MINUTES OF THE EIGHTH MEETING

REGIONAL TELECOMMUNICATIONS PLANNING ADVISORY COMMITTEE (Reconstituted)

DATE: June 29, 2005

TIME: 2:00 P.M.

PLACE: Commissioners' Conference Room
Regional Planning Commission Offices
W239 N1812 Rockwood Drive
Waukesha, Wisconsin

Members Present

Kurt W. Bauer Chairman	Executive Director Emeritus, SEWRPC
Kenneth Brown	RF Engineer, Nextel Communications, Inc.
Bob Chernow	Chairman, Regional Telecommunications Commission
Michael Falaschi	President, Wisconsin Internet
Barry Gatz	Network Supervisor, CenturyTel
Michael E. Klasen	Director, Regulatory Affairs, SBC Wisconsin
George E. Melcher	Director, Office of Planning and Development, Kenosha County
Paul E. Mueller	Administrator, Washington County Planning and Parks Department
Steven L. Ritt	Attorney at Law, Michael Best & Friedrich
James W. Romlein	Managing Director, MVLabs, LLC
Gustav W. Wirth, Jr.	SEWRPC Commissioner
Darryl Winston	Director of Data Services, City of Milwaukee Police Department

Members Absent

William R. Drew Vice Chairman	Vice-Chairman, SEWRPC; Executive Director, Milwaukee County Research Park
Roger Caron	President, Racine Area Manufacturers and Commerce
David L. DeAngelis	Village Manager, Village of Elm Grove
Brahim Gaddour	Director of Network Operations, Time Warner Telecom of Wisconsin
J. Michael Long	Attorney-at-Law, Murn and Martin, SC
Jeff Mantes	Commissioner of Public Works, City of Milwaukee
Jody McCann	Network Domain Manager, Wisconsin Department of Administration, BadgerNet
Bennett Schliesman	Director, Kenosha County Emergency Management /Homeland Security
Dale R. Shaver	Director, Waukesha County Department of Parks and Land Use
Paul R. Schumacher	Program Manager, Tricounty Business Partnerships
Michael Ulicki	Vice President and Chief Technology Officer, Norlight Telecommunications

Staff
Kenneth J. Schlager, PhD Chief Telecommunications Engineer, SEWRPC
Lynn G. Heis Staff Secretary, SEWRPC

CALL TO ORDER AND ROLL CALL

Chairman Bauer called the meeting to order at 2:00P.M. Roll call was taken by circulating an attendance signature sheet, and a quorum was declared present.

CONSIDERATION OF THE MINUTES OF THE MEETING OF MAY 10, 2005

Chairman Bauer noted that copies of the minutes of the seventh meeting of the Reconstituted Regional Telecommunications Planning Advisory Committee held on May 10, 2005, had been distributed to all members of the Committee for review prior to the meeting; and asked that the Committee consider approval of those minutes.

There being no questions, comments, or corrections, on a motion by Mr. Wirth, seconded by Mr. Melcher, and carried unanimously, the minutes of the meeting of May 10, 2005, were approved as published.

FURTHER CONSIDERATION OF PRELIMINARY DRAFT OF SEWRPC REGIONAL TELECOMMUNICATIONS PLANNING PROGRAM, TECHNICAL STUDY DESIGN MEMORANDUM NO. 7, WIRELESS PERFORMANCE MONITORING INVENTORY.

Chairman Bauer noted that a copy of the revised preliminary draft of SEWRPC Regional Telecommunications Planning Program, Technical Study Design Memorandum No. 7, Wireless Performance Monitoring Inventory had been distributed to all members of the Committee for review prior to the meeting.

Chairman Bauer recalled that the Committee had received a preliminary draft of this planning report at its meeting held on May 10, 2005; but had postponed action on the report until a revised draft incorporating changes which the Committee had directed to be made could be reviewed. He then asked Dr. Schlager to undertake a page by page review of the revised draft with the Committee, emphasizing the deletions, additions, and other changes which the Committee had directed to be made in the initial draft.

In presenting the new text concerning the potential limitations of the proposed performance monitoring procedure, Dr. Schlager called attention to Figure 1 of Appendix IV "Wireless Network Monitoring System – Circuit-Switched Version" diagramming the proposed monitoring system.

Mr. Klasen indicated that, in his opinion, the proposed monitoring system, as diagrammed, would not provide accurate data on the performance of the telecommunications networks of the six providers concerned since the proposed procedure involved use of the Internet and the individual providers had no control over the routing of wireless calls through the Internet unlike the initial routing of such calls through the wireline network. He suggested that the procedure could be substantially improved by obtaining multiple cellular telephones for use in monitoring performance prior to any use of the Internet for call transmission. Mr. Chernow agreed with Mr. Klasen, and a lengthy discussion ensued concerning the proposed procedure and its dependence upon software limitations. In the discussion Mr. Klasen

reiterated that the proposed procedure constituted a convoluted approach requiring questionable adjustments to the measured data, as opposed to direct measurement of the performance of each particular provider's network from origination to termination of calls made on that network including the provider selected wireline portion of the routing. He noted further, that that portion of monitored calls which utilized voice over the Internet transmission was uncontrolled by the service provider and could only, in his opinion, be properly adjusted for by simultaneous measurements. He indicated further that the proposed procedure would be more properly identified as customer experience with measurement of wireless originated calls than as measurement of the quality of the actual wireless network services. In this respect Mr. Klasen suggested, and the Committee agreed, to change the major heading on the page 2 from "Wireless Network Monitoring System" to "Wireless Customer Experience Monitoring System". In the discussion Mr. Brown also agreed with Mr. Klasen that the monitoring system should be limited to that part of the routing under control of the service provider, and this would require the monitoring to take place before any transfer to the Internet. Mr. Romlein agreed with Messrs. Brown and Klasen's comments.

In the discussion Dr. Schlager agreed that Mr. Klasen's suggestion to change the proposed monitoring procedure was to be desired, but that limitations of the software proposed to be used in the procedure might preclude the desired simplification. Mr. Klasen stressed that the Commission needed to address this issue at this time since proceeding with implementation of the monitoring system as proposed might very well leave the Commission at the end of -- for example -- two years of monitoring with data, at best, of questionable quality.

At the conclusion of the lengthy discussion, Chairman Bauer suggested that the proposed procedure for the monitoring of circuit-switched network service be referred back to the staff for reconsideration. In the reconsideration, the staff would investigate the possibility of moving the measurement reference and receiving equipment locations from -- as diagrammed -- after transmission of the wireless calls through the Internet to monitoring of the wireless calls immediately after initial transmission through the wireline network. The findings of the staff investigation and response would be incorporated in new and revised text and -- if found feasible -- into a revised diagram for further consideration by the Committee. The proposed reconsideration would include, if necessary, the possible need for different software for use in the procedure. The Committee concurred in this suggestion.

Mr. Chernow called attention to the text on page 14 which called for the written permission of each wireless service provider prior to public release of monitoring data specific to the particular service providers concerned. He suggested that this requirement be eliminated and instead the individual service providers concerned not be identified by name in any Commission published reports, but simply referred to as provider A, B, C, D, E, or F. Mr. Ritt indicated that while he had no objection to eliminating all references in Commission published reports to named service providers -- substituting a code identification; he was of the opinion that written permission from the service providers should be required for the public release of any data by named provider. The use of a code for identification may not insure the confidentiality of the data if a third party can request the link between the code letter and name of the provider under the State open records law.

In this respect, Mr. Ritt noted that the Committee had requested the staff to investigate the ability of the Commission to withhold data collected under the study from publication or other distribution under the State open records law. He reiterated that Mr. Chernow's suggestion would be meaningless if the Commission could not withhold from public dissemination the actual identity of service providers noted by the assigned letter or number in the public reports. Chairman Bauer indicated that a staff report on this issue would be made an agenda item for the next Committee meeting, and suggested that any further consideration of the identification of monitoring data by service providers in published Commission reports be deferred to the next meeting.

[Secretary's Note: In response to the Committee direction, the staff reconsidered the performance monitoring procedure proposed for the circuit-switched circuits and found that the Committee's suggested changes were feasible. Accordingly, the following paragraph replaces the first paragraph on page 13 of the memorandum.

"The Commission Advisory Committee expressed concern about the structure of the circuit-switched network monitoring procedure as proposed in both the first and second draft of this memorandum. The concern related to the use in the proposed procedure with respect to the circuit-switched traffic of multiple networks involving the Internet or other wireless-wireline networks that may obscure the monitoring results. This concern has been addressed by removing the Internet and all other non-wireless service provider circuit elements from the circuit-switched traffic monitoring circuit as explained in a revised draft of Appendix IV, dated July 12, 2005. The circuit-switched monitoring procedure is now proposed to consist of a wireless-to-wireless configuration as suggested by the Advisory Committee. The circuit as now proposed contains only infrastructure elements selected by each wireless service provider."

The Staff also has revised Appendix IV concerning the circuit-switched monitoring to read as follows: The revised Appendix includes as Figure 1, a revised diagram.]

"This Appendix will explain the voice traffic flow in the circuit-switched version of the system proposed to be used to measure the availability and voice quality of the wireless cellular-PCS networks in the planning area as shown in Figure 1. Voice messages are originated at the transmitting end point using a laptop computer, cellular-PCS telephones and associated software as described in Appendix I. The voice message is transmsitted to the base transceiver station (antenna site) of the particular wireless service provider. The voice message then moves through the transmission network of the provider to the mobile switching center (MSC) of the provider where it interconnects with a wireline service provider that is an integral part of the wireless service provider's network system. The wireline service provider then directs the call to the call destination through the wireless service provider's transmission subsystem to the appropriate antenna site which then transmits it to the remote cell phone transceiver. The management server located at the Commission offices initially sets up the call and then later receives the values of the performance parameters after each message transaction.

The mean opinion score (MOS) for voice quality will be calculated from monitoring measurements using the E-model method defined in International Telecommunications Standard ITO G.107.

Dr. Schlager then called attention to Figure 1 of Appendix V, "Wireless Network Monitoring System – Packet-Switched Version", which diagrammed the proposed monitoring system concerned. The

consensus of the Committee was that this aspect of the proposed monitoring system was sound and could be implemented.

After some brief further discussion, Mr. Chernow moved, and Mr. Wirth seconded, approval of the revised portions of the Technical Study Design Memorandum No. 7, Wireless Performance Monitoring Inventory, dated May 19, 2005, as indicated by the italicized text, contingent upon any further revisions, additions or deletions as may be required by the staff's findings relative to the Committee suggested changes of the circuit-switched monitoring system procedure. Final approval of the memorandum would, however, be deferred to the next meeting of the Committee.

Chairman Bauer reported that Committee member Jeffery J. Mantes, Commissioner of Public Works, City of Milwaukee, did on June 28, 2005 provide to the Commission an e-mail message indicating that, while he could not attend the meeting, he had reviewed the materials provided with the agenda and was of the opinion that the corrections and modifications to the Technical Study Design Memorandum No. 7, as directed by the Committee at its last meeting, had all been made by the staff and he would support approval of those changes as indicated by the italicized text in the revised memorandum. He indicated further that unless either any of the individual service providers, or the counties and local governments represented on the Committee had specific suggestions for changes to the partial draft of Chapter V of planning report No. 51, the tables and maps should be approved and used as a model for the presentation of the inventory data concerned for the other six counties of the region.

The motion was carried unanimously.

CONSIDERATION OF PRELIMINARY DRAFT OF CHAPTER V "WIRELESS TELECOMMUNICATIONS INVENTORY FINDINGS' OF SEWRPC PLANNING REPORT NO. 51, A WIRELESS ANTENNA SITING AND RELATED INFRASTRUCTURE PLAN FOR SOUTHEASTERN WISCONSIN.

Chairman Bauer noted that a copy of the preliminary partial draft of Chapter V Wireless Telecommunications Inventory Findings, Of SEWRPC Planning Report No. 51, A Wireless Antenna Siting And Related Infrastructure Plan For Southeastern Wisconsin had been distributed to all members of the Committee for review prior to the meeting. He stressed that this partial draft was intended to present, in a preliminary form, the inventory findings for one of the seven counties of the planning region -- Kenosha County for Committee review and comment. He noted that the data presented in Table 1 and on Maps 1-7 deliberately had not been reviewed with the technical staffs of the individual service providers pending Committee review of the materials and advice as to how to proceed with such reviews.

Chairman Bauer then asked Dr. Schlager to undertake a page by page review of the preliminary partial draft of Chapter V.

In answer to a question by Mr. Wirth, Dr. Schlager indicated that the Federal Aviation Administration (FAA) database was not listed as a source of data on page 2 of the Chapter because that database focused primarily on antenna structure locations and heights, and the data concerned are more accurately available from the other sources listed.

Mr. Ritt called attention to the list of data collected as set forth on page 4. He noted that the Commission letters to the county and local units of government within the Region requesting the inventory data included a request for -- in addition to the nine items listed on page 4 -- data on conditional use permits issued by the county and local units of government concerned and about lease arrangements. He asked for an explanation of the requests concerning the two items of information not listed on page 4. He indicated he was particularly concerned about the request for information about lease arrangements. In

response Chairman Bauer indicated that in requesting these two items of information, the Commission was looking ahead to the possible preparation of a Commission local planning guide on the siting of wireless antenna structures and related facilities within the Region. He noted that information concerning the conditions placed by county and local municipalities on antenna structure locations and designs was of material interest to other counties and municipalities, as were data concerning permit fees and lease arrangements and payments. This information, he noted, was in the public sector and should be provided to all counties and local units of government within the Region for use in permitting and in structuring municipal, county and local lease programs.

Mr. Wirth indicated that as a former Chairman of the Ozaukee County Board, he could attest to the interest of the counties and local municipalities within the Region in the information concerned. He noted that counties and municipalities found the exchange of this kind of information to be most helpful in structuring public programs in the public interest. Mr. Chernow agreed with Mr. Wirth, indicating that the Regional Telecommunications Commission, which he represented on the Committee, was indeed interested in obtaining these kinds of data. Chairman Bauer reiterated that as a comprehensive public planning agency, the Commission should have these kinds of data in its files, data which are always of interest to local planners, engineers, and elected and appointed officials.

A brief discussion ensued, at the conclusion of which Mr. Ritt requested, and the Committee agreed, that the two items of information concerned be added to the list on page 4, and that a paragraph be added to the text explaining the reasons for the Commission's desire to collect these types of information.

Mr. Ritt suggested, and the Committee agreed, that the term "base station" in the introductory phase of the list of inventory items set forth on page 4 be changed to "site". Mr. Ritt further suggested, and the Committee agreed, that the staff provide a glossary of terms, including -- among others -- the definitions of the terms base station, antenna site, antenna structure and antenna as used in the report. Chairman Bauer noted that the Commission staff was in the process of compiling such a glossary, and that that process would necessarily have to continue to the completion of the planning document concerned. He indicated, however, that the Committee would be provided a draft of that portion of the glossary compiled to date for consideration at the next meeting.

