



**ENGINEERING EXHIBIT**

**APPLICATION FOR CONSTRUCTION PERMIT  
TO CHANGE DAYTIME ANTENNA  
AND INCREASE DAYTIME POWER**

**MIDWEST COMMUNICATIONS, INC.  
WGEE(AM), GREEN BAY, WISCONSIN**

**NOVEMBER 2002**

Prepared by:

**Evans Associates  
Consulting Communications Engineers  
210 S. Main Street  
Thiensville, WI 53092  
(262) 242-6000 • Fax (262) 242-6045  
E-mail: [hen@evansassoc.com](mailto:hen@evansassoc.com)  
[www.evansassoc.com](http://www.evansassoc.com)**



## **ENGINEERING STATEMENT**

This engineering statement, the attached figures, and all calculations relating thereto have been prepared by or under the direction of B. Benjamin Evans, P.E. of Evans Associates, Consulting Communications Engineers in Thiensville, Wisconsin. This exhibit has been prepared on behalf of Midwest Communications, Inc., licensee of AM broadcast station WGEE assigned to Green Bay, Wisconsin. Evans Associates has been retained by Midwest to prepare the instant engineering exhibit specifying a daytime power increase to 10 kilowatts, and to change the daytime antenna parameters of the existing non-directional operation to utilize two of the nighttime towers in the directional mode (DA-2). Accordingly, this application constitutes a minor change under FCC Rules. The nighttime operation of the station will not be changed under this proposal.

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### **PRELIMINARY**

WGEE presently operates on 1360 kHz with 5 kW of power daytime using a single tower, and 5 kW at night, using a 4-tower array (DA-N). The present nighttime operation would not be changed by this proposal. The day antenna system, as proposed herein, consists of two of the existing towers (towers 2 and 4) operating with current ratios and phases as described in attached Figure 6, with a power increase to 10 kW. The instant application does not constitute a major environmental action, since no additional tower construction is proposed, no strobe lights are to be used, and there will be no radiation hazard.

### **RF EXPOSURE CONSIDERATIONS**

A fence with a two-meter inscribed radius will be erected around each of Towers 1 through 4, with a locked gate and warning signs. These fences will keep the RF exposure level below ANSI limits for the general public. Service personnel inside the fence or on the towers will be protected by timed exposure, power reduction, or complete power turn-off.

### **SIGNAL COVERAGE**

The proposed predicted 5 mV/m daytime contour extends well beyond the present 5 mV/m in most directions including the direction towards Green Bay, the community of license. The proposed facility will easily serve Green Bay with a 5 mV/m signal daytime.



## **DAYTIME ALLOCATIONS**

At present, there is grandfathered contour overlap between WGEE and two other stations: WPDR, 1350 KHz in Portage, WI, and WLBK, 1360 KHz, De Kalb, IL (see attached Figure 2). The daytime operation proposed herein for WGEE would not increase these overlaps nor create areas of overlap that do not now exist. This proposal respects the contour protection provisions of §73.37 with respect to all other stations within 30 KHz of 1360 KHz. All daytime contours shown in the attachments have been determined using M-3 conductivities.

## **MULTIPLE OWNERSHIP STUDY**

Figure 8, attached, shows the community service contours of all the Midwest stations in northeastern Wisconsin. The present 5 mV/m daytime contour of WGEE is shown, as well as the proposed WGEE 5 mV/m contour. At present, WGEE overlaps all other Midwest stations except WBFM and WHBZ. WGEE, as modified herein, would not overlap either WBFM or WHBZ. Thus, this proposal is in compliance with §73.3555 of the FCC Rules.

This statement and attached figures are true and accurate to the best of my knowledge and belief.



