



# Sussex County VHF Paging and Dispatch Study and Recommendations

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Sussex County  
Sheriff's Department

VHF Paging and Dispatch Radio  
Coverage Study and  
Recommendations  
Report

AKF Group, LLC  
Project No. Y160007-000  
October 31, 2016

## I. Introduction.

- A. Sussex County requires reliable, two-way, countywide radio communications capability from its new Public Safety Answering Point (PSAP) facility to support the Sheriff's Office, Prosecutor's Office, countywide Fire Dispatch, participating law enforcement agencies, Emergency Medical Services (EMS), paging and other public safety functions.
- B. Reliable, countywide radio frequency (RF) paging and dispatch communications are central to the PSAP mission of quickly getting first responders to incident scenes throughout the county. The County has identified a need for a centralized county-wide Very High Frequency (VHF) paging and dispatch system to replace the current multiple systems operated by the County and individual municipalities. The current systems are physically fragmented, operate on multiple incompatible frequencies and have significant coverage gaps. Also, the majority of the systems rely on obsolescent Low Band paging technology which is being phased out by manufacturers.
- C. The County commissioned a feasibility study to determine if a single VHF system could be developed to provide reliable coverage throughout the county by maximizing the use of existing resources and facilities. The concept envisions a master control and dispatch facility at the existing Emergency Operations Center/Public Safety Answering Point (EOC/PSAP) and multiple remote receiver-transmitters that would be activated simultaneously ("simulcast") from the PSAP. Simulcasting is necessary because the irregular terrain in the county means that a user in the field cannot always communicate with the nearest site, which may be blocked by terrain. The best signal may come from any site, depending on the user's location.

## II. Proposed System

- A. The study identified a total of five existing telecommunications facilities capable of supporting the proposed system. By using communications links from the EOC/PSAP, and receiver-transmitters at the remote sites, the system can provide reliable countywide VHF paging and two-way radio communications outdoors and within buildings of medium construction.
- B. The study also determined that an additional "collocated remote" site should be established at the EOC/PSAP central control facility (identified as Collocated Remote Site #1). This site does not significantly increase the VHF coverage provided by the other sites, but it is included in the system to provide redundancy in the event of the failure of a remote site. Remote sites are under the control of third parties and will be connected to the control center by radio links, whereas the EOC/PSAP Collocated Remote site is completely within a secure parameter and is staffed and maintained by County personnel. It is also "hard wired" to the control center, eliminating the potential for a radio link failure. The existing tower at the EOC/PSAP may need to be extended from its current 180-foot height to 195 feet using an additional 15-foot section (which is already on hand) to accommodate the radio link antennas serving the remote sites.

- C. All of the remote sites identified can support the requirements of the system without the need for major new investment in buildings, site improvements, utilities and/or additional tower structures although some minor site improvements will be needed. Besides the EOC/PSAP facility, which is owned by the County, three of the remaining facilities are owned or controlled by the New Jersey State Police (NJSP) and two are operated by American Tower, Inc. Preliminary surveys and contacts have determined the NJSP sites are available at no recurring cost to the County. All of the NJSP sites have sufficient tower capacity, utility power and emergency power to support the County's needs although one site has insufficient equipment space and will require the installation of an equipment shelter or small outdoor cabinet. The two American Tower sites have sufficient equipment space, power, emergency power and antenna capacity and will require a monthly rent payment of \$625.00 each.