Mr. Brown observed that the antenna power outputs listed in Table 1, if taken from the Federal Communications Commission (FCC) database, represented maximum "permitted" power outputs, and did not reflect actual power outputs of the installed facilities. Dr. Schlager agreed, and indicated that the Committee would very much like to have the service providers provide the actual power used. This was, he said, one of the important reasons for desiring a technical review of the inventory findings by the technical staffs of the service providers. A lengthy discussion then ensued at the conclusion of which it was agreed that a footnote should be added to Table 1 explaining the source and meaning of the listed data on antenna power.

[Secretary's Note: The following footnote is proposed to be added as footnote c to Tables 1 through 6 of Chapter V of SEWRPC Planning Report No. 51:

"The antenna power listed as collated from FCC data represent the maximum power output authorized for the particular installation concerned."]

Mr. Klasen observed that in the antenna height inventory data listing on page 4, the height was given in meters; however, the actual data in Table 1 were given in feet. A brief discussion ensued concerning the use of the metric versus English systems of measurement; Mr. Melcher observed that the county and local

units of government desired to have the data concerned presented in feet and not meters. At the conclusion of the discussion it was agreed that the data would be presented as requested by Mr. Melcher.

With respect to the first numbered item on page 5, Mr. Chernow suggested that the term “site” be substituted for the term “base station”. Dr. Schlager disagreed, indicating that the term base station was broader than either the term antenna or antenna structure; the term base station being intended to include the antenna, the antenna support structure, and the attendant electronic and electric power support equipment necessary for an operating facility. A brief discussion ensued in which it was agreed that the use of the term “base station” was proper in the context concerned.

Mr. Ritt called attention to the second sentence of the first full paragraph on page 5 concerning the use of the Commission radio propagation model to identify a minimal antenna site configuration for regional service coverage. He noted that such use might be appropriate for identification of an antenna site configuration that would serve public enterprise applications -- such as police and fire service networks. However, Mr. Ritt noted that he had consistently expressed his concern about the Commission preparing what might in effect be development plans for networks owned and operated by private service providers. He indicated that his concern was that presentation of inventory data that may -- in many instances and respects -- differ from the data held by the private service providers will be detrimental to obtaining public approval of needed facility expansions and improvements.

Mr. Ritt asked, and the Committee agreed, that the staff provide to the Committee for consideration at its next meeting, a staff memorandum describing the content of the proposed Commission telecommunication plans. Chairman Bauer indicated that the memorandum concerned would be prepared, and consideration of the memorandum would be made an agenda item for the next Committee meeting.

Dr. Schlager then focused attention on Table 1, and asked whether the format and content were acceptable. Mr. Ritt responded that he had no problems with the format, but that the table contained inaccurate data. Mr. Ritt, however, declined to provide any specific examples of the inaccuracies referred to. Dr. Schlager noted that it was intended that the tables, if approved by the Committee with respect to format, would be checked by the technical staffs of the individual service providers for accuracy.

In answer to a question by Dr. Schlager, Mr. Brown expressed the opinion that the selection of the value of a minus 80 decibels per miliwatt provided a sound measure of good quality service.

In answer to a question by Mr. Brown, Dr. Schlager indicated that the canopy data used in the propagation modeling had a 30 meter resolution, and was derived from National Aeronautics and Space Administration (NASA) mapping.

Mr. Brown indicated that he would very much like to correct a number of inaccuracies reflected in Table 1, and in Map 2, concerning the service provided by his firm, but that his management had specifically instructed him not to cooperate in that manner. He noted further, that he had been able to check the coordinate positions of the antennas operated by his firm and found those coordinate positions to be correct. However, he said he had serious problems with Map 2 – the Nextel coverage map. In answer to a further question by Dr. Schlager, Mr. Brown indicated that the inaccuracies in the mapped coverage derived from -- in part -- inaccuracies in the assumed antenna power operating levels and not from the geographic location of the antennas.

Mr. Melcher observed that, based on personal experience, he believed that the coverage maps did accurately reflect the service coverage provided by at least some of the firms concerned.

In answer to a question by Mr. Falaschi, Dr. Schlager indicated that there could indeed be coverage dead zones in Lake Michigan, those dead zones being attributable to propagation interference by structures between the transmitting antenna and the lake such as power plant structures, cooling towers, electric power transmission line towers, and high trees located along the high bluffs above the surface of Lake Michigan. Dr. Schlager added further that signal propagation may vary over time with wind and other weather conditions, and that the coverage maps were based on the assumption of generally ideal conditions.

Mr. Brown observed that the maps represented theoretical coverage and probably could not be verified by physical field measurements. He indicated that in his firm's analyses correction factors, based on field measurements, are developed and applied to adjust the simulation models and model application results.

Chairman Bauer observed that failure of individual service providers to cooperate with the Commission in the review of the inventory data as provided in Table 1, and as reflected on Maps 1-7, would constitute a serious impediment to the planning effort. He indicated that in his opinion, the inventory data with respect to antenna site location and antenna height are probably the most accurate available to date. To be considered reliable, however, it would appear that the data concerning antenna type, power, and frequency needed verification by the service providers. If corporate policies precluded such cooperative effort, the staff, Committee, and Commission will have to consider how to proceed.

Mr. Ritt suggested, and Mr. Brown concurred, that the cooperation of the private firms concerned should be solicited by presenting formal requests to the corporate headquarters. Chairman Bauer expressed the opinion that -- based on his experience with the Milwaukee County Automated Mapping and Land Information System Program -- such an approach would entail an inordinate and unacceptable time to obtain even a negative response, but certainly to receive a positive response. Mr. Chernow agreed, indicating that it should be possible to have the inventory data reviewed for technical accuracy by discussions with the technical staffs of the individual providers; the discussions being held in an independent manner. Mr. Brown agreed that the time involved would be a serious constraint, and that the letters of request to the corporate headquarters would have to describe the Commission, its legal responsibilities, and the planning program, as well as to set forth the requested assistance in extremely specific terms. Such a letter, he said, would probably illicit return correspondence posing a large number of questions to which the response initially provided by the Commission would probably be found insufficient. He indicated that as an engineer he would very much like to see the preparation of a coverage map on which his firm and the Commission could agree, but corporate policy made the attainment of this goal difficult or impossible at this time.

In answer to a question by Mr. Melcher, Mr. Brown indicated that the management of his firm at least was not as concerned about the provision of technical information to the Commission on a totally confidential basis than about the feasibility of the data being publicly distributed.

Mr. Ritt indicated that the discussion again raised a significant area of tension, with the industry being concerned that the Commission was over-stepping its proper boundaries by attempting to regulate the industry and usurp the design of the providers networks. He indicated he did not believe that the Commission had the capability of inserting itself into the current situation and should not attempt to do so. The distribution of particularly the coverage maps, may infringe upon the ability of a private provider to design and develop a system to serve its customers. As an example, he noted that if a coverage map inaccurately indicates adequate service coverage by a provider, that provider may be denied a permit from a county or local unit of government to locate an antenna required to improve coverage and service.

Mr. Melcher indicated that the tension referenced by Mr. Ritt between permitting counties and municipalities and service providers exists in any case, and in the case of a corporation submitting a siting

proposal, the counties and local municipalities will -- in the absence of an agreed upon plan -- continue to address the problem on an ad hoc basis by retaining independent consultants to review the siting proposals and provide advice as to whether or not approval should be granted.

Mr. Romlein indicated that the concerns being expressed by Mr. Ritt could be addressed in the text of the planning report in which it could be clearly stated that it is not the intent of the plan to specify how individual provider networks be designed, but to provide a point of departure for use in such design.

Mr. Brown suggested as an option, requesting each individual service provider to provide a coverage map based upon corporate studies modeling for acceptance by the Commission without reference to the information on which the modeling was based. He indicated that his firm would probably make its own service coverage maps available, but would not provide the data on which the maps were based. Chairman Bauer indicated that it was unlikely that the Commission could accept such a procedure. The Commission, he said, had a responsibility to assure its constituent counties and municipalities that the data which it provides are accurate; and such assurance would not be possible under a procedure such as that suggested by Mr. Brown.

At this point in the lengthy discussion, Chairman Bauer observed that it was well after 5:00PM and no consensus as to how to proceed appeared to be emerging from the discussion. He suggested that the partial draft of Chapter V further be considered at the next meeting of the Committee, along with alternative means of proceeding with the regional telecommunications planning effort in the absence of a willingness on the part of the private service providers to review and verify the inventory data, including particularly, the coverage maps. Other agenda items would include further review of Technical Study Design Memorandum No. 7; a memorandum setting forth the content of the proposed Commission telecommunication planning element; and -- if ready -- a glossary, the latter to be considered as a work in progress. The consensus was to proceed in accordance with the Commission's suggestion.

CORRESPONDENCE

Chairman Bauer reported that there was no correspondence to be brought to the attention of the Committee.

DATE AND TIME OF NEXT MEETING

Chairman Bauer then asked the Committee to consider the date and time for the next Committee meeting. After a brief discussion it was agreed that the next meeting of the Committee would be held on Wednesday, July 27, 2005, at the Commission offices, beginning at 2:00PM.

ADJOURNMENT

There being no further business to come before the Committee, on a motion by Mr. Ritt, seconded by Mr. Brown, and carried unanimously, the meeting was adjourned at 5:25P.M.

Respectfully Submitted,

Lynn G. Heis
Staff Secretary

KWB/lgh
7/15/05
#109120 V1 - T/C Minutes - 8th Meeting

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

REGIONAL TELECOMMUNICATIONS PLANNING PROGRAM

TECHNICAL STUDY DESIGN MEMORANDUM No. 7
WIRELESS PERFORMANCE MONITORING INVENTORY

April 12, 2005

INTRODUCTION

The Regional Telecommunications Planning Program as set forth in the Commission approved Prospectus[1] for that program includes the conduct of a quality of service inventory. That inventory is envisioned to be conducted through end user performance monitoring utilizing computer and telecommunications hardware and software adopted for this purpose. This memorandum describes the proposed network monitoring system, defines the proposed monitoring parameters, and presents the necessary experimental design that provides the basis for the system. A wireless component of the system will be used to monitor the performance of the cellular/PCS wireless service within the seven county planning region. Wireline components will be used to monitor the performance of the regional wireline telecommunications system. This memorandum describes the proposed wireless system performance monitoring system.

The purpose of the proposed performance monitoring inventory is to provide information on the existing level of wireless service within the planning area. That existing level of service can then be compared to the level of service required to maintain the economic viability of this Region in competition with other regions of the world. The proposed Commission wireless antenna siting and relating infrastructure plan will then describe any needed facilities and service improvements, and identify actions required to be taken by private service providers and by the county and local municipal governments concerned to facilitate the attainment of the desired level of service.

The NetIQ AppManager network monitoring system is proposed to be used as the software vehicle to collect this performance data for packet-switched networks. The NetIQ Vivinet

[1] SEWRPC: "Prospectus for a Regional Telecommunications Planning Region" Southeastern Wisconsin Regional Planning Commission, December, 2003.

Assessor will function as the evaluation software for circuit-switched networks. Although the NetIQ AppManager and Vivinet Assessor were originally developed for wireline network monitoring, they can be adapted to wireless application with the addition of transceiver interface cards, laptop computer agents and suitable supporting software as described in Appendices I and II.

WIRELESS ~~NETWORK~~ *CUSTOMER EXPERIENCE* MONITORING SYSTEM

The equipment components of the network monitoring system include:

1. Network Management System (NMS) Server Computer– located at SEWRPC
2. Supervisory NMS Desktop Computer– located at SEWRPC
3. Six Laptop Computer Agents– located at various rotating temporary locations throughout the Region.
4. Six Transceiver Interface Access Cards
   - one for each wireless cellular/PCS service provider
   - each integrated with one of the six laptop computers
5. Six cell phones and supporting cable interconnect
   - one for each cellular/PCS service provider
   - each integrated with one of the six laptop computers

The above listed equipment will be operated using the NetI QAppManager and the NetIQ Vivinet Assessor software. The AppManager will collect data on the packet-switched network parameters defined below while the Vivinet Assessor measures the readiness of each provider's packet-switched network for Voice over Internet Protocol (VoIP). While none of the Regional wireless providers currently offers VoIP, Vivinet measurements of VoIP readiness do provide a well conceived overall measure of network quality. The Vivinet Assessor will also determine the availability and the voice quality of circuit-switched networks.

Originally, it was intended to monitor only the packet-switched network since that is the type of network for which the monitoring software was designed. Packet-switched networks are also the wave of the future and will eventually replace circuit-switched networks. Current day cellular/PCS networks, however, serve primarily voice communications in the circuit-switched domain. Since a major purpose of the wireless performance inventory is to present the performance of the existing wireless network system, it was decided to include circuit switched

voice communications in the wireless performance inventory. This inclusion can be accomplished at little cost since the same laptop computer agent can be used to monitor both networks. Aside from the cell phone and its associated cabling, the only other addition required will be interface device driver software to interface the laptop computer to a particular cell phone.

NETWORK MONITORING PARAMETERS

The primary objective of the wireless network monitoring effort is to measure the four primary network performance parameters: availability; throughput; response time; and accuracy

Specific monitoring measurements, however, depend on the characteristics of wireless network operations and practices. For example, availability measurements such as blocked calls or dropped calls may have no meaning in a wireless packet-switched network. In a wireless circuit-switched network, there are only a limited number of channels. When all of these channels are in use, subsequent calls will be blocked. In packet-switched wireless networks, available bandwidth is typically rationed so that blocked or dropped calls do not occur. Such a practice, however, is inconsistent with the maintenance of a standard for quality of service (QoS). In any event, such spectral rationing, if it takes place, will be indicated in the throughput and response time measurements of the network monitoring system. Availability, however, is a major concern on circuit-switched voice networks. Blocked and dropped calls are key parameters in the evaluation of voice network quality. Given that service providers practices such as the above spectral rationing may influence the indications of some network measurements, the following network parameters have been specified for monitoring:

AVAILABILITY

During any monitoring session, lack of network availability will be time duration recorded as a lack of service. Lack of service time on packet-switched networks will be recorded as a "zero" on a one-zero availability chart over the monitoring period as shown in Appendix III. Chart data will then be accumulated to determine overall availability expressed as a percentage of user operating time. For circuit-switched networks, blocked and dropped calls will be recorded and time accumulated to determine the network availability percentage.

THROUGHPUT

For packet-switched networks, data throughput is recorded in bits per second. In current cellular/PCS networks, data rates will be in the kilobits per second range. For a given network,

there are two relevant throughput data rates – burst and sustained. Small files will transmit at burst rates while larger files will slow to reduced sustained rates. The Federal Communications Commission (FCC) defines the minimum "little-broadband" data rate as 200 kilobits per second. Current 3G wireless networks are achieving around 300 kilobits per second. Since circuit-switched monitoring will emphasize voice traffic, throughput is not a meaningful parameter.