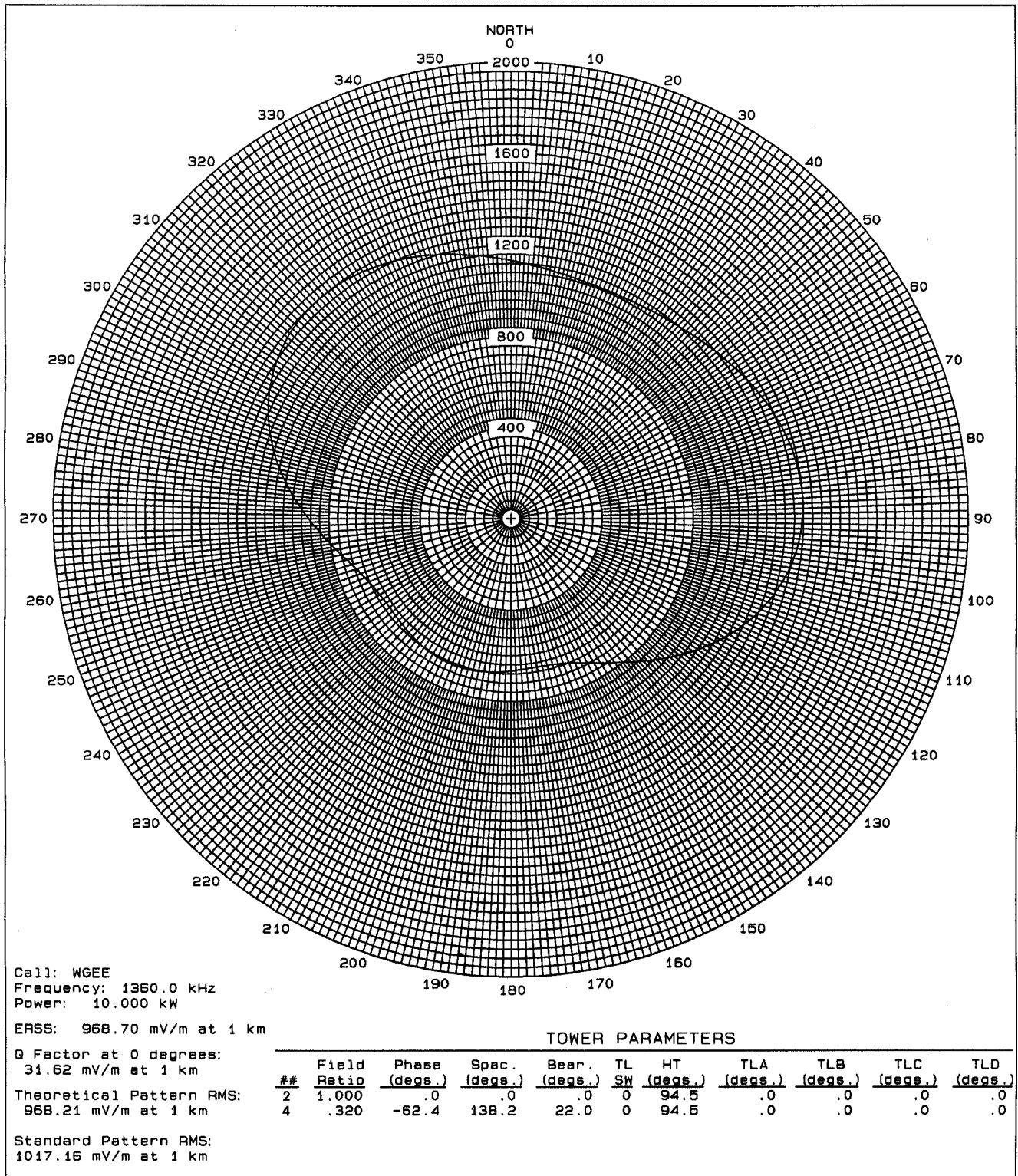
B. Benjamin Evans, P.E.  
Consulting Engineer for Midwest Communications, Inc.

