the number of frequencies available for assignment at a given site.

Expanded Use of Industrial/Business Frequencies

Using IB frequencies to support public safety is done often, but the IB frequency coordinators require proof that all public safety frequency pool options have been exhausted before they will grant licenses to IB frequencies for use in public safety. Coordinators must also see proof that adequate IB frequency resources remain available for use by future Industrial and Business applicants. The licensing process for IB frequencies is more expensive and takes longer than that for PS pool frequencies.

To improve the likelihood of success a policy of first exhausting all available PS frequency pool resources before considering use of IB frequency pool resources may need to be adopted. In addition, contingency funds should be set aside in the event that spectrum must be purchased. Some frequencies used by public safety are actually licensed by radio shops. The public safety entity using the frequencies may have no authority to contribute the frequency resources.

Using Alternative Private Sites

In some cases, it may not be possible for SIRN channels to coexist with any on-site transmitters currently used by public safety. Local agencies may also not be able to contribute those channels early in the program due to their operational needs. Therefore, in cases where both sets of sites have to be operational, SIRN may need to employ alternative nearby private sector towers. In general, deploying SIRN on a private tower will be more costly due to the added infrastructure, and access and lease costs. However, it is a viable approach to avert onsite transmitter issues. The SIRN Tower database provides a repository of alternative sites for virtually all proposed locations.

RECOMMENDATIONS

CONTINUED CONSULTATION WITH LOCAL STAKEHOLDERS

Because ultimately, this is their network, factoring in the daily operational and capacity needs of local stakeholders is vital. This includes:

- Identifying how many frequencies' "on-site transmitters" can be incorporated into SIRN or temporarily "turned off"
- Outlining a migration strategy that minimizes downtime and maintains communications interoperability
- Maintaining interoperability, which could require multiple rounds of radio programming
- Further consultation with counties above Line A on fully incorporating most of their already licensed frequencies into SIRN

PROPOSED ORDER FOR SIRN PHASES

Many risks can be best managed by adopting a disciplined order for processing. The first two phases are relatively low risk and reduce the risks for all subsequent phases, while for the frequency assignment phases, the highest risk phases are done first and stabilized, therefore substantially reducing the risk of rework for the subsequent phases. However, it is also important to maintain sufficient flexibility so additional phases can be added if necessary.

Design and implement 800 MHz systems

Early deployment of 800 MHz systems will free up VHF resources in metropolitan areas for incorporation into SIRN.

Establish Stable Selection of SIRN Sites

Stabilizing site selection will minimize compounded frequency coordination rework. This is most critical at sites located above Line A. Construction of common infrastructure for selected sites may be started immediately, assuming that frequencies will be successfully assigned to the sites. If there are questions about the feasibility of successfully assigning frequencies, construction should be delayed accordingly. Construction, if initiated, can include everything except that equipment that must be customized to support the site frequency assignments.

Identify Talk-in/Talk-out Frequency Boundary

Establish a frequency boundary where all receive frequencies are below and all transmit frequencies are above. The current frequency assignment process has identified a placeholder, but subsequent iterative frequency assignment efforts may require modifying this.

Assign Frequencies in Phases

These phases are prioritized in such a way that the first assignments require the most frequency options in order to be successfully planned. At the conclusion of the planning for each phase, the remaining frequencies can be incorporated with confidence in the next phase.

The physical building of the network can be performed in the same order, where, as site frequencies are successfully licensed, site construction of frequency supporting equipment can begin.

A recommended sequence targeting the most challenging frequency options first is outlined below:

1. **Above Line A – State Radio sites**: Frequencies assigned must be compatible with the existing State Radio frequencies as well as Canadian coordination.

2. **Above Line A – Sites without State Radio:** Frequencies assigned must be compatible with Canadian coordination and all earlier SIRN assignments.

3. **Below Line A – State Radio Sites**: Frequencies assigned must be compatible with the existing State Radio frequencies and all earlier SIRN assignments.

4. **Metropolitan Ares:** Frequencies assigned must be compatible with all earlier SIRN assignments.

5. **All Remaining**: Frequencies assigned must be compatible with all earlier SIRN assignments.

Complete one Frequency Phase before Starting the Next

Failure to complete and stabilize the frequency assignment phases in order increases the chances that rework will be needed in one or more phases. Changes to above Line A frequencies at sites with State Radio can propagate ripples of frequency changes throughout the entire design.

CONCLUSION

There are challenges ahead in successfully designing and implementing SIRN as with any extensive network of this nature. The good news is that there are adequate frequency resources available for achieving success. Success, however, will depend substantially on how the project is managed and particularly on the goodwill of local public safety partners throughout the State. It is crucial that the network design is perceived as being an adequate replacement to local networks and that the governance of the network will be functional and responsive in supporting local needs.

SIRN VHF Frequency Survey and Analysis

One significant challenge is managing the gap between the need to implement the network in phases that maximize frequency assignment options while minimizing risks and the discrepancies in the coverage of those phases and the coverage needs of local networks. Careful management of the transition will be critical to maintaining local goodwill and confidence in the network.

Implementation must be highly disciplined, coordinated and transparent to all local and State partners. Success in finding frequencies is contingent on cooperative incorporation of a significant percentage of the existing on-site transmitters. A critical step in enabling this process will be implementing the 800 MHz systems in the major metropolitan areas. This step must be coordinated with local partners with the understanding that existing VHF resources in these communities will be freed up for incorporation into SIRN.

Establishing a stable selection of SIRN sites before initiating the frequency assignment process is critical for avoiding the compounding of the expected rework in coordinating frequencies with Canada with modifications to the site selection. Every effort should be made to avoid this compounding rework scenario.

The assignments of frequencies should be performed in phases where the riskiest assignments are performed first. This approach will quickly eliminate the largest of risks while quickly building confidence in project success. This successful rapid reduction of risk and building of confidence will help build momentum toward the successful completion of the project.

It is essential to remember that frequency planning is a sequential process where the choice of available frequencies is highly dependent on the status of current frequency assignments. Confidence in the project is also highly dependent on the confidence in the stability of those current assignments. This confidence can only be built by being adequately patient and thorough during the earliest and riskiest part of the frequency assignment process.

Frequency planning for SIRN can be expected to take 18 to 24 months, but significant site construction can go on in parallel. Common site infrastructure that is not dependent on frequency assignments can begin as soon as a site is selected as long as there is confidence that SIRN frequencies will be successfully assigned to a site.

Ideally, in the early stages, the riskiest frequency assignments will performed during the design and implementation of the 800 MHz networks.