RESPONSE TIME

Response time data for packet-switched networks are recorded by network application such as Domain Name Service (DNS) IP address lookup, POP3/SMTP (e-mail) protocol, Hyper Text Transfer Protocol (HTTP) – text or graphic and HTTPS -- the secure version, of HTTP. The response time is recorded in seconds over a monitoring time period again as shown in Appendix III. While there is no specific standard for data traffic response time, these times should be consistent with throughput rate standards.

ACCURACY

Accuracy measurements vary with the type of media. For voice communications (VoIP), voice quality is recorded in terms of the R value which in turn depends on three network characteristics: latency time, jitter and lost packets. On-line measurements of these three factors are converted into R values using a standard formula. R values are then converted into MOS values through a linear conversion. R values range from 0 to 100 while MOS values range from 1 to 5. An R value of 80 is equivalent to an MOS value of 4.0.

Data and video communications are monitored in terms of saved and unsaved lost data expressed in percentage. The unsaved percentage will be converted into an uncorrected bit error rate of bits per million bits transmitted. Typical values for saved and unsaved lost data are:

1. Saved
   - maximum packet loss of 10 percent data and 5 percent voice

2. Unsaved
   - uncorrected bit error rate of 15 bits per million bits transmitted (0.0015 percent)

Circuit-switched voice traffic will be evaluated based on this same MOS value as packet-switched VoIP although the impact of the VoIP compression algorithm will be removed.

NETWORK MONITORING CATEGORIES

Wireless network monitoring data will be analyzed and summarized in a number of categories.

1. Regionwide

   -Average (mean) values for all of the regional network performance parameters along with their 95 percent confidence interval limits will be provided.

2. Regional Areas

   Average values for these same parameters will also be summarized for urban, suburban and rural areas of the Region. The Commission land use inventories categorize U.S. Public Land Survey system quarter sections as either urban, suburban or rural based on population density, measured in terms of average lot size per dwelling unit as follows:

   a. Urban
      - less than 1.5 acres
   b. Suburban
      - between 1.5 to 5.0 acres
   c. Rural
      -greater than 5.0 acres

3. Wireless Technology

   Network performance can also be analyzed by type of technology

   a. GSM (2G)
      - Global system for mobile communications
      - the global 2G standard
   b. GPRS (2.5G)
      - General packet radio service
      - a 2.5G addition
   c. Edge (2.5G)
      - Enhanced data for GSM evolution

d. iDEN (2.5G)
e. 3G (Third generation)

All of the above technologies support wireless data transmission. GSM is the slowest. Transmission rates increase in the order listed with 3G technology being the fastest.

4. Service Provider

Mean values for these same parameters will also be estimated for the following Regional service providers:

a. AT&T/Cingular
b. Nextel Communications
c. Sprint
d. Verizon Wireless
e. U.S. Cellular
f. T-Mobile

Service provider data will be reviewed with each provider prior to internal documentation. These data will not be published without the permission of the service provider concerned.

5. County

Cellular/PCS network performance data will also be summarized by each county in the Region.

6. Cellular versus PCS

Cellular Wireless networks operate in the 800-900 MHz spectral region while PCS networks operate at higher frequencies around 1900 MHz. Performance summaries will be prepared for each of these two spectral technologies.

EXPERIMENTAL DESIGN

All of the network performance parameters measurements involve estimates of a sample mean. The accuracy of these estimates depend on the variance of the sampling distribution and the number of samples collected. The standard deviation of the estimated mean is expressed as:

$\sigma_{\bar{x}} = \sigma/n$ ½

Where:

$\sigma_{\bar{x}}$ -standard deviation of the mean
σ-standard deviation of the distribution
n-number of samples

Knowing the standard deviations of the mean, it is possible to calculate the 95 percent confidence interval which will be $x \pm 2\sigma_X$. Knowing the confidence interval will enable the wireless performance inventory to state with 95 percent confidence that the performance parameter is within the stated value interval.

Sample Volume

From the above, it is clear that two factors determine performance parameters estimation accuracy; the number of samples and the sample variance. Since there is no way to control the variance of the sample, sample volume is the only control variable. The objective of the wireless performance monitoring inventory is to generate a significant of samples to provide accurate estimates of the performance parameters for each of the categories described previously.

To generate such sample volume, the wireless network monitoring system will be deployed and operate as follows:

1. Sampling Time Period
   The sampling time period at each location will be one week.

2. Sample Frequency - Circuit-switched network
   Ten (10) three minute voice calls will be scheduled daily. These calls will occur during both peak and off-peak time periods during the 24 hour day.

3. Sample Frequency-Packet switched networks

   Packet-switched monitoring will occur every five minutes continuously throughout the day.

With the above time periods and sample frequencies, the following category based sample volumes are expected in the initial three month data collection period:

Region/Circuit-Switched

Conditions:

Laptop Agents – 6

Sample Period – 1 week

Inventory Period – 13 weeks

Samples/Day – 60

Samples/Week – 420

Samples/Inventory – 5,460

Region/Packet-Switched

Conditions:

Same as above except:

Samples/Day – 1,728

Samples/Week – 12,096

Inventory Period – 13 Weeks

Samples/Inventory – 157,248

Urban/Packet-Switched

Conditions:

Samples/Day – 1,728

Samples/Week – 12,096

Inventory Period – 5 Weeks

Samples/Inventory – 60,480

Urban/Circuit-Switched

Conditions:

Samples/Week – 420

Inventory Period – 5 Weeks

Samples/Inventory – 2,100

Suburban/Packet-Switched

Conditions:

Samples/Week – 12,096

Inventory Period – 5 Weeks

Samples/Inventory – 60,480

Suburban/Circuit-Switched

Conditions:

Samples/Week – 420

Inventory Period – 5 Weeks

Samples/Inventory – 2,100

Rural/Packet-Switched

Samples/Week – 12,096

Inventory Period – 3 Weeks

Samples/Inventory – 36,288

Rural/Circuit-Switched

Samples/Week – 420

Inventory Period – 3 Weeks

Samples/Inventory – 1,260

Note: The rural inventory sample volumes are smaller than the urban/suburban because only three weeks of sampling is conducted in rural areas versus five weeks in both urban and suburban areas.

Technology

Technology performance inventory summaries apply to both packet-switched and circuit-switched network, but the categories are somewhat different.

Circuit-switched

1. TDM
2. GSM - 280

3. iDEN - 70
4. UMTS (3G) - 70

Packet-Switched

1. GPRS – 104,832
2. Edge – 26,208
3. 3G – 26,208

Service Provider

Each service provider would be represented by one-sixth of the samples for the regional urban, suburban and rural categories.

County

The following sample sizes are estimated for each of the seven counties:

Kenosha – 15,725
Milwaukee – 15,725
Ozaukee – 15,725
Racine – 15,725
Walworth – 31,450
Washington – 31,450
Waukesha – 31,450

Cellular versus PCS

The three Regional cellular (800-900 MHz) providers are Nextel, Cingular and U.S. Cellular. The other four providers are PCS: Sprint, AT&T, T-Mobil and Verizon Wireless. At the Regional level, the sample size totals will be:

Cellular – 67,392
PCS – 89,856

SAMPLE LOCATION SELECTIONS

Monitoring data will be collected over 78 agent-period locations (6 agents over 13 weeks). To insure adequate geographic coverage of the seven county planning area, the area will be divided

into ten data collection zones – one each for Kenosha, Milwaukee, Ozaukee, and Racine counties, and two each for Walworth, Washington, and Waukesha counties. The latter counties will be assigned two zones because they are approximately twice the area of the smaller counties. Each zone will then be assigned 8 agent-period locations with assignment order randomized. The last two zones in the assignment order will receive only seven agent-periods. Within each zone, agent-period entities will be randomly assigned to a prepared list of available sites within the zone. It is anticipated that the agent sites will be located at local government offices randomly selected from the 147 sites available.

The number of samples collected for each of the above categories will be limited by the agent-period entities available in a 13 week period. After the initial three-month inventory period, represented categories will be improved by subsequent weighted, randomized selections that will serve to achieve proper balance in all of the categories based on established principles of statistical sequential analysis.

ESTIMATE ACCURACIES AND CONFIDENCE INTERNALS – SAMPLE ESTIMATES

Without actually collecting sufficient data to determine sample variances, it is not possible to estimate the accuracies of the parameter means and confidence intervals. It is possible, however, to assume a range of variances in percentage terms and then apply that range to probable parameter values to estimate mean and confidence interval deviations.

REGIONAL-LEVEL ACCURACY ESTIMATES

Availability: Packet-Switched

Assumed value - 99.9 percent

Assumed standard deviation – 5.0 percent

Sample size – 157,248

Standard error, mean= 0,01 percent

Availability: Circuit-Switched

Assumed value - 99.9 percent

Assumed standard deviation – 5.0 percent

Sample size – 5,460

Standard error, mean – 0.07 percent

Throughput – Packet-switched

Assumed value – 20 – 200 Mbps

Assumed means

2.5G – 75 Kbps

3.0G – 300 Kbps

Assumed standard deviation

2.5G – 25 Kbps

3.0G– 100 Kbps

Sample size/2.5G - 104,832

Standard error, mean/2.5G – 0.077 Kbps

Sample size/3G – 26,208

Standard error, mean/3G = 0.62 Kbps

Throughput: Circuit-Switched

Not applicable

Accuracy: Packet-Switched

Assumed value – MOS 4.0

Assumed mean – 3.0

Assumed standard deviation 1.0

Sample size – 157,248

Standard error, mean = 0.0025

Accuracy: Circuit – Switched

Assumed value – MOS = 4.0

Assumed mean – 3.0

Assumed standard deviation – 1.0

Sample size – 5,460

Standard error, mean = 0.0135

The foregoing analysis indicates that the proposed sample sizes will be sufficient to obtain accurate parameter estimates, even in the smaller category sizes. In this respect it should be noted that accuracy estimates were not calculated for packet-switched networks response times because

of the wide variation of these values for each application. These estimates will be calculated when sufficient monitoring data are available. Response time is not a meaningful parameter for circuit-switched networks.

POTENTIAL LIMITATIONS OF THE PROPOSED PERFORMANCE MONITORING PROCEDURE

It is important to understand that the proposed wireless performance monitoring may have certain potential limitations. One of these limitation concerns the use of multiple networks involving the Internet or other wireline-wireless service providers that may obscure the monitoring results. *The Commission Advisory Committee expressed concern about the structure of the circuit-switched network monitoring procedure as proposed in both the first and second draft of this memorandum. The concern related to the use in the proposed procedure with respect to circuit-switched traffic of multiple networks involving the Internet or other wireless-wireline networks that may obscure the monitoring results. This concern has been addressed by removing the Internet and all other non-wireless service provider circuit elements from the circuit-switched traffic monitoring circuit as explained in a revised draft of Appendix IV, dated July 12, 2005. The circuit-switched monitoring procedure is now proposed to consist of a wireless-to-wireless configuration as suggested by the Advisory Committee. The circuit as now proposed contains only infrastructure elements selected by each wireless service provider.*

A second potential limitation relates to the proposed fixed nature of the remote testing location. In this respect it should be noted that most service providers field test their networks using moving vehicles. Fixed versus mobile wireless network testing is herein proposed for the first three-month data collection period in order to simplify initial monitoring operations to meet plan completion schedules. Nomadic (walking user) and mobile test sequences will be added in later quarterly periods. Fixed testing was also selected to serve as a performance base for later nomadic and mobile monitoring measurements. All wireless communications systems are first developed and tested in the fixed mode where higher performance is typically experienced. Development and testing then moves on to nomadic and mobile versions of the technology. Regional wireless service providers will usually record their highest performance in fixed location use. Later nomadic and mobile testing will then allow for the determination of the effects of mobility on system performance.

A third potential limitation relates to avoiding special test site location situations that would enhance or degrade service. To overcome this limitation it will be necessary to avoid test site locations where a particular carrier would have network performance enhancements in place for a designated facility, or where the buildings concerned may inordinately interfere with wireless transmissions. Locations where service is provided through roaming arrangements with other carriers should also be avoided.

Monitoring operations during periods of maintenance down time should not, as such, comprise a limitation. Such downtime is part of the provider's network service availability and should, therefore, be treated impartially as part of the availability parameters for all carriers.

Finally, great care will be taken in the use and publication of performance parameter values with small sample sizes. The initial three-month inventory may only permit reliable parameter estimates at the regional level, with other categories having sample sizes too small for accurate parameter estimates. Needed caution will be exercised and parameter values will be stated with both their mean value accuracy estimate, and their 95 percent confidence interval, both of which are dependent on sample size.

Advisory Committee Review Process

All wireless network monitoring system data will be reviewed with the Advisory Committee prior to publication. All monitoring data specific to a particular service provider will be reviewed with that provider and publicly released only with the written permission of each wireless service provider.

Documentation

The wireless performance inventory resulting from the three initial months of data collection will be documented in both the antenna siting and related infrastructure planning report and later in an inventory technical report. Both reports will include tabular summaries of network parameters for the various categories discussed in this report. Tabular summaries will also be shown using regional and county-level maps displaying wireless network performance by geographic area. A detailed description of the wireless network monitoring system will also be included in these reports.

Following the initial wireless performance inventory, performance monitoring will continue on a year-around basis with technical reports issued quarterly summarizing network performance during the quarter and comparisons made with previous time periods.

KWB/KJS/lgh
07/12/05
#106128 V4 - T/C-Tech Study Design Memo No. 7-Performance Monitoring Inventory

Appendix I

WIRELESS NETWORK MONITORING EQUIPMENT

APPENDIX I

Wireless Network Monitoring Equipment

The wireless network performance monitoring system utilizes two Net IQ Corp. software packages:

1. Net IQ AppManager
   - for packet-switched network performance monitoring
2. Net IQ Vivinet Asessor
   - for circuit –switched network performance monitoring

Both of these software packages were originally designed for wireline network monitoring. Employing them in wireless networks requires additional equipment in the form of wireless network cards to interface a packet-switched transceiver to the mobile laptop computer through a PCMIA port. These transceivers act as wireless dataphones for each provider's wireless network. Six different transceiver cards are used each unique to a wireless service provider as listed below.