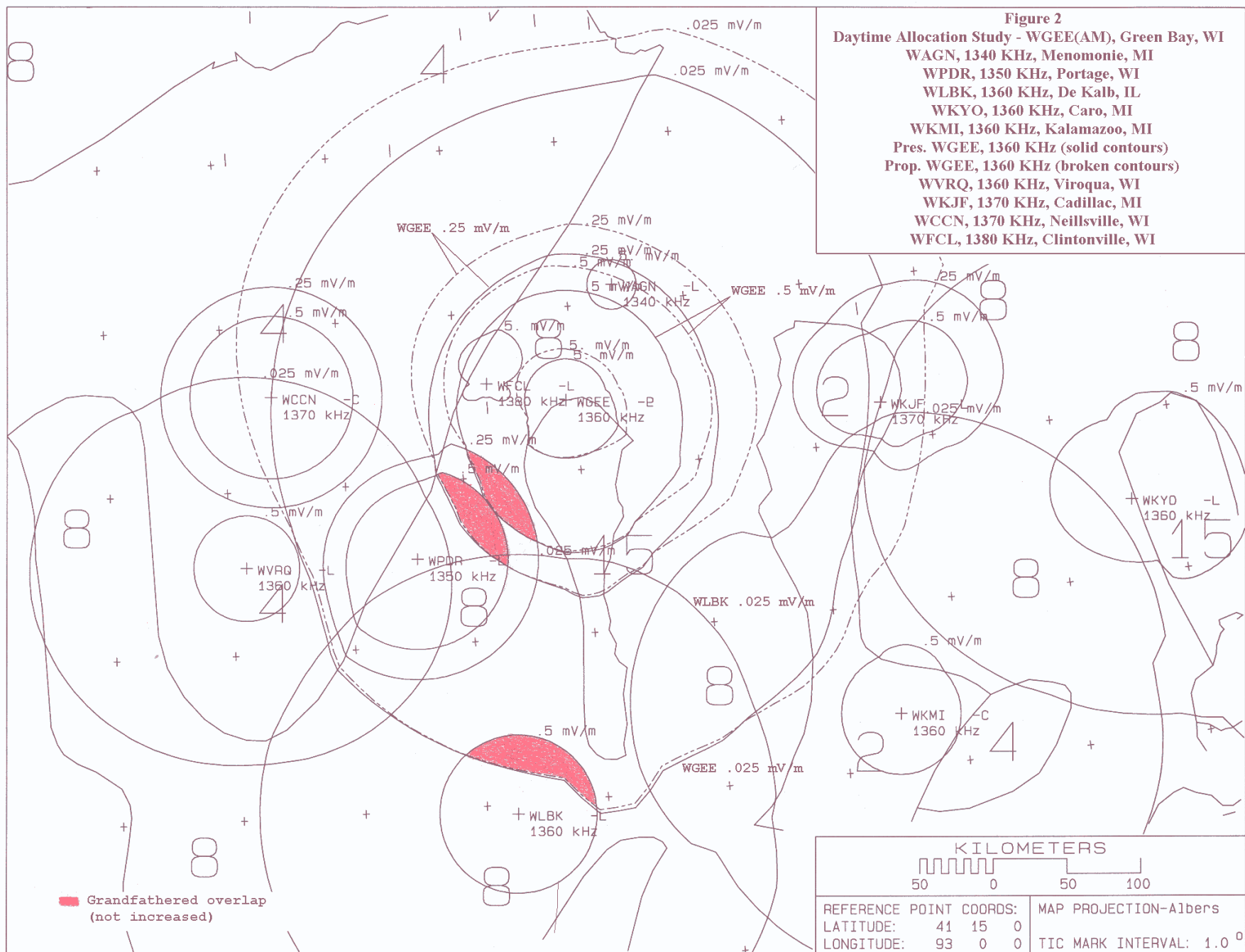
November 14, 2002

## **ATTACHED FIGURES:**

- Figure 1 - - - Daytime Directional Standard Pattern Polar Plot
- Figure 2 - - - Daytime Allocation Study
- Figure 3 - - - Present and Proposed Daytime Contours
- Figure 4 - - - Proposed Day 1000 mV/m Contour
- Figure 5 - - - Distances to WGEE Present and Proposed Daytime Contours
- Figure 6 - - - Daytime Directional Antenna Design Formulae
- Figure 7 - - - Specifications of Proposed Daytime Pattern