### III. Project Phases

- A. It is anticipated that the project will be developed in two phases. The county has identified 11 priority municipalities to receive service in Phase One. These municipalities are:
  - 1. Montague Twp.
  - 2. Sandyston Twp.
  - 3. Frankford Twp.
  - 4. Branchville Borough
  - 5. Stillwater Twp.
  - 6. Hampton Twp.
  - 7. Fredon Twp.
  - 8. Lafayette Twp.
  - 9. Green Twp.
  - 10. Walpack Twp.
  - 11. Newton Twp.
- B. The Phase One remote coverage and master control sites are:
  - 1. Collocated Remote Site #1 and Master Control Center at the existing EOC/PSAP facility;
  - 2. Remote Site #2 at the existing NJSP 1606 tower;
  - 3. Remote Site #3 at the existing NJSP Highpoint tower;
  - 4. Remote Site #4 at the existing American Tower Weldon Road facility,
  - 5. Microwave/UHF link relay site at the existing Triple Crown water tank.
- C. Phase Two will require two additional remote coverage sites and additional head-end equipment at the master control site. Phase Two will serve the remainder of the county not covered under Phase One. The additional Phase Two sites are:
  - 1. Remote site #5 at the existing American Tower Vernon-Hamburg tower
  - 2. Remote Site #6 at the existing NJSP Netcong tower.

### IV. System Topology and Coverage Predictions

- A. The coverage sites will be linked to the control center by a combination of existing line-of sight (LOS) microwave, near-line-of-sight (NLOS) microwave and/or UHF radio control links, depending on the final design. Path studies indicate that these links can be implemented as shown on the topographic connectivity map which can be found in Appendix A.
- B. The Phase One and Phase Two network topologies are shown schematically in Appendix B.
- C. The accuracy of propagation modeling is greatly influenced by the assumptions made in the analysis. For purposes of this report, we chose conservative assumptions so that the results represent typical, rather than best-case conditions. For example, we assumed that all portable radios and pagers were worn at hip level and had a 50% depleted battery. We also made allowances for body losses and inefficient portable antennas. For mobile units, we assumed that vehicle antennas were four feet above ground level. In all cases, we required sufficient signal strength to provide good audio quality even though intelligible audio might be possible at lower signal strengths. Finally, we used conservative receiver sensitivity and power output based on the type of unit and typical equipment specifications. Based on discussions with County officials, we used a basic criterion of -74dBm for the indoor (medium construction building) required minimum signal strength for coverage. Coverage in outdoor locations and/or using different equipment will be greater.
- D. The resulting propagation modeling indicates that Phase One will provide coverage to hip-mounted pagers located inside buildings of moderate construction over about 90% to 95% of the area of the Phase One municipalities. The combined Phase One and Two sites will provide approximately 90% to 93% pager coverage county-wide. In both cases, coverage to outdoor two-way portable and mobile radios should be 95% or higher. Propagation maps showing indoor and outdoor (worst-case) pager coverage for Phase One and Phase One and Phase Two combined are provided in Appendix C.
- E. A summary of the remote coverage site locations, management, equipment requirements, antenna mounting heights and assumptions used in the analysis can be found in Appendix D.

## V. Project Budget

- A. A capital budget was developed for the implementation of Phases One and Two. The rough probable cost estimates provided below are based on the following assumptions:
  - 1. The facilities and antenna mounting locations currently available will remain available when the system is constructed.
  - 2. Portable and mobile radio equipment and pagers needed to access the system will be furnished by the using agencies and their cost is not included in this estimate.
  - 3. The operating frequencies needed by the system will be provided by repurposing existing County frequencies.
  - 4. The equipment for Collocated Remote Site #1 will be repurposed from existing resources.
  - 5. Actual equipment and technology in the completed system may vary depending on final system design and specific equipment manufacturer(s), but will be fall within the estimated costs outlined below.