Packet-Switched Network:

- Sierra Aircard 555 (U.S. Cellular)
- Sierra Wireless Aircard 750 (T-Mobile)
- Novatel V620 (Verizon)
- M1100 Wireless Modem (Nextel)
- Sony Ericsson GC83 (Cingular)
- Sierra Wireless PC 3300 (Sprint)

For circuit-switched performance monitoring, selected mobile phones from each service provider are interfaced through a USB port to the laptop computer with no two phones from the same provider connected to the same laptop. Such an interface allows the Vivinet Assessor to transmit synthetic voice signals through the circuit-switched network. The specific mobile phones to be used are listed below:

- Two Motorola V262 plus USB cables and software[1] (U.S. Cellular)
- Two Motorola V180 plus mini USB cables and software[1] (T-Mobile)
- Two Motorola V65p plus USB cables and software[1] (Verizon)

- Two Motorola I205 plus Motorola USB charging data cables[1] (Nextel)
- Two Motorola V180 plus mini USB cables and software[1] (Cingular)
- Two Samsung I500 plus USB synch cables[2] (Sprint)

---

[1] *Utilizes Mobile Phone Tools v3.0 software*

[2] *Utilizes Samsung software drivers*

KJS/lgh
04/20/05
#107222 V1 - APPENDIX I

Appendix IV

WIRELESS NETWORK MONITORING SYSTEM (WNMS)

CIRCUIT-SWITCHED VERSION

APPENDIX IV

WIRELESS NETWORK MONITORING SYSTEM (WNMS)
CIRCUIT-SWITCHED VERSION

~~This Appendix will explain the voice-data traffic flow in the circuit-switched version of the system proposed to be used to measure the availability and voice quality of wireless cellular-PCS networks in the planning area as shown in Figure 1. Voice messages are originated at the transmitting end point using a laptop computer, cellular-PCS telephones and associated software as described in Appendix I. The voice message is transmitted to the base transceiver station (antenna site) of the particular wireless service provider. The voice message then moves through the transmission network of the provider to the mobile switching center (MSC) of the provider where it interconnects with a Plain Old Telephone Service (POTS) provider which relays it to the Internet Service Provider A (ISPA).~~

~~The ISP A then sends the voice message over the Internet and back through a second ISP (ISP B) to the receiving endpoint at SEWRPC. The management server at SEWRPC receives the values of the performance parameters after each message transaction.~~

~~The first part of the voice message circuit to ISP A is unique to each service provider's network. The second part of the circuit from ISP A to the receiving endpoint is common to all message transactions. Both halves of the circuit will impact the parameter measurements. In order to account for the effects of the second half circuit on wireless service provider performance, an additional network agent will be installed at ISP A in order to determine the average availability and voice quality factors from ISP A to the receiving endpoint over time. Because the second half of the network is entirely wireline, these factors will probably be much better than the first half circuit which is partially wireless. Nonetheless, these second half circuit factors will be used to adjust the total performance parameters values to remove the effect of second half circuit performance. Means and variances of both circuits will be combined in a mathematically appropriate manner.~~

~~The mean opinion score (MOS) for voice quality will be calculated from monitoring measurements using the E-model method defined in International Telecommunications Standard ITU G.107.~~

This Appendix will explain the voice traffic flow in the circuit-switched version of the system proposed to be used to measure the availability and voice quality of the wireless cellular-PCS networks in the planning area as shown in Figure 1. Voice messages are originated at the transmitting end point using a laptop computer, cellular-PCS telephones and associated software as described in Appendix I. The voice message is transmitted to the base

transceiver station (antenna site) of the particular wireless service provider. The voice message then moves through the transmission network of the provider to the mobile switching center (MSC) of the provider where it interconnects with a wireline service provider that is an integral part of the wireless service provider's network system. The wireline service provider then directs the call to the call destination through the wireless service provider's transmission subsystem to the appropriate antenna site which then transmits it to the remote cell phone transceiver. The management server located at the Commission offices initially sets up the call and then later receives the values of the performance parameters after each message transaction.

The mean opinion score (MOS) for voice quality will be calculated from monitoring measurements using the E-model method defined in International Telecommunications Standard ITO G.107.

KWB/KJS/lgh
07/12/05
#108132 V2 - Appendix IV Wireless Network Monitoring System Circuit-Switched Version

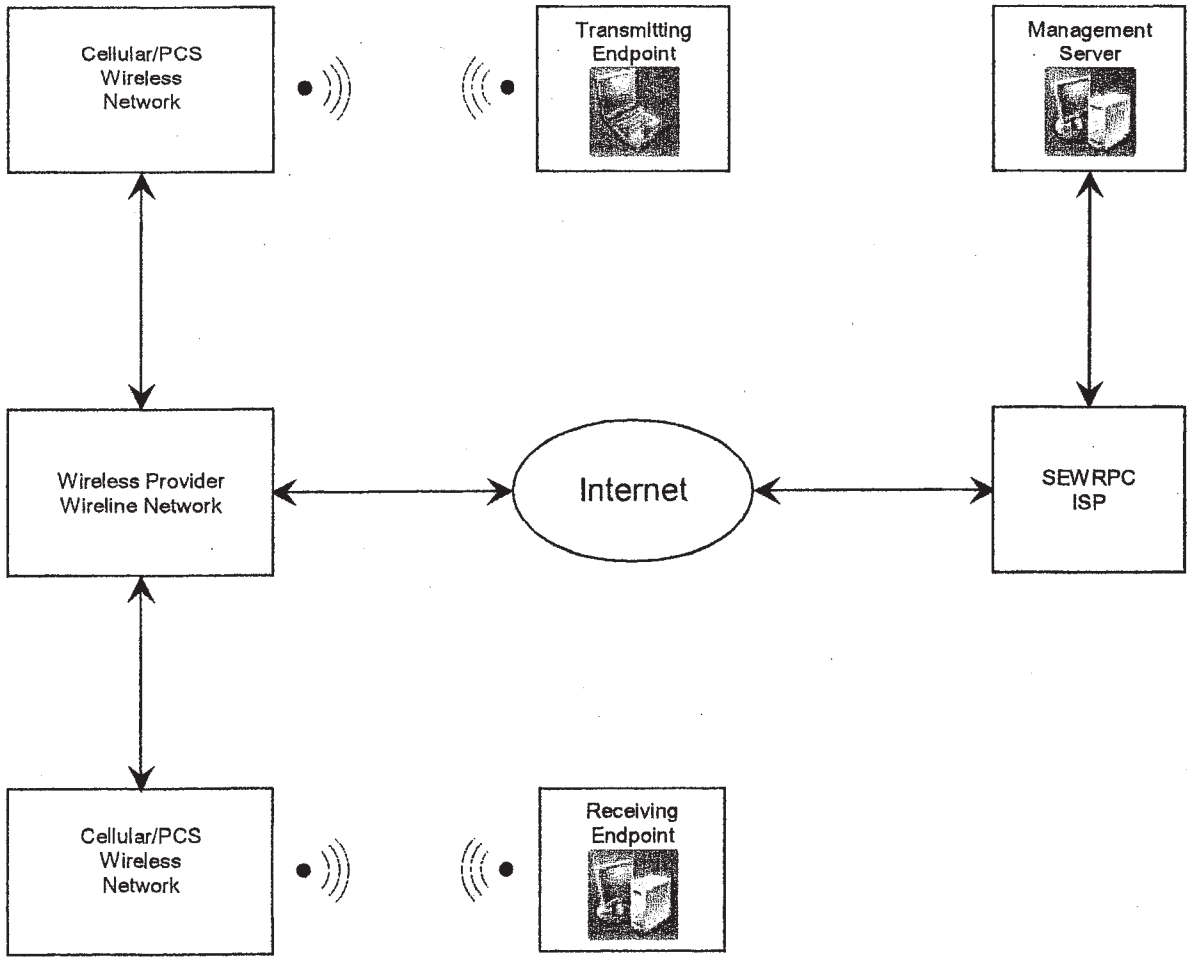


Figure 1: Circuit-Switched Monitoring System

Appendix V

WIRELESS NETWORK MONITORING SYSTEM (WNMS)

PACKET-SWITCHED VERSION

APPENDIX V

WIRELESS NETWORK MONITORING SYSTEM (WNMS)
PACKET-SWITCHED VERSION

A diagram of the packet-switched version of WNMS is shown in Figure 1. In this application, packet-switched data from the transmitting end-point employs a laptop computer and the transceiver card of each provider to transmit wirelessly as in the circuit-switched application. Data moves through the provider's wireless network and on to the Internet through the provider's Internet Service Provider (ISP). From the Internet, the data message is passed on to the receiving endpoint at SEWRPC as before. Once again, the management server collects performance data on a continuous basis. There is no need to correct for second half circuit effects since they are part of a typical Internet-based packet-switched application.

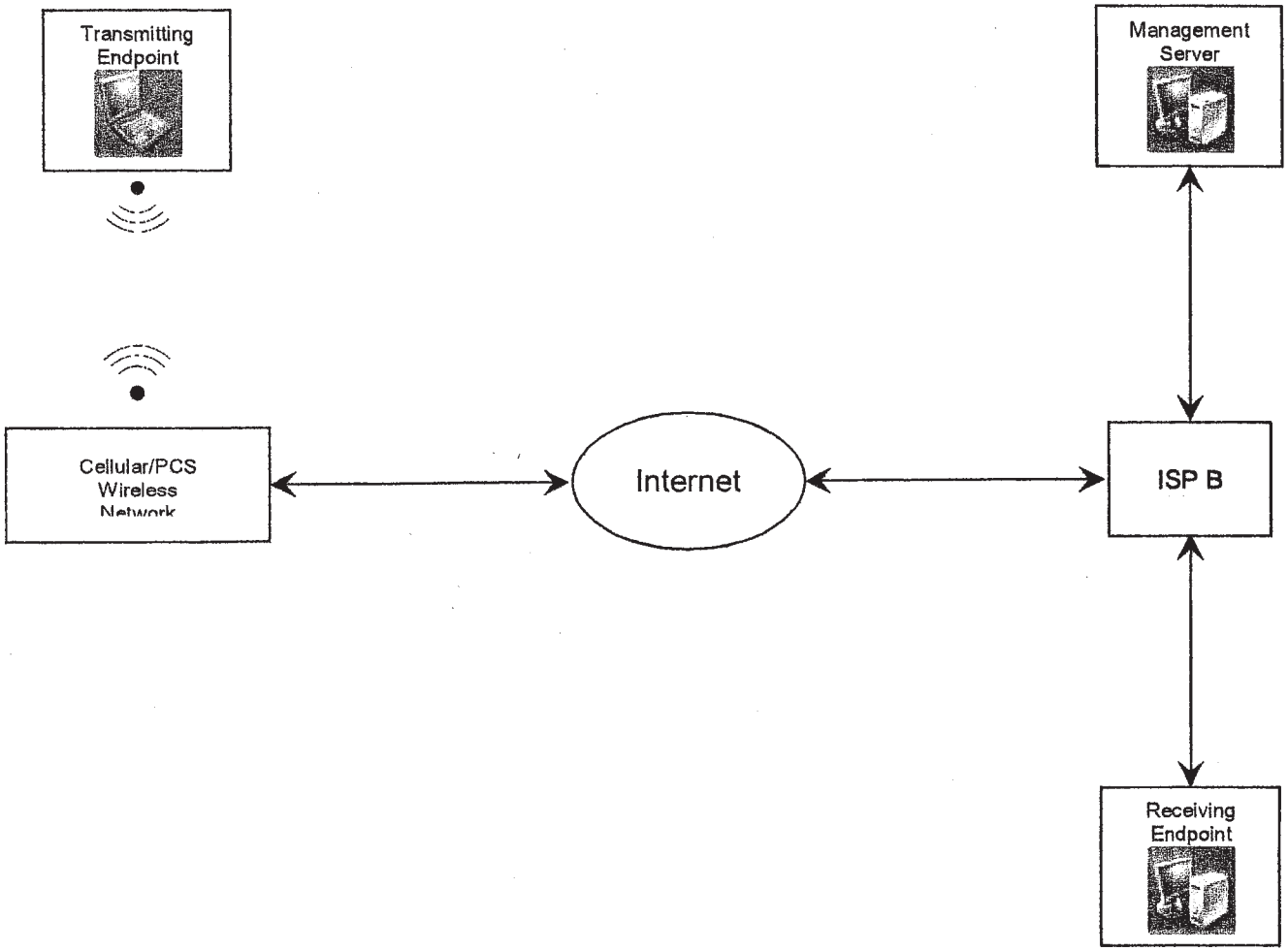


Figure 1: Packet-Switched Monitoring System

PRELIMINARY DRAFT

SEWRPC Planning Report No. 51,
A WIRELESS ANTENNA SITING AND RELATED INFRASTRUCTURE PLAN
FOR SOUTHEASTERN WISCONSIN

Chapter V

WIRELESS TELECOMMUNICATIONS INVENTORY FINDINGS

INTRODUCTION

Reliable planning data are essential for the formulation of workable development plans. Consequently, an inventory of existing conditions is the first step in the planning process. The crucial nature of factual information in the planning process should be evident, since no reliable forecasts can be made or alternative courses of action evaluated without knowledge of the current state of the system being planned. The necessary inventory not only provides data describing the existing conditions, but also provide a basis for identifying existing and potential problems in the planning area and opportunities for development. The inventory data are also crucial to the forecasting of future facility and service needs, formulating alternative plans, and evaluating such plans.

Chapter IV presented data on the existing demography and economy; the existing land use pattern; and the existing transportation system of the planning area. These factors provide the setting for the telecommunication facilities and services of an area, and affect the configuration of the demand upon those facilities and services, and the configuration of the facilities and services themselves. The sound development of a telecommunications facilities and services plan must also consider: telecommunications technologies currently employed within the Region; emerging technologies that may displace these current technologies; the planimetry and hypsometry of the Region that has a major impact on the deployment of wireless communications systems displayed as Canopy data; and the existing telecommunications infrastructure within the Region. The performance of that existing infrastructure must also be monitored. The results of the monitoring is reported in a later chapter. The regulatory environment must also be inventoried. The results of this inventory will also be provided in a separate chapter.

Infrastructure inventories in wireless networks relate primarily to antenna sites, their transmission interconnection to core networks and the coverage areas of these sites. Wireless performance inventories are based on standard measurements of availability, throughput, response time and accuracy.

Infrastructure Inventory

Comprehensive and accurate wireless telecommunications infrastructure inventories are a rare commodity. Although national data bases on antenna sites have been compiled by the (FCC) Federal Communications Commission and Federal Aviation Administration (FAA), these data bases tend to be inaccurate and incomplete. Neither agency has attempted a comprehensive antenna site compilation, so that an accurate antenna site inventory requires collation of data from at least four major sources: the FAA database is primarily concerned with the location and height of antenna structures, data more conveniently and often more accurately collated from the other databases used. Therefore, the FAA database, although obtained, was not used in the compilation of the inventories.

1. FCC Database

   This data base is a good starting point for an inventory of antennae sites for traditional cellular networks in the 800 to 900 MHz range; but is a poor source of data for personal communication system (PCS) wireless networks in the 1900 MHz range.

2. Mobiledia Website

   This data base is of fair quality for information relating to PCS networks.

3. Local Units of Government

   The county and municipal units of government within the Region constitute a good confirmation source for antennae site locations providing cellular and PCS service, and the only independent source of data for fixed wireless antenna sites.

4. Network Operators

   The network operators comprise the final confirmation source for all four classes of wireless networks and a critical check on the coverage element of the inventory.

Using all four of the above sources, a comprehensive inventory can be compiled for regional antenna sites. Geographic and technical data for each site then provides the foundation for radio propagation studies to determine the radio coverage of individual sites and the overall radio coverage of the Region.