*Proposed Daytime Standard Pattern  
WGEE(AM), Green Bay, WI*





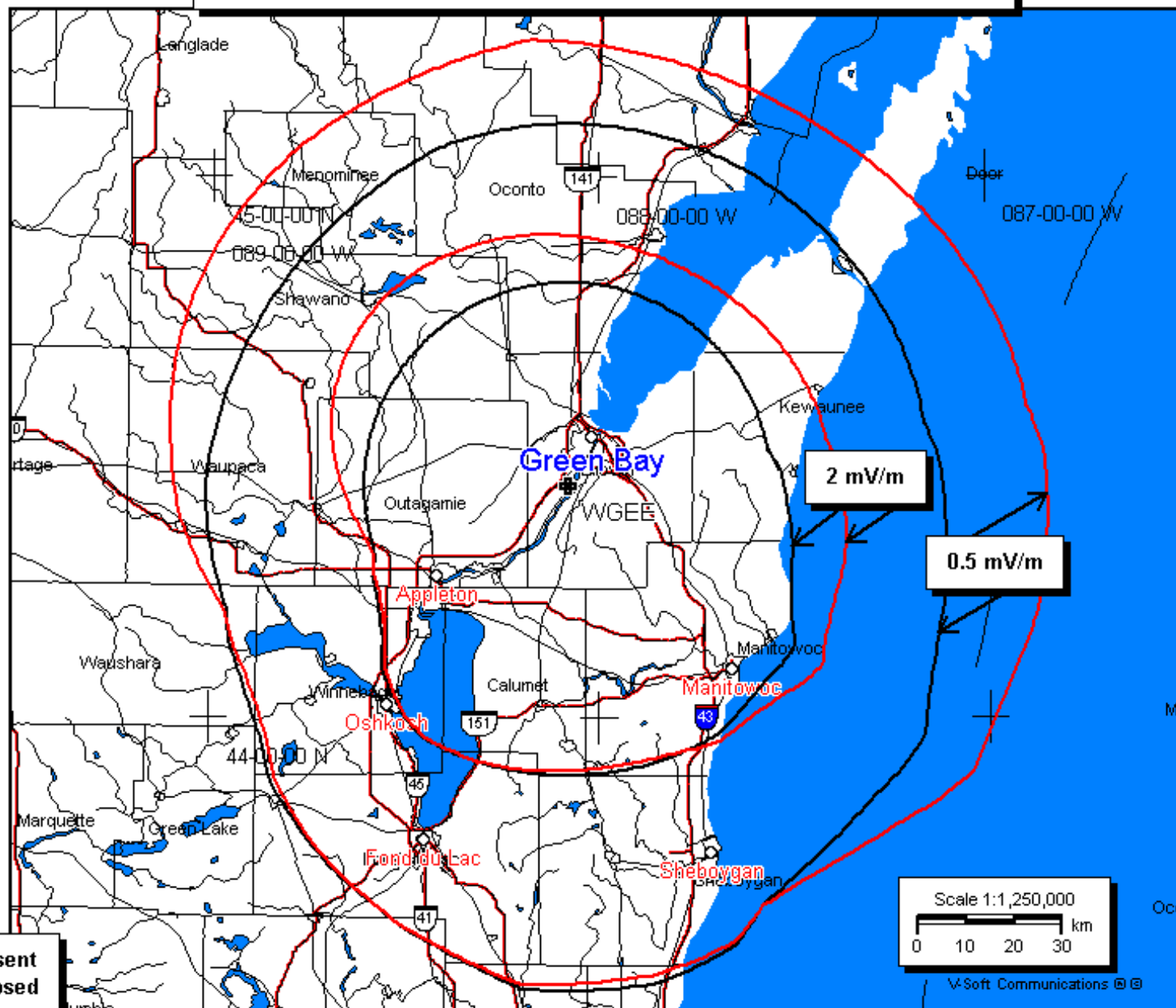
**Figure 3-A : WGEE(AM) Present & Proposed Daytime Contours**

**WGEE-L**

Latitude: 44-25-51 N  
 Longitude: 088-04-51 W  
 Power: 5.0 kW  
 Frequency: 1.36 MHz  
 Horiz. Pattern: ND  
 Vert. Pattern: No  
 Prop Model: FCC  
 Conductivity: M-3