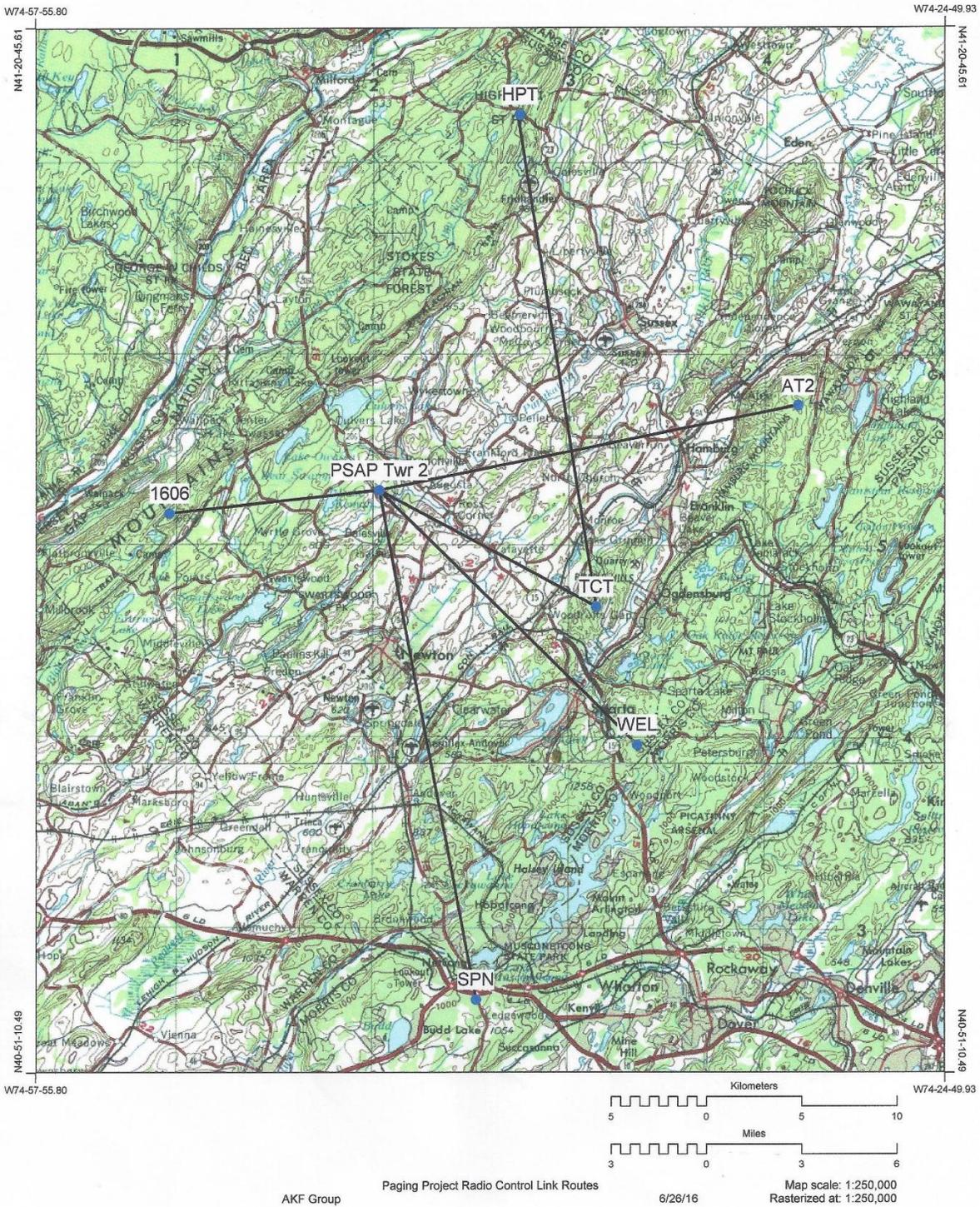
6. The system will be equipped to provide analog simulcast VHF paging and two-way, half-duplex voice communications on a single channel.
  7. Monthly recurring costs such as rent, utilities and maintenance will be funded separately and are not included in this cost estimate.
- B. The budgetary cost for Phase One was determined to be \$1,152,415, including all equipment and installation, minor construction, design, engineering, licensing, permits, training, testing, systems integration and a 10% contingency. For Phase Two it is \$475,640. For site-by-site details see Appendix E.