The antenna site inventory was focused on those sites related to wireless service providers and public agencies that furnish telecommunication services to the general public or to county and local units of government. Other antenna sites serve a wide range of commercial and public uses. Such sites may be classified as follows:

1. Mobile cellular and PCS antennae serving cellular phone networks; cellular in the 800 to 900 MHz band; and PCS in the 1900 MHz band.
2. Fixed wireless antennae serving broadband internet service providers (ISPs), antennae operating in the unlicensed 2.4 GHz and 5.2 - 5.9 GHz bands.
3. Land mobile wireless antennae, including antennae serving multi-agency, multi-jurisdictional 800 trunk networks operating under 800 MHz range; and antennae serving other police, fire, emergency medical service and public works networks.
4. Paging antenna sites
5. Microwave antenna sites

Excluded from the inventory were private commercial and broadcast auxiliary land mobile networks; amateur radio service antennae; commercial radio and restricted radio telephone (FRC) antennae; and general mobile radio service (GMRS) antennae. These types of networks were excluded because they do not provide communication services to the public or to local units of government.

Of the inventoried sites, only the first three classes listed above were inventoried for site coverage and capacity. Site data for paging and microwave point-to-point links were collected only to provide a comprehensive inventory of antenna sites and structures that may be utilized in future wireless antenna site planning. For those sites of direct planning interest, the mobile cellular - PCS class dominates in terms of both number and regional impact, but each category was covered in the Regional telecommunications infrastructure inventory.

Mobile Cellular/PCS Infrastructure Inventory

The mobile cellular infrastructure inventory describes the antenna sites and related supporting infrastructure of the three 800 to 900 MHz band wireless service providers in Southeastern Wisconsin: Nextel Communications; Cingular Communications; and U.S. Cellular. Together, these providers account for 300 antenna base stations in the Region according to the FCC database. Because of co-located antennas, the number of antenna sites is less than the number of antenna base stations. Classified by provider, the number of antenna base stations were recorded as follows:

1. Nextel Communications – 104
2. U.S. Cellular – 146
3. Cingular Communications – 50

The FCC database does not provide comprehensive information on PCS antenna sites. Such information is, however, available from the local units of government as described below:

For each antenna site, the following data were collected and tabulated:

1. Name of Service Provider
2. Type of structure
3. Sole locator or co-locator
4. Geographic Coordinates
   - latitude and longitude
   - State plane coordinates
   - U.S. Public Land Survey System Section, Township and Range
   - street address
5. Antenna Height
   - above ground (feet)
6. Antenna Sectors
   - number, if applicable
7. Antenna Power
   - in watts
8. Antenna Frequency
   - in megahertz (MHz)
   - or in gigahertz (GHz)
9. Antenna Pattern
   - if available
10. Zoning, Conditional Use Permit and Lease Data[1]

These data were used for locating antenna sites on regional maps, and as input to radio propagation models that delineate the geographic coverage areas of each base station. Primary model inputs include location, antenna height, output power, and the antenna radiation patterns. From these inputs the radio propagation model plots the coverage area based on the expected sensitivity of remote cell phones. Based on the experience of local radio frequency

[1] The information on zoning, conditional use permit and lease data are proposed to be collected at this time in the interest of efficiency. In collecting this information, the Commission is looking ahead to the possible preparation of a Commission local planning guide on the siting of wireless antenna structure and related facilities within the Region. In addition, information concerning the conditions placed by county and local municipalities on antenna structure locations and designs is of material interest to the Commission's constituents, counties and municipalities as are data concerning fees and lease arrangements and payments.

engineers, a sensitivity threshold of minus 80 dBmW (decibel milliwatts) was established. Radio propagation coverage plots for each antenna site were generated using two different geographic databases: a terrain database and a Canopy database. The terrain database follows the ground elevations found on a topographic map with no allowance for forested areas, buildings, or other structures that modify radio propagation paths. The Canopy database does provide for radio path interferences caused by trees, buildings, or any other obstruction that would modify the path of a radio wave. As the name suggests, the ground surface of an area is elevated for any natural or other obstruction as if a canopy sheet were thrown over the area. The particular Canopy database employed has a 30 meter resolution and was compiled from National Aeronautics and Space Administration (NASA) shuttle photography.

The end results of a wireless infrastructure inventory are not only a mapping of antenna site locations but also a mapping of coverage areas. Coverage area maps were compiled at three levels of detail:

1. Coverage areas for each antenna base station;
2. Coverage areas for each wireless service provider; and
3. Coverage area for all wireless service providers

The first mapping is of use primarily for input to the antenna site location optimization model. This model and its operation will be discussed in detail in a later chapter of this report. At this point, it is only important to emphasize the model's need for individual antenna site coverage area inputs to allow the model to select the minimal number of sites for regional coverage.

The maps displaying service provider coverage areas constitute a major output of the wireless infrastructure inventory since they are indicators of cellular communications service quality in the Region. For cellular service in the 800-900 MHz spectral region and PCS service in the 1900 MHz spectral region, radio coverage maps were prepared for each of the service providers. Since there are no known roaming management partnerships within the planning area between these providers, each service provider's coverage area stands alone. In order to provide accurate and reliable radio coverage mapping, all radio coverage maps were verified with each individual carrier. Previous to such verification, antenna site data were cross-checked between the two original sources: the Federal Communications Commission (FCC) databases, and the local governmental database. Critical site data collected included geographic location and antenna height, power, frequency and configuration. With these data verified, site coverage was then determined by radio propagation modeling. The models -- given inputs of location, antenna technical characteristics, and cell phone sensitivity -- were used to delineate area of radio coverage.

Two classes of radio propagation models were employed in the radio propagation coverage studies: empirical models and physical models. The empirical models were based on field measurements in various terrains and urban-

suburban-rural environments. These models estimate typical radio path lengths for a defined radio environment. The currently most widely used empirical model is the Okumura (Hata) model used by many wireless service providers. Empirical models do not explicitly recognize topographic or structural features in a particular geographic area. Physical models, in contrast, do recognize specific topographic or structural aspects and trace out radio paths based on free space attenuation and the modifying effects of ground reflection, diffraction and other physical factors. A particularly preferred physical model is the Anderson 2D Model.

Wireless Infrastructure Inventory

As previously noted, antenna site data were collected in the following categories:

1. Mobile cellular and PCS networks;
2. Fixed wireless networks; and
3. Land mobile public networks

The inventory data collected in these three categories include:

1. Positional data in the form of latitude and longitude, state plane coordinates, U.S. Public based Survey System Section, Township and street address;
2. Type of Structure;
3. Technical data including antenna height, type, power and frequency; and
4. Geographic coverage for each service provider based upon radio propagation.

The findings of only the first two inventory categories are herein presented. The findings of the land mobile public network inventory will be presented as part of the companion memorandum report on public enterprise networks. Inventory data were also collected on paging antenna sites and point-to-point microwave antenna sites as potential sites for future wireless network deployments. No radio propagation modeling studies, however, were carried out for these sites.

The inventory findings are presented herein by county.

KENOSHA COUNTY

Antenna site data for Kenosha County were compiled from the following sources:

1. Federal Communications Commission (FCC) databases
   a. For Cellular (800-900MHz) sites-cellular-47 CFR Part 22

b. For Nextel Communications, Inc. – Land Mobile – Commercial

2. Local governmental databases, including data provided by the following local units of government in Kenosha County:

Community	Number of Sites
City of Kenosha	16
Village of Paddock Lake	1
Village of Pleasant Prairie	12
Village of Silver Lake	0
Village of Twin Lakes	2
Town of Brighton	4
Town of Bristol	4
Town of Paris	5
Town of Randall	3
Town of Salem	4
Town of Somers	7
Town of Wheatland	2
Total	**60**

Anetnna and Anetnna Site Inventory – Cellular/PCS

The cellular/PCS antenna site inventory findings are summarized in a series of tables – reproduced on pages 11 through 16 one for each wireless service provider as follows:

Table 1. – Cingular Wireless – 16 antennae

Table 2. – Nextel Communications – 13 antennae

Table 3. – Sprint Communications – 18 antennae

Table 4. – T-Mobile 11 antennae

Table 5. – U.S. Cellular – 21 antennae

Table 6. – Verizon Wireless – 8 antennae

The data presented in Tables 1, 2, and 5, representing the cellular (800 – 900 MHz) service providers, are based on compilation and reconciliation of data from the FCC and local government data bases. Positional data from Nextel was also used to reconcile data on the geographic positions of the sites. In general, power and frequency data were acquired from the FCC data bases since these types of data were mostly absent from local governmental files. Tables 3, 4, and 6 representing the PCS service providers were compiled almost entirely from local governmental data bases, since PCS sites were largely absent from the FCC data bases.

The site inventory and the geographic service coverages of each of the six wireless carriers are described below:

[Editor's Note: *The service providers concerned will be contacted as indicated after review of the preliminary draft of this text by the Commission Technical Advisory Committee and appropriate text documenting, the results of the reviews provided to the Committee for insertion into the text here*].

Antenna Site Inventory – Fixed Wireless Providers

Only one fixed wireless service provider is known to be operating in Kenosha County; Cyberlink, Inc. of Franklin, Wisconsin. Two fixed wireless service antenna sites are reported to be located in the County – both of which are mounted on building structures. For this reason neither of these sites was recorded in the FCC or the local governmental data bases. This requisite data, however, were obtained directly from the carrier and are tabulated as follows:

Site Number 1

1. Geographic Coordinates
2. Street Address
3. Antenna Height (data to be provided)
4. Antenna Type
5. Antenna Power (Watts)
6. Antenna Frequency – 2.4 Gigahertz

Site Number 2

1. Geographic Coordinates
2. Street Address
3. Antenna Height (data to be provided)
4. Antenna Type
5. Antenna Power (Watts)
6. Antenna Frequency – 2.4 Gigahertz

Inventory Findings - Geographic Coverage

One of the purposes for compiling the wireless antenna site inventory was to help determine the quality of existing wireless communications services in the Region. The quality of service -- in terms of such parameters as availability, throughput and accuracy, -- will be directly measured by the Commission wireless network monitoring system and reported separately. The geographic coverage inventory findings as herein presented, were intended to reveal dead zones in the Region where either no service, or a low quality of service, may be expected.

For this reason, six radio coverage maps -- one for each cellular/PCS, service provider -- were generated using the EDX Signal Pro TM software for the recovery propagation simulation. EDX Signal Pro is a long established and well respected radio propagation planning tool.

In addition to the antenna site inventory parameters listed in the tables for each wireless carrier, the following universal set of modeling applications were employed in each of the radio propagation studies:

1. Propagation Model – Anderson 2D
   - universally accepted physical model
2. Received Power at Remote Threshold – 80 dBmW
3. Terrain Database - Canopy
   - allowing for building and trees as well as topography
4. Remote (cell phone) Parameters
   Power – 0.6 watts.
   Antenna Type – 0mni
   Antenna Gain – 0 dbi

The geographic coverage maps for each wireless service provider are herein provided in the same order as the previously described tables, namely: Cingular, Nextel, Sprint, T-Mobile, U.S. Cellular, and Verizon. (See pages 17 through 22).

AT&T Wireless antenna sites in the PCS frequency range were merged with the Cingular network in recognition of the recent merger of these two companies.

The yellow colored areas on each map represent service coverage based on a 80.0 dBmW receiver threshold. Red areas represent locations with signal levels below the receiver threshold indicating a lack of quality wireless service or no service at all.

SUMMARY

The findings of the antenna site and related infrastructure inventory as herein reported document the existence -- as of July 1, 2005 -- of 60 cellular-PCS mobile wireless service antenna structure sites within Kenosha County. The findings of the inventory also document the existence of two fixed wireless service antenna structure sites within the County. The 60 mobile wireless service antenna sites support 87 omnidirectional or sectoral antennae. The inventory indicates that four of the current six wireless carriers concerned provide excellent coverage throughout Kenosha County. Two of the carriers provide excellent coverage of that part of Kenosha County located east of IH-94 – the most highly urbanized area of the County, but provide less than complete coverage in the more rural western part of the County. The antenna sites represent a significant resource that can be used in planning for future advanced wireless networks within the County.

KWB/KJS/lgh
06/15/05
#104044 V1 - Chapter V - Wireless T/C Inv. Findings

Table 1

LOCATIONS AND SELECTED CHARACTERISTICS OF CINGULAR WIRELESS ANTENNAS IN KENOSHA COUNTY, WISCONSIN: 2005

Site Number (See Map 1)	Location						Antenna Characteristics			
	Geographic Coordinates		State Plane Coordinates[a]		U.S. Public Land Survey Township-Range-Section	Street Address	Height (feet)	Type[b]	Power (watts)	Frequency (Megahertz)
	Latitude	Longitude	North	East						
1	42-32-20	88-12-32	201,588	2,482,752	T. 1 N., R. 19 E. Sec.14	9240 328th Ave. Town of Randall	150.88	S	140.82	891.51
2	42-33-03	88-16-50	205,534	2,463,350	T. 1 N., R. 19 E. Sec.17	37800 87th St. Town of Randall	190.24	S	45	1945
3	42-34-17	88-05-38	214,117	2,513,469	T. 1 N., R. 20 E. Sec.2	6969 236th Ave. Village of Paddock Lake	98.4	S	140.82	891.51
4	42-34-53	88-08-48	217,441	2,499,174	T. 1 N., R. 20 E. Sec. 4	27811 60th St. Town of Salem	265.68	S	140.82	891.51
5	42-33-37	88-02-28	210,398	2,527,777	T. 1 N., R. 21 E. Sec. 8	19460 81st St. Town of Bristol	193.52	S	45	1945
6	42-33-34	87-57-38	210,615	2,549,483	T. 1 N., R. 21 E. Sec. 12	2028 128th Ave. Town of Bristol	141.04	S	45	1945
7	42-32-13.7	87-59-07	202,326	2,543,020	T. 1 N., R. 21 E. Sec. 23	14901 Wilmot Rd. Town of Bristol	150.88	S	140.82	891.51
8	42-32-40.3	87-53-22.3	205,655	2,563,751	T. 1 N., R. 22 E. Sec. 15	8851 Green Bay Rd. Village of Pleasant Prairie	280.76	S	140.82	891.51
9	42-30-01	87-57-02	189,123	2,552,706	T. 1 N., R. 22 E. Sec. 31	WisDOT Weigh Station IH94 and CTH ML, Village of Pleasant Prairie	98.4	S	140.51	891.51
10	42-32-35	87-49-28	205,570	2,586,299	T. 1 N., R. 23 E. Sec. 18	8961 Sheridan Rd. City of Kenosha	78.72	S	140.82	891.51
11	42-36-00	88-16-00	223,527	2,466,720	T. 2 N., R. 19 E. Sec. 29	3403 392nd Ave. Town of Wheatland	229.6	S	45	1945
12	42-38-12	88-04-37	238,007	2,517,484	T. 2 N., R. 20 E. Sec. 13	1271 224th Ave. Town of Brighton	200.08	S	45	1945
13	42-37-30	88-00-15	234,216	2,537,164	T. 2 N., R. 21 E. Sec. 22	16105 Burlington Rd. Town of Paris	141.04	S	45	1945
14	42-39-28	87-50-12	247,282	2,581,922	T. 2 N., R. 22 E. Sec. 1	7th St. Town of Somers	190.24	S	45	1945
15	42-39-03	87-55-52	244,107	2,556,587	T. 2 N., R. 22 E. Sec. 8	900 100th Ave. Town of Somers	278.8	S	45	1945
16	42-37-30	87-49-41	235,400	2,584,549	T. 2 N., R. 23 E. Sec. 18	1815 Birch Rd. Town of Somers	98.4	S	140.82	891.51

[a] *State Plane Coordinates are from the Wisconsin State Plane Coordinate System, South Zone, North American Datum of 1927. Coordinates are rounded to the nearest foot.*

[b] *Antenna Types: S=Sectoral, O=Omni. A Sectoral antenna uses a more complex antenna structure and transmits and receives over a sector with the total number of sectors covering a 360 degrees pattern. An Omnidirectional uses a monoplex antenna and receives and transmits over a 360 degree pattern.*

Source: Federal Communications Commission, Universal Licensing System Cellular License Database, local municipalities of Kenosha County, Wisconsin and SEWRPC.