**WGEE-P**

Latitude: 44-25-51 N  
 Longitude: 088-04-51 W  
 Power: 10.0 kW  
 Frequency: 1.36 MHz  
 Horiz. Pattern: DA  
 Vert. Pattern: No  
 Prop Model: FCC  
 Conductivity: M-3



**Black Contours - Present**  
**Red Contours - Proposed**

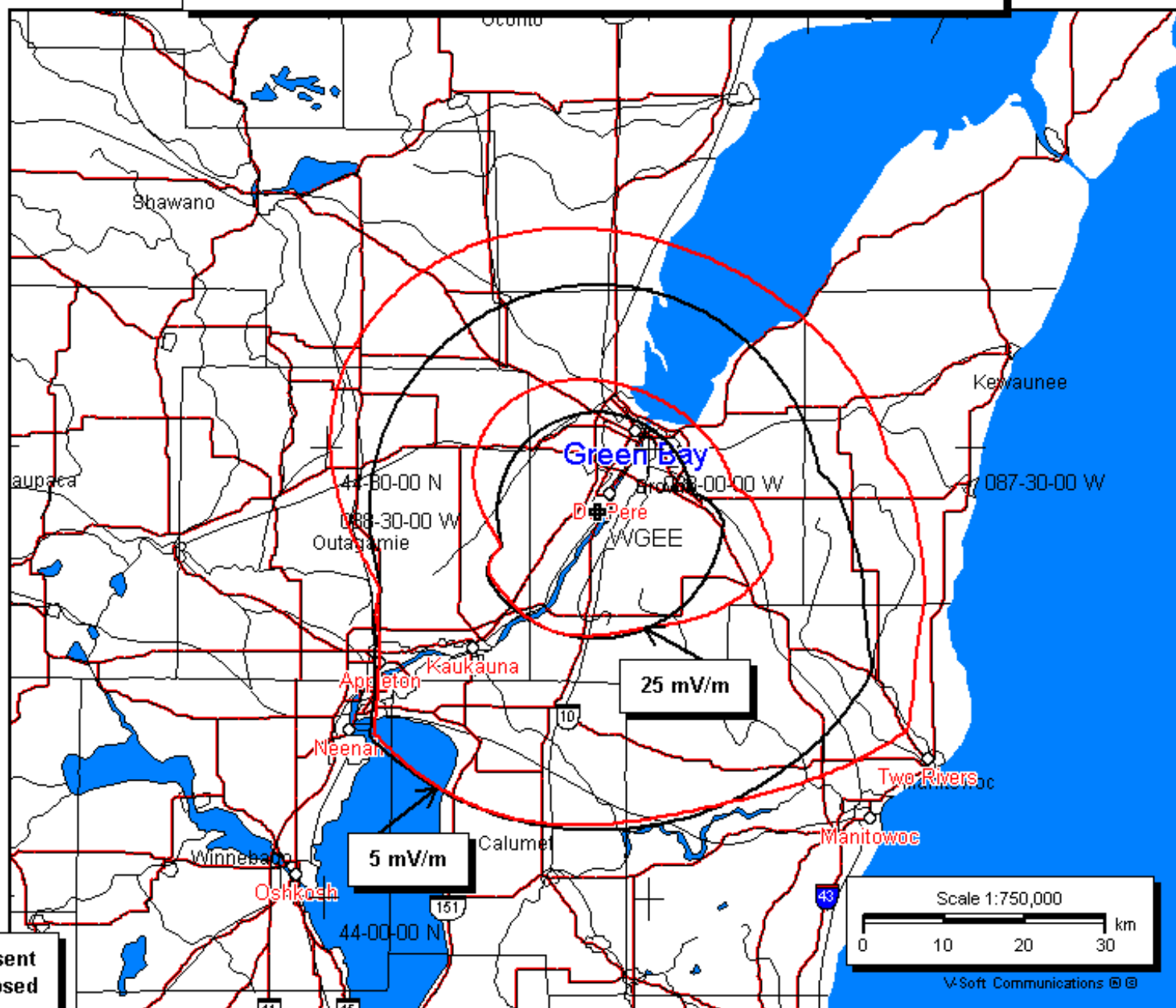
**Figure 3-B : WGEE(AM) Present & Proposed Daytime Contours**