#### IV. Recommendations

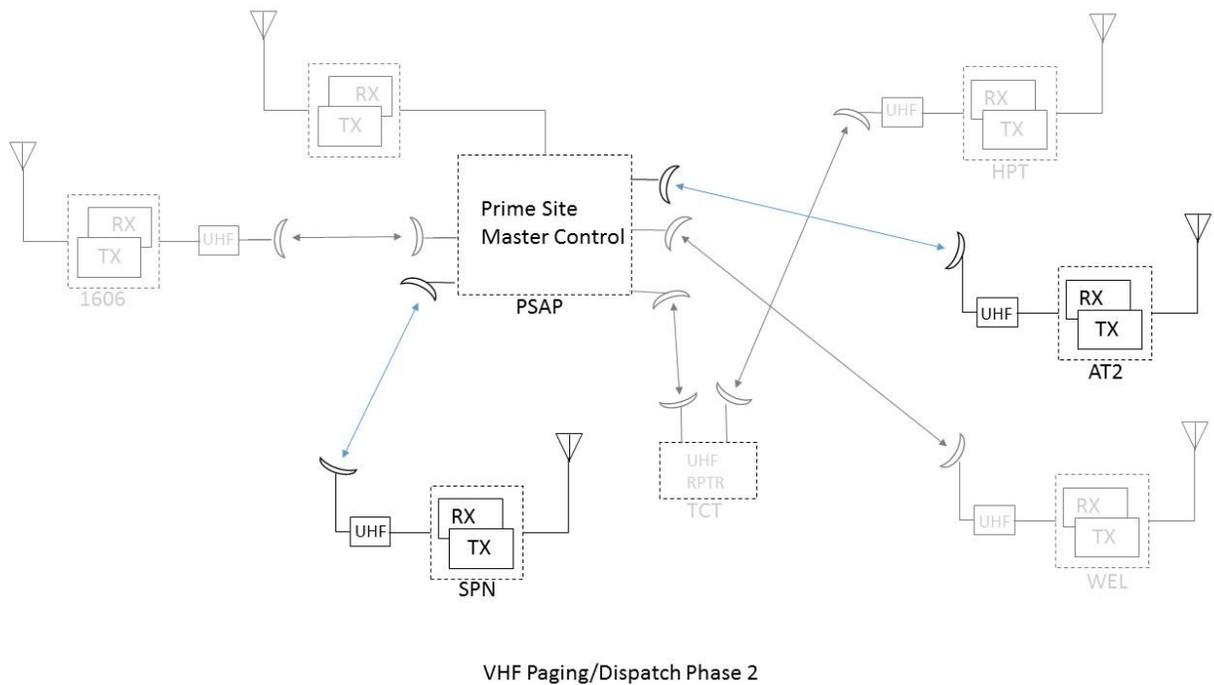
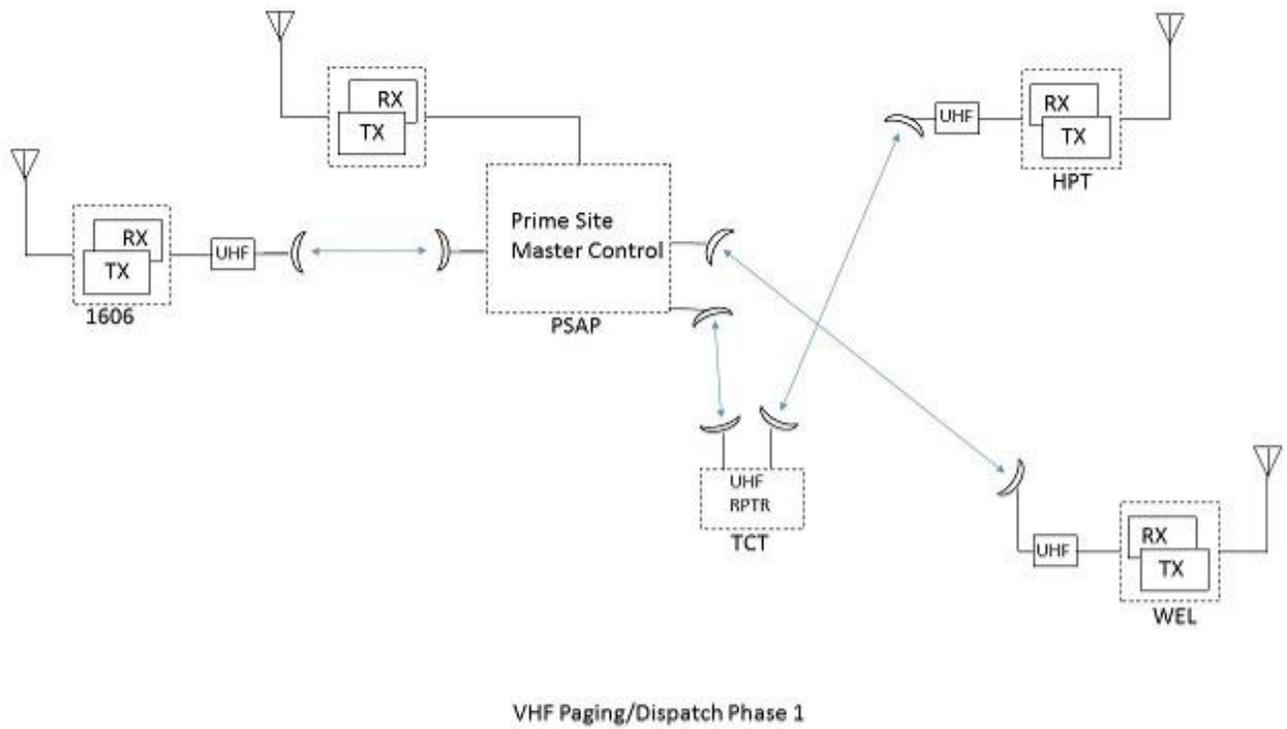
- A. The County should review this report and advise of any significant exceptions noted.
- B. The County should complete the identification of existing assets (including facilities, equipment and radio frequencies) to be repurposed for use in the new system.
- C. The County should initiate the budgeting process for the final design and implementation of Phase One and subsequent implementation of Phase Two.