#109190 V2 - Location Table – Cingular-Kenosha (06/14/05)

Table 2

LOCATIONS AND SELECTED CHARACTERISTICS OF NEXTEL WIRELESS ANTENNAS IN KENOSHA COUNTY, WISCONSIN: 2005

Site Number (See Map 2)	Location						Antenna Characteristics			
	Geographic Coordinates		State Plane Coordinates[a]		U.S. Public Land Survey Township-Range-Section	Street Address	Height (feet)	Type[b]	Power (watts)	Frequency (Megahertz)
	Latitude	Longitude	North	East						
1	42-33-03	88-16-50	205,534	2,463,350	T. 1 N., R. 19 E. Sec. 17	37800 87th St. Town of Randall	200.08	O	62	851.6625
2	42-32-19	88-11-23	201,599	2,487,919	T. 1 N., R. 19 E. Sec. 24	31315 93rd St. Town of Randall	180.4	O	45	851.6625
3	42-34-17	88-05-37	214,119	2,513,544	T. 1 N., R. 20 E. Sec. 2	6969 236th Ave. Village of Paddock Lake	226.32	O	45	851.6625
4	42-33-34	87-57-38	210,615	2,549,483	T. 1 N., R. 21 E. Sec. 12	2028 128th Ave. Town of Bristol	134.48	O	250	851.6625
5	42-34-41	87-50-34	218,194	2,581,030	T. 1 N., R. 22 E. Sec. 1	6203 28th Ave. City of Kenosha	65.6	O	250	851.6625
6	42-34-32	87-54-00	216,889	2,565,645	T. 1 N., R. 22 E. Sec. 4	6509 77th Ave.. City of Kenosha	150.88	O	45	851.6625
7	42-35-44	87-53-11.03	211,569	2,569,446	T. 1 N., R. 22 E. Sec. 10	10415 Sherdian Rd. Village of Pleasant Prairie	150.88	O	45	851.6625
8	42-33-38.52	87-53-16.13	192,811	2,569,539	T. 1 N., R. 22 E. Sec. 27	11513 Green Bay Rd. Village of Pleasant Prairie	459.2	O	45	851.6625
9	42-38-12	88-04-37	238,007	2,517,484	T. 2 N., R. 20 E. Sec. 13	1271 224th Ave. Town of Brighton	98.4	O	45	851.6625
10	42-36-24	87-57-33	227,829	2,549,436	T. 2 N., R. 21 E. Sec. 25	12508 38th St. Town of Paris	75.44	O	500	851.6625
11	42-39-03.1	87-55-51.3	244,119	2,556,639	T. 2 N., R. 22 E. Sec. 8	1000 100th Ave. Town of Somers	321.44	O	100	865.8375
12	42-37-01.1	87-52-28.3	232,153	2,572,120	T. 2 N., R. 22 E. Sec. 23	HWY 31 off Becker Rd. Town of Somers	308.32	O	37	865.6625
13	42-37-30	87-49-41	235,400	2,584,549	T. 2 N., R. 23 E. Sec. 18	1815 Birch Rd. Town of Somers	78.72	O	45	851.6625

[a]State Plane Coordinates are from the Wisconsin State Plane Coordinate System, South Zone, North American Datum of 1927. Coordinates are rounded to the nearest foot.

[b]Antenna Types: S=Sectoral, O=Omni. A Sectoral antenna uses a more complex antenna structure and transmits and receives over a sector with the total number of sectors covering a 360 degrees pattern. An Omnidirectional uses a monoplex antenna and receives and transmits over a 360 degree pattern.

Source: Federal Communications Commission, Universal Licensing System Cellular License Database, local municipalities of Kenosha County, Wisconsin and SEWRPC.

#109346 V1 - Location Table – Nextel-Kenosha (06/14/05)

Table 3

LOCATIONS AND SELECTED CHARACTERISTICS OF SPRINT WIRELESS ANTENNAS IN KENOSHA COUNTY, WISCONSIN: 2005

Site Number (See Map 3)	Location						Antenna Characteristics			
	Geographic Coordinates		State Plane Coordinates[a]		U.S. Public Land Survey Township-Range-Section	Street Address	Height (feet)	Type[b]	Power (watts)	Frequency (Megahertz)
	Latitude	Longitude	North	East						
1	42-32-35	87-49-28	205,570	2,586,299	T. 1 N., R. 23 E. Sec. 18	8961 Sheridan Rd City of Kenosha	88.56	O	45	1970
2	42-33-54	87-52-29	213,216	2,572,550	T. 1 N., R. 22 E. Sec. 10	75th St. City of Kenosha	104.96	O	45	1970
3	42-34-11	87-57-38	214,359	2,549,391	T. 1 N., R. 21 E. Sec.1	75th St. City of Kenosha	88.56	O	45	1970
4	42-34-22	87-51-19	216,184	2,577,714	T. 1 N., R. 22 E. Sec. 2	6724 39th Ave. City of Kenosha	68.88	O	45	1970
5	42-34-41	87-50-34	218,194	2,581,030	T. 1 N., R. 22 E. Sec. 1	6203 28th Ave. City of Kenosha	78.72	O	45	1970
6	42-35-02	87-49-07	220,488	2,587,482	T. 2 N., R. 23 E. Sec. 31	625 57th St. City of Kenosha	111.52	O	45	1970
7	42-35-44	87-53-9	224,273	2,569,275	T. 2 N., R. 22 E. Sec. 27	46th St. City of Kenosha	118.08	O	45	1970
8	42-35-49	87-50-43	225,058	2,580,179	T. 2 N., R. 22 E. Sec. 25	4311 30th Ave. City of Kenosha	137.76	O	45	1970
9	42-36-17	87-50-45	227,888	2,579,957	T. 2 N., R. 22 E. Sec. 25	3520 30th Ave. City of Kenosha	88.56	O	45	1970
10	42-38-46	87-58-18	242,119	2,545,722	T. 2 N., R. 21 E. Sec. 11	843 136th Ave. Town of Paris	150.88	O	45	1970
11	42-37-31	87-53-41	235,041	2,566,609	T. 2 N., R. 22 E. Sec. 16	7150 18th St. Town of Somers	118.08	O	45	1970
12	42-37-47	87-52-32	236,791	2,571,725	T. 2 N., R. 22 E. Sec. 15	1533 Green Bay Rd. Town of Somers	150.88	O	45	1970
13	42-36-00	88-16-00	223,527	2,466,720	T. 2 N., R. 19 E. Sec. 29	3403 392nd Ave. Town of Wheatland	249.28	O	45	1970
14	42-34-17	88-05-37	214,119	2,513,544	T. 1 N., R. 20 E. Sec. 2	6969 236th Ave. Village of Paddock Lake	249.28	O	45	1970
15	42-30-12.12	87-57-1.01	190,251	2,552,752	T. 1 N., R. 22 E. Sec. 31	12001 120th Ave. Village of Pleasant Prairie	111.52	O	45	1970
16	42-31-25	87-52-32	198,131	2,572,710	T. 1 N., R. 22 E. Sec. 22	10300 57th Ave. Village of Pleasant Prairie	131.2	O	45	1970
17	42-33-28.49	87-55-7.48	210,335	2,560,758	T. 1 N., R. 22 E. Sec. 8	9201 Wilmot Rd. Village of Pleasant Prairie	134.48	O	45	1970
18	42-31-40	88-16-08	197,198	2,466,668	T. 1 N., R. 19 E. Sec. 20	920 Lance Dr. Village of Twin Lakes	252.56	O	45	1970

[a] State Plane Coordinates are from the Wisconsin State Plane Coordinate System, South Zone, North American Datum of 1927. Coordinates are rounded to the nearest foot.

[b] Antenna Types: S=Sectoral, O=Omni. A Sectoral antenna uses a more complex antenna structure and transmits and receives over a sector with the total number of sectors covering a 360 degrees pattern. An Omnidirectional uses a monoplex antenna and receives and transmits over a 360 degree pattern.

Source: Federal Communications Commission, Universal Licensing System Cellular License Database, local municipalities of Kenosha County, Wisconsin and SEWRPC.

#109319 V1 - Location Table – Sprint-Kenosha (06/14/05)

Table 4

LOCATIONS AND SELECTED CHARACTERISTICS OF T-MOBILE WIRELESS ANTENNAS IN KENOSHA COUNTY, WISCONSIN: 2005

Site Number (See Map 4)	Location						Antenna Characteristics			
	Geographic Coordinates		State Plane Coordinates[a]		U.S. Public Land Survey Township-Range-Section	Street Address	Height (feet)	Type[b]	Power (watts)	Frequency (Megahertz)
	Latitude	Longitude	North	East						
1	42-31-40	88-16-08	197,198	2,466,668	T. 1 N., R. 19 E. Sec. 20	920 Lance Dr. Village of Twin Lakes	219.76	O	45	1990
2	42-34-17	88-05-37	214,119	2,513,544	T. 1 N., R. 20 E. Sec. 2	6969 236th Ave. Village of Paddock Lake	200.08	O	45	1990
3	42-34-11	87-57-38	214,359	2,549,391	T. 1 N., R. 21 E. Sec. 1	75TH St. City of Kenosha	111.52	O	45	1990
4	42-34-30	87-51-01	217,028	2,579,040	T. 1 N., R. 22 E. Sec. 1	3303 66th St. City of Kenosha	98.4	O	45	1990
5	42-33-03	87-53-32	207,935	2,567,967	T. 1 N., R. 22 E. Sec. 15	8600 Green Bay Rd. Village of Pleasant Prairie	180.4	O	45	1990
6	42-31-38.82	87-51-13.24	199,680	2,578,570	T. 1 N., R. 22 E. Sec. 23	9915 39th Ave. Village of Pleasant Prairie	121.36	O	45	1990
7	42-39-03	87-55-52	244,107	2,556,587	T. 2 N., R. 22 E. Sec. 8	900 100th Ave. Town of Somers	246	O	45	1990
8	42-37-01	87-52-27	232,145	2,572,217	T. 2 N., R. 22 E. Sec. 23	23rd St. Town of Somers	98.4	O	45	1990
9	42-35-44	87-53-09	224,273	2,569,275	T. 2 N., R. 22 E. Sec. 34	46th St. City of Kenosha	88.56	O	45	1990
10	42-37-30	87-49-41	235,400	2,584,549	T. 2 N., R. 23 E. Sec. 18	1815 Birch Rd. Town of Somers	121.36	O	45	1990
11	42-35-02	87-49-07	220,488	2,587,482	T. 2 N., R. 23 E. Sec. 31	625 57th St. City of Kenosha	114.8	O	45	1990

[a]State Plane Coordinates are from the Wisconsin State Plane Coordinate System, South Zone, North American Datum of 1927. Coordinates are rounded to the nearest foot.

[b]Antenna Types: S=Sectoral, O=Omni. A Sectoral antenna uses a more complex antenna structure and transmits and receives over a sector with the total number of sectors covering a 360 degrees pattern. An Omnidirectional uses a monoplex antenna and receives and transmits over a 360 degree pattern.

Source: Federal Communications Commission, Universal Licensing System Cellular License Database, local municipalities of Kenosha County, Wisconsin and SEWRPC.

#109351 V1 - Location Table – T-Mobile-Kenosha (06/15/05)

Table 5

LOCATIONS AND SELECTED CHARACTERISTICS OF U.S. CELLULAR WIRELESS ANTENNAS IN KENOSHA COUNTY, WISCONSIN: 2005

Site Number (See Map 5)	Location						Antenna Characteristics			
	Geographic Coordinates		State Plane Coordinates[a]		U.S. Public Land Survey Township-Range-Section	Street Address	Height (feet)	Type[b]	Power (watts)	Frequency (Megahertz)
	Latitude	Longitude	North	East						
1	42-34-50	88-13-13	216,705	2,479,359	T. 1 N., R. 19 E. Sec. 2	33807 Geneva Rd. Town of Wheatland	180.4	S	100	890.01
2	42-31-40	88-16-08	197,198	2,466,668	T. 1 N., R. 19 E. Sec. 20	920 Lance Dr. Village of Twin Lakes	180.4	S	140.82	890.01
3	42-31-55.1	88-15-07.3	198,821	2,471,180	T. 1 N., R. 19 E. Sec. 21	236 E. Main St. Village of Twin Lakes	115.128	O	28	890.01
4	42-32-00	88-04-46	200,340	2,517,678	T. 1 N., R. 20 E. Sec. 24	23100 98th St. Town of Salem	121.36	S	140.82	890.01
5	42-31-13	88-05-54	195,466	2,512,696	T. 1 N., R. 20 E. Sec. 26	23913 Wilmot Rd. Town of Salem	59.04	S	10	890.01
6	42-31-14	88-10-44	195,083	2,490,982	T. 1 N., R. 20 E. Sec. 30	10720 Fox River Rd. Town of Salem	150.88	S	75	890.01
7	42-33-37	88-02-28	210,398	2,527,777	T. 1 N., R. 21 E. Sec. 8	19460 81st St. Town of Bristol	177.12	S	140.82	890.01
8	42-32-15.56	87-59-58.36	202,421	2,539,171	T. 1 N., R. 21 E. Sec.22	14401 Wilmot Rd. Town of Bristol	150.88	O	45	890.01
9	42-32-14.1	87-59-07.3	202,366	2,542,997	T. 1 N., R. 21 E. Sec. 23	14401 Wilmot Rd. Town of Bristol	149.896	S	90	890.01
10	42-34-41	87-50-34	218,194	2,581,030	T. 1 N., R. 22 E. Sec. 1	6203 28th Ave. City of Kenosha	99.056	O	100	890.01
11	42-33-03	87-53-32	207,935	2,567,967	T. 1 N., R. 22 E. Sec. 15	8600 Green Bay Rd. Village of Pleasant Prairie	249.28	O	100	890.01
12	42-30-57	87-49-22	195,664	2,587,007	T. 1 N., R. 22 E. Sec. 24	Sheridan Rd. Village of Pleasant Prairie	65.6	O	15	890.01
13	42-31-10.03	87-56-51.42	196,129	2,553,326	T. 1 N., R. 22 E. Sec. 30	11800 108th St. Village of Pleasant Prairie	88.888	S	140.82	890.01
14	42-31-38.82	87-51-13.24	199,680	2,578,570	T. 1 N., R. 23 E. Sec. 30	9915 39th Ave. Village of Pleasant Prairie	98.4	O	140.82	890.01
15	42-38-12	88-04-37	238,007	2,517,484	T. 2 N., R. 20 E. Sec. 13	1271 224th Ave. Town of Brighton	141.04	S	45	890.01
16	42-35-26	88-05-29	221,116	2,513,982	T. 2 N., R. 20 E. Sec. 35	4320 232nd Ave. Town of Brighton	164	O	50	890.01
17	42-39-07	87-57-22	244,346	2,549,854	T. 2 N., R. 21 E. Sec. 12	12209 7th St. Town of Paris	141.04	S	100	890.01
18	42-35-23	87-58-00	221,606	2,547,568	T. 2 N., R. 21 E. Sec. 36	4815 128th Ave. Town of Paris	98.4	S	45	890.01
19	42-37-01.1	87-52-28.3	232,153	2,572,120	T. 2 N., R. 22 E. Sec. 23	2380 47th Ave. City of Kenosha	299.792	S	75	890.01
20	42-35-04	87-51-41	220,392	2,575,959	T. 2 N., R. 22 E. Sec. 35	5619 44th Ave. City of Kenosha	78.72	O	45	890.01
21	42-36-37	87-49-28	230,062	2,585,661	T. 2 N., R. 23 E. Sec. 19	3000 Sheridan Rd. City of Kenosha	98.4	O	140.82	890.01