Appendices:   A - Topographic Connectivity Map  
                  B - Network Topology Schematics  
                  C - Propagation Coverage Maps  
                  D - Site Information Summary  
                  E - Site-by-Site Budget Breakdown

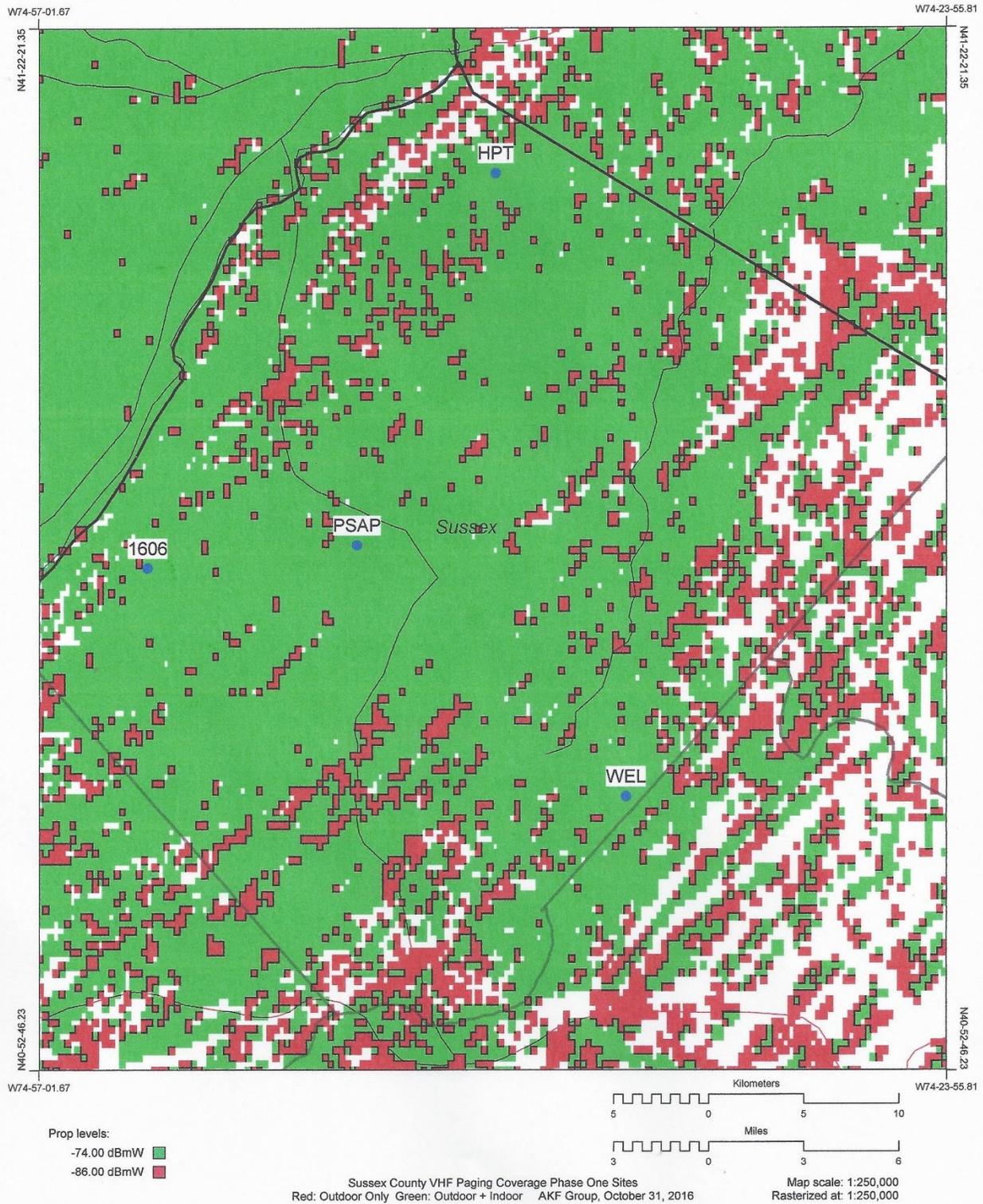
**Appendix A – Topographic Connectivity Map**

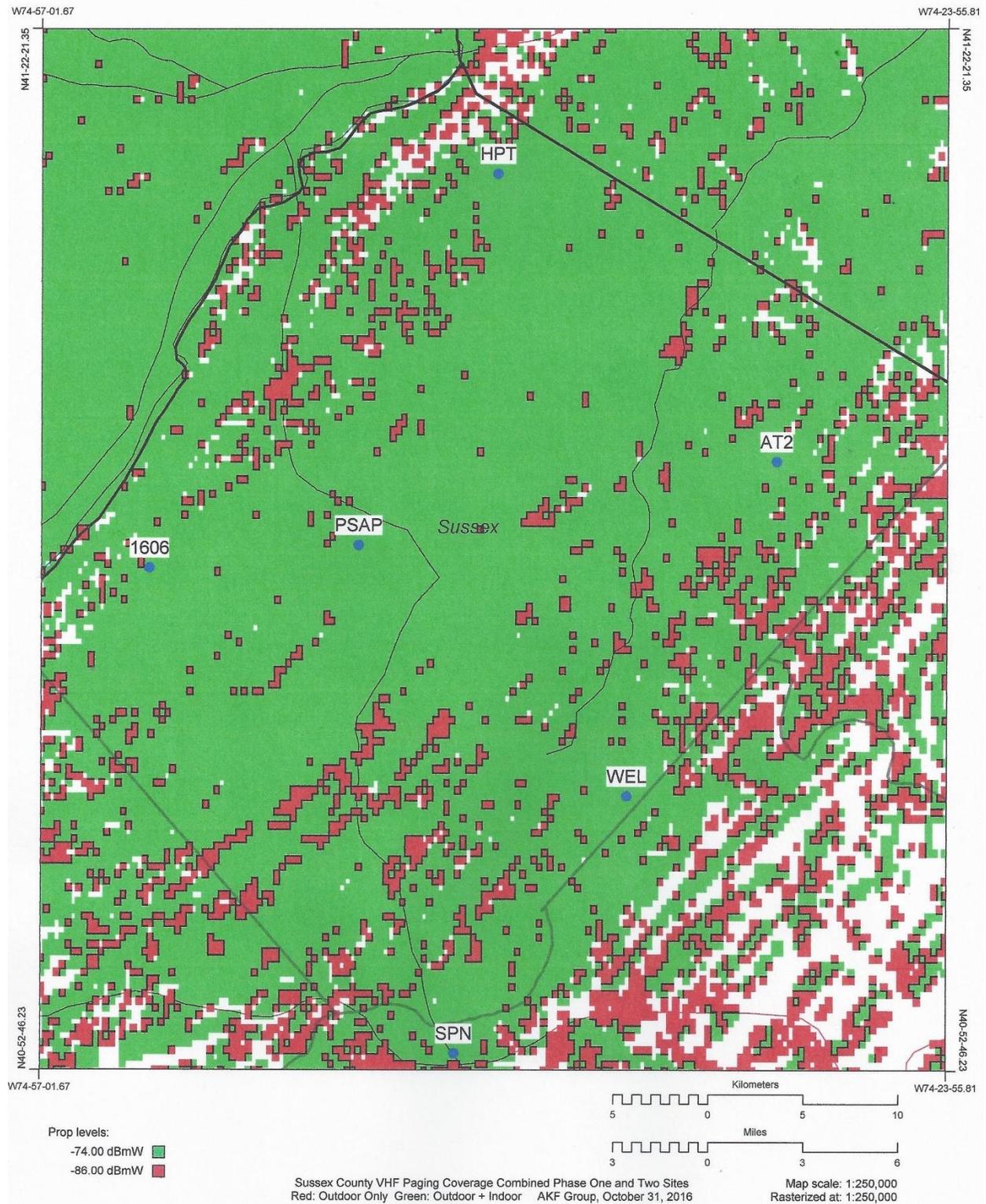


**Appendix B – Network Topology Schematics**



**Appendix C – Propagation Coverage Maps**





Appendix D – Site Information Summary

Sites and Tower Structures Used for Sussex County VHF Paging Study (Revised 10/31/16)

Site ID	Map ID	Latitude	Longitude	Elevation (AMSL)	Tower Type	Shelter	HVAC	GEN	Management Contact	Antenna & Azimuth (AGL)	Control Link Azimuth <sup>2</sup>	Equip Space <sup>3</sup>	Equip Type <sup>4</sup>
Phase 1 Sites & Equipment													
PSAP/Colocated Remote 1	PSAP	41°07'41.6"	74°45'26.7"	564'	180' self supported lattice*	Building/Hut	Y	Y	Sussex County	VHF Omni	(3) UHF Yagis/ various	(3) 19" Rack3	A
1606-NJSP/Remote 2	1606	41°07'03.42"	74°53'03.65"	1,606'	120' Self supported lattice	Building	Ac/heat	Y	State Police/Dan Elliot 609-409-6966	VHF Omni	various	1/2 19" Rack	B
High Pl-NJSP/Remote 3	HPT	41°18'14.4"	74°40'22.8"	1,571.6'	206.7' Self supported lattice	No Space	Y	Y	State Police/A1T/Dan Elliot 609-409-6966	VHF Omni	Yagi/85°	1/2 19" Rack	B
Weidon Road-MCI/Remote 4	WEL	41°00'35.57"	74°35'37.39"	1,332'	275' Self supported lattice	TBD	Y	Y	American Tower/Ryan Peterson 620-704-0117	VHF Omni	UHF Yagi/173°	1/2 19" Rack	B
Triple Crown Tank/Link Repeater	TCT	41°04'24.34"	74°37'31.25"	1048'	60' Water Tank	NEMA Box	Heat	Y	Town of Sparta/TDB	N/A	(2) UHF Yagis/300' & 350°	NEMA Box	C