[a] *State Plane Coordinates are from the Wisconsin State Plane Coordinate System, South Zone, North American Datum of 1927. Coordinates are rounded to the nearest foot.*

[b] *Antenna Types: S=Sectoral, O=Omni. A Sectoral antenna uses a more complex antenna structure and transmits and receives over a sector with the total number of sectors covering a 360 degrees pattern. An Omnidirectional uses a monoplex antenna and receives and transmits over a 360 degree pattern.*

Source: Federal Communications Commission, Universal Licensing System Cellular License Database, local municipalities of Kenosha County, Wisconsin and SEWRPC.

#109363 V1 - Location Table – U.S. Cellular-Kenosha (06/15/05)

Table 6

LOCATIONS AND SELECTED CHARACTERISTICS OF VERIZON WIRELESS-WIRELESS ANTENNAS IN KENOSHA COUNTY, WISCONSIN: 2005

Site Number (See Map 6)	Location						Antenna Characteristics			
	Geographic Coordinates		State Plane Coordinates[a]		U.S. Public Land Survey Township-Range-Section	Street Address	Height (feet)	Type[b]	Power (watts)	Frequency (Megahertz)
	Latitude	Longitude	North	East						
1	42-34-50	88-13-13	216,705	2,479,359	T. 1 N., R. 19 E. Sec. 2	33807 Geneva Rd. Town of Wheatland	164	S	45	929.1125
2	42-31-40	88-16-08	197,198	2,466,668	T. 1 N., R. 19 E. Sec. 20	920 Lance Dr. Village of Twin Lakes	200.08	S	45	929.1125
3	42-34-17	88-05-38	214,117	2,513,469	T. 1 N., R. 20 E. Sec. 2	6969 236th Ave. Village of Paddock Lake	180.4	S	45	929.1125
4	42-31-14	88-10-44	195,083	2,490,982	T. 1 N., R. 20 E. Sec. 30	10720 Fox River Rd. Town of Salem	98.4	S	45	929.1125
5	42-31-25	87-52-32	198,131	2,572,710	T. 1 N., R. 22 E. Sec. 22	10300 57th Ave. Village of Pleasant Prairie	72.16	S	45	929.1125
6	42-38-26	88-06-42	239,210	2,508,110	T. 2 N., R. 20 E. Sec. 15	25000 Burlington Rd. Town of Brighton	167.28	S	45	929.1125
7	42-36-09	88-09-40	225,047	2,495,115	T. 2 N., R. 20 E. Sec. 29	3930 288th Ave. Town of Brighton	180.4	S	45	929.1125
8	42-39-03.1	87-55-50.3	244,121	2,556,714	T. 2 N., R. 22 E. Sec. 8	BTC Tower Town of Somers	98.4	S	45	929.1125

[a] *State Plane Coordinates are from the Wisconsin State Plane Coordinate System, South Zone, North American Datum of 1927. Coordinates are rounded to the nearest foot.*

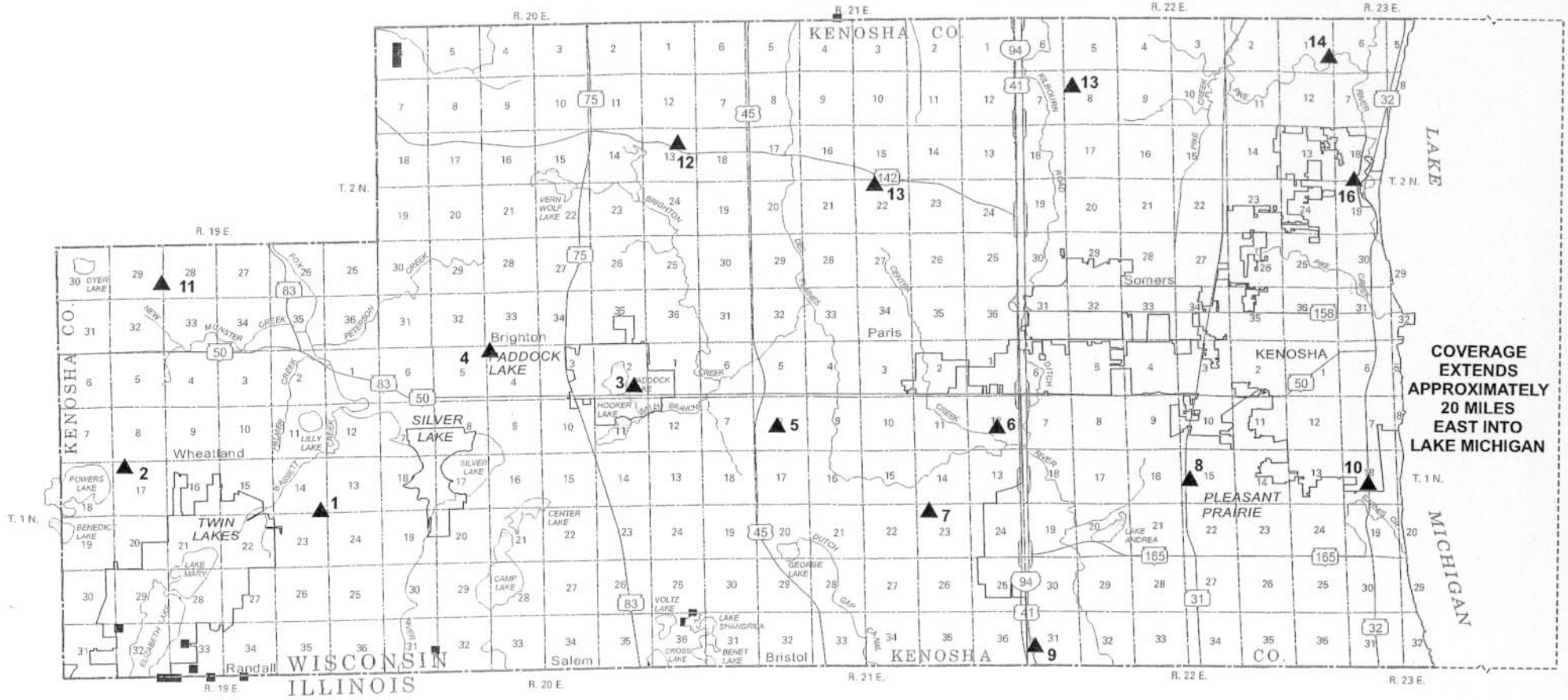
[b] *Antenna Types: S=Sectoral, O=Omni. A Sectoral antenna uses a more complex antenna structure and transmits and receives over a sector with the total number of sectors covering a 360 degrees pattern. An Omnidirectional uses a monoplex antenna and receives and transmits over a 360 degree pattern.*

Source: Federal Communications Commission, Universal Licensing System Cellular License Database, local municipalities of Kenosha County, Wisconsin and SEWRPC.

#109365 V1 - Location Table – Verizon Wireless-Kenosha (06/16/05)

Map 1

ANTENNA SITE LOCATIONS AND RADIO PROPAGATION COVERAGE FOR CINGULAR WIRELESS IN KENOSHA COUNTY, WISCONSIN: 2005



▲ ANTENNA SITE

5 IDENTIFICATION NUMBER (SEE TABLE 1)

RECEIVED POWER AT REMOTE GREATER THAN-80.0 dBmW

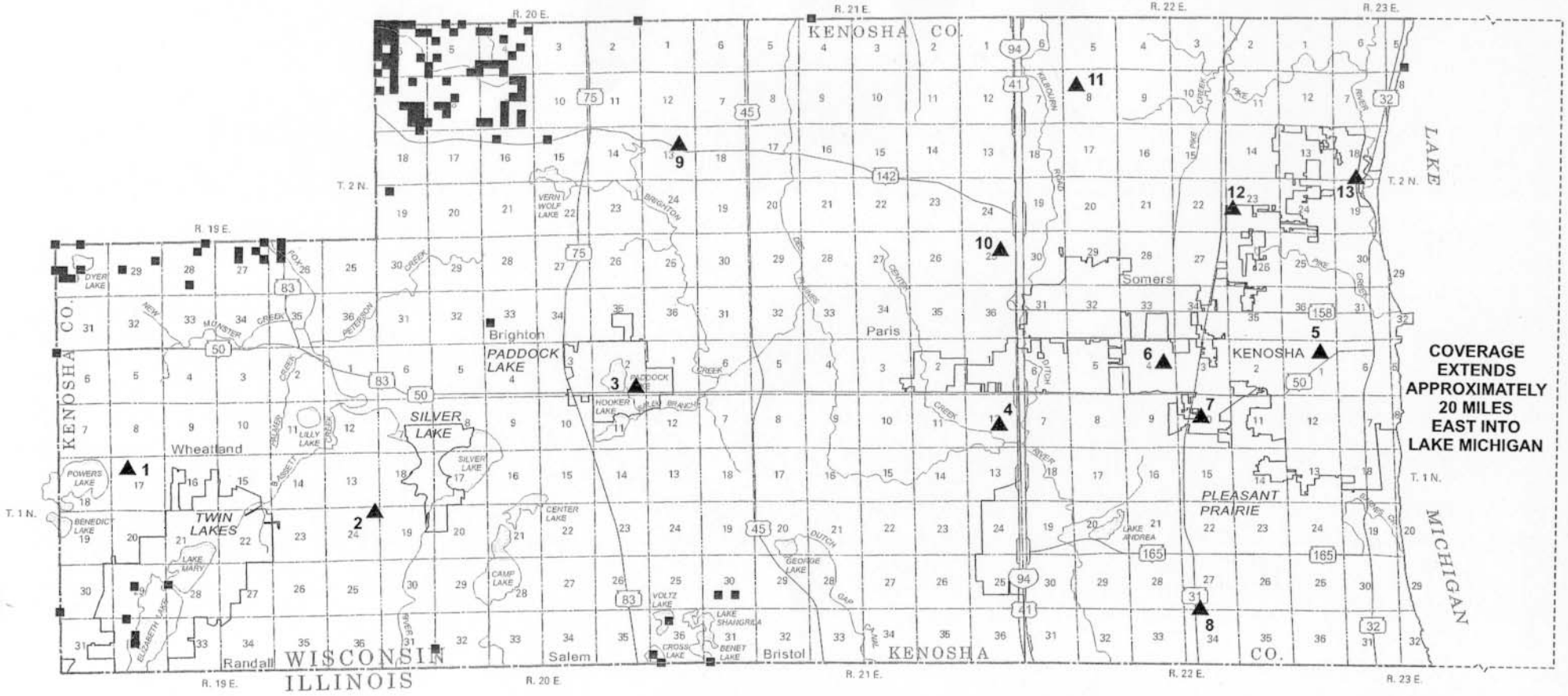
RECEIVED POWER AT REMOTE LESS THAN-80.0 dBmW

GRAPHIC SCALE

Source: SEWRPC.

Map 2

ANTENNA SITE LOCATIONS AND RADIO PROPAGATION COVERAGE FOR NEXTEL WIRELESS IN KENOSHA COUNTY, WISCONSIN: 2005



▲ ANTENNA SITE

5 IDENTIFICATION NUMBER (SEE TABLE 2)

RECEIVED POWER AT REMOTE GREATER THAN-80.0 dBmW

RECEIVED POWER AT REMOTE LESS THAN-80.0 dBmW

GRAPHIC SCALE

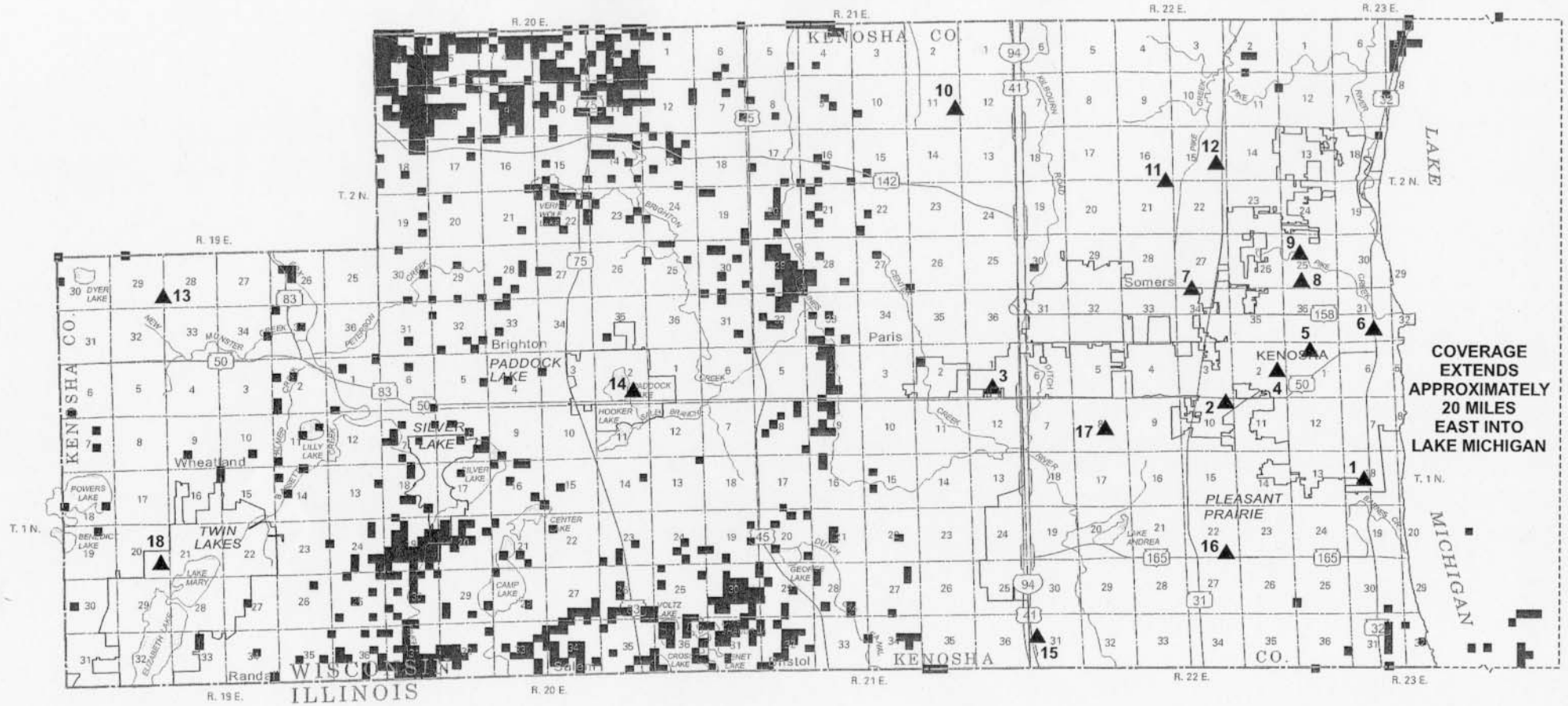
0 1 2 MILE

0 4,000 8,000 12,000 16,000 FEET

Source: SEWRPC.