Phase 2 Additional Sites & Equipment

PSAP/Colocated Remote 1	PSAP	41°07'41.6"	74°45'26.7"	564'	180' self supported lattice*	Building/Hut	Y	Y	Sussex County	VHF Omni	(2) UHF Yagis/ various	Existing Racks	D
Vernon-Hamburg Mtn./Remote 5	AT2	41°10'05.20"	74°30'09.72"	1412'	204' Self supported lattice	TBD	TBD	Y	American Tower/Ryan Peterson 620-704-0117	VHF Omni	UHF Yagi/260°	1/2 19" Rack	B
Netcong-NJSP/Remote 6	SPN	40°53'15.48"	74°41'53.81"	1060'	189' Self supported lattice	Small Cabinet	Y	Y	State Police/Dan Elliot	VHF Dir/0°	UHF Yagi/348°	1/2 19" Rack	B

NOTES:

- \* Tower can be extended to 195'
- 1. Currently available mounting height based on overall height of structure and placement of existing antennas-Must be verified. Higher or lower heights will affect coverage.
- 2. Assumed for planning purposes. Actual control link may be UHF or NLOS microwave depending on final design of system.
- 3. Assumed worst-case configuration for planning purposes. Will vary depending on final design of system.
- 4. Generic equipment types at each location will vary depending on final design.
  - A. Console interface, audio processors, delay modules, voter receivers, control modules, link transceivers, VHF base stations, power supplies, jack fields, filters.
  - B. Control link transceiver, VHF repeater, alarm and control module, power supplies.
  - C. UHF link repeater, power supply.
  - D. Additional link transceivers, voters, power supplies, control modules

**Appendix E – Site-by-Site Budget Breakdown**

**Rough Probable Cost Estimate**

Phase One		
Site/Line Item	Description	Installed Cost
Master Control Center	New console interface, audio processors, delay modules, comparators, alarm and control modules, link transceivers, cabinets, antennas, power supplies, filters, jack fields, cabling and associated software, 15-foot tower extension	\$591,000
Collocated Remote #1	Modify existing VHF transceiver and antenna	\$5,000
Remote #2 NJSP 1606	New VHF transceiver, link transceiver, antennas, cabling, power supplies, alarm and control module, cabling, cabinet or NEMA box	\$86,000
Remote #3 NJSP Highpoint	New VHF transceiver, transceiver, antennas, cabling, power supplies, alarm and control module, cabling, site improvements, cabinet or NEMA box	\$101,000
Remote #4 Weldon Road	New VHF transceiver, transceiver, antennas, cabling, power supplies, alarm and control module, cabling, cabinet or NEMA box	\$86,000
Repeater Site Triple Crown	New channel bank, link transceiver, antenna, power supply, cabling, NEMA box	\$42,000
Subtotal		\$911,000
Soft costs	Design, engineering, systems integration, licenses, training, test and acceptance	\$136,650
Contingency	10%	\$104,765
Total Phase One		\$1,152,415
Phase Two		
Site/Line Item	Description	Installed Cost
Master Control Center	Upgrade console interface, additional audio processors, delay modules, comparators, alarm and control modules, link transceivers, antennas, power supplies, filters, jack fields, cabling	\$204,000
Remote #5 Vernon-Hamburg Mtn.	New VHF transceiver, link transceiver, antennas, cabling, power supplies, alarm and control module, cabling, cabinet or NEMA box	\$86,000
Remote #6 NJSP Netcong	New VHF transceiver, transceiver, antennas, cabling, power supplies, alarm and control module, cabling, cabinet or NEMA box	\$86,000
Subtotal		\$376,000
Soft costs	Design, engineering, systems integration, licenses, training, test and acceptance	\$56,400
Contingency	10%	\$43,240
Total Phase Two		\$475,640