Map 3

ANTENNA SITE LOCATIONS AND RADIO PROPAGATION COVERAGE FOR SPRINT WIRELESS IN KENOSHA COUNTY, WISCONSIN: 2005



▲ ANTENNA SITE

5 IDENTIFICATION NUMBER (SEE TABLE 3)

RECEIVED POWER AT REMOTE GREATER THAN -80.0 dBmW

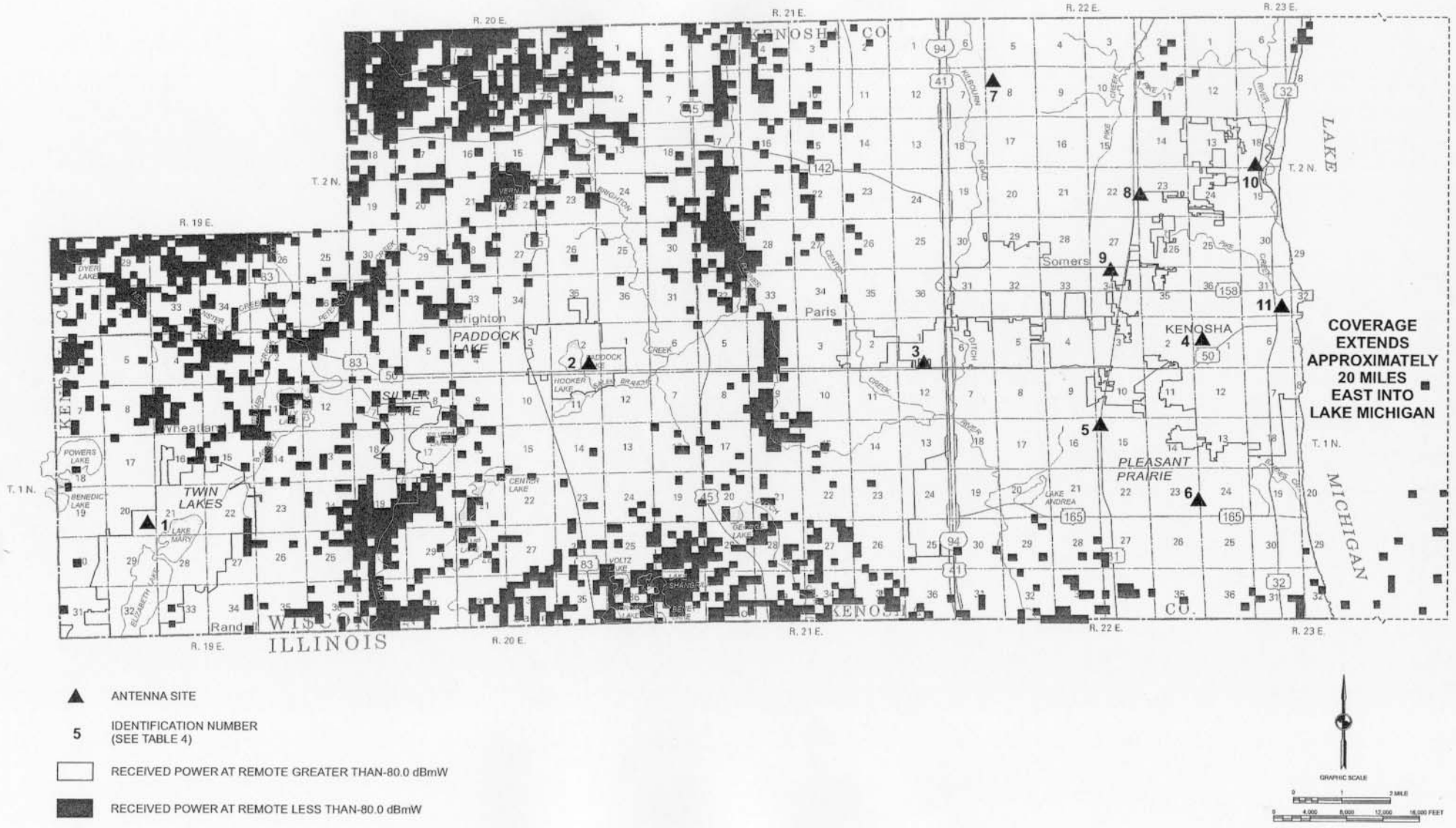
RECEIVED POWER AT REMOTE LESS THAN -80.0 dBmW

GRAPHIC SCALE

Source: SEWRPC.

Map 4

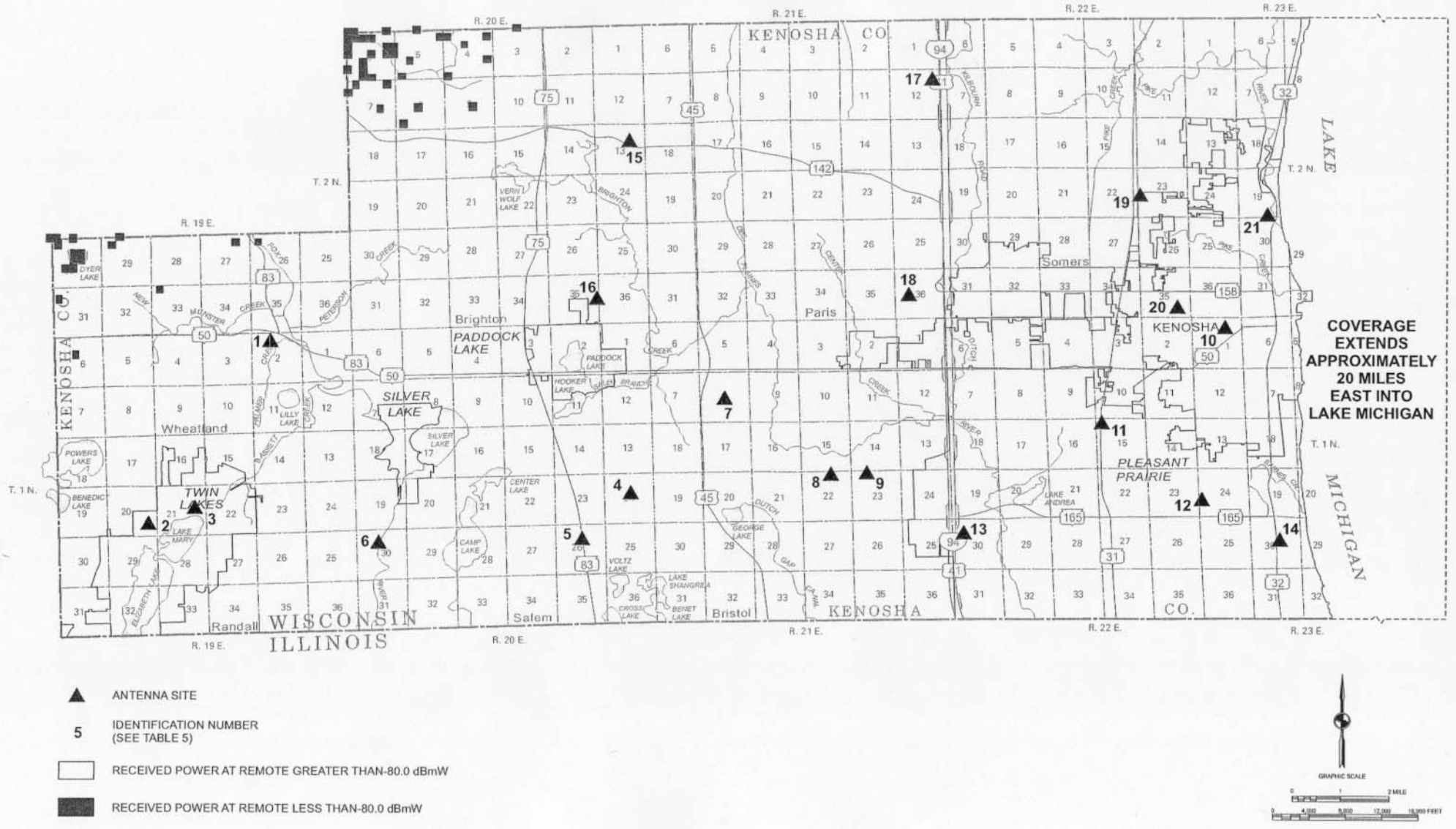
ANTENNA SITE LOCATIONS AND RADIO PROPAGATION COVERAGE FOR T-MOBILE WIRELESS IN KENOSHA COUNTY, WISCONSIN: 2005



Source: SEWRPC.

Map 5

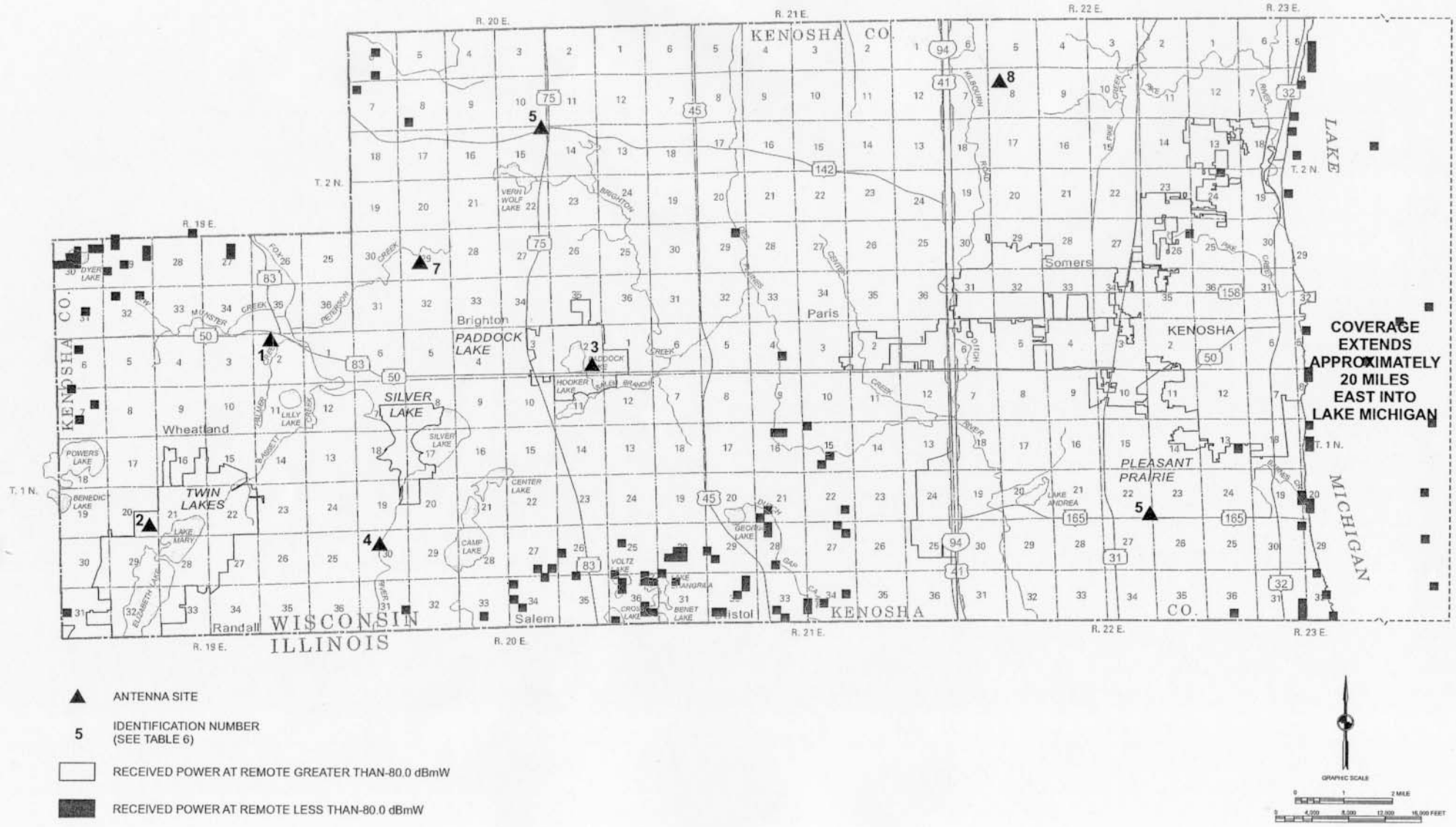
ANTENNA SITE LOCATIONS AND RADIO PROPAGATION COVERAGE FOR U.S. CELLULAR WIRELESS IN KENOSHA COUNTY, WISCONSIN: 2005



Source: SEWRPC.

Map 6

ANTENNA SITE LOCATIONS AND RADIO PROPAGATION COVERAGE FOR VERIZON WIRELESS IN KENOSHA COUNTY, WISCONSIN: 2005



▲ ANTENNA SITE

5 IDENTIFICATION NUMBER (SEE TABLE 6)

RECEIVED POWER AT REMOTE GREATER THAN-80.0 dBmW

RECEIVED POWER AT REMOTE LESS THAN-80.0 dBmW

GRAPHIC SCALE

Source: SEWRPC.

Map 7

ANTENNA SITE LOCATIONS IN KENOSHA COUNTY, WISCONSIN: 2005

Source: SEWRPC.