**WGEE-L**

Latitude: 44-25-51 N  
Longitude: 088-04-51 W  
Power: 5.0 kW  
Frequency: 1.36 MHz  
Horiz. Pattern: ND  
Vert. Pattern: No  
Prop Model: FCC  
Conductivity: M-3

**WGEE-P**

Latitude: 44-25-51 N  
Longitude: 088-04-51 W  
Power: 10.0 kW  
Frequency: 1.36 MHz  
Horiz. Pattern: DA  
Vert. Pattern: No  
Prop Model: FCC  
Conductivity: M-3



**Black Contours - Present**  
**Red Contours - Proposed**

Scale 1:750,000

0 10 20 30 km

V-Soft Communications ©



**Figure 5-A**

**DISTANCES TO PRESENT DAYTIME CONTOURS  
WGEE(AM), 1360 KHz, GREEN BAY, WI**

Coordinates: N 44°-25'-51", W 88°-04'-51"

Azimuth (deg.)	Radiation (mV/m at one km)	Distances to Contours in Kilometers :				
		Contour levels in mV/m.				
		1000.000	25.000	5.000	2.000	.500
.0	690.92	.64	12.16	27.93	41.63	74.17
5.0	690.92	.64	12.16	27.93	41.63	74.17
10.0	690.92	.64	12.16	27.93	41.63	74.17
15.0	690.92	.64	12.16	27.93	41.63	74.17
20.0	690.92	.64	12.16	27.93	41.63	74.17
25.0	690.92	.64	12.16	27.93	41.63	74.17
30.0	690.92	.64	12.16	27.93	41.63	74.17
35.0	690.92	.64	12.16	27.93	41.63	74.17
40.0	690.92	.64	12.16	27.93	41.63	74.17
45.0	690.92	.64	12.16	27.93	41.63	74.17
50.0	690.92	.64	12.16	27.93	41.63	74.17
55.0	690.92	.64	12.16	27.93	41.63	74.17
60.0	690.92	.64	12.16	27.93	41.63	74.17
65.0	690.92	.64	12.16	27.93	41.63	74.17
70.0	690.92	.64	12.16	27.93	41.63	74.17
75.0	690.92	.64	12.16	27.93	41.63	74.17
80.0	690.92	.64	12.16	27.93	41.63	74.17
85.0	690.92	.64	14.09	29.85	43.55	76.10
90.0	690.92	.66	14.97	30.73	44.43	76.97
95.0	690.92	.66	15.77	31.53	45.23	77.78
100.0	690.92	.66	15.80	32.85	46.55	79.10
105.0	690.92	.66	15.80	34.11	47.81	80.36
110.0	690.92	.66	15.80	35.24	48.94	81.49
115.0	690.92	.66	15.80	36.87	50.57	83.11
120.0	690.92	.66	15.80	39.30	53.00	85.55
125.0	690.92	.66	15.80	39.46	56.85	89.39
130.0	690.92	.66	15.80	39.46	57.26	89.80
135.0	690.92	.66	15.80	39.46	56.95	89.49
140.0	690.92	.66	15.80	39.46	57.61	90.15
145.0	690.92	.66	15.80	39.46	58.76	91.31
150.0	690.92	.66	15.80	39.46	59.66	92.75
155.0	690.92	.66	15.80	39.46	59.66	94.91
160.0	690.92	.66	15.80	39.46	59.66	100.61
165.0	690.92	.66	15.80	39.46	59.66	102.27
170.0	690.92	.66	15.80	39.46	59.66	103.93
175.0	690.92	.66	15.80	39.46	59.66	103.93
180.0	690.92	.66	15.80	39.46	59.66	103.93
185.0	690.92	.66	15.80	39.46	59.66	103.93
190.0	690.92	.66	15.80	39.46	59.66	101.18
195.0	690.92	.66	15.80	39.46	59.66	98.76
200.0	690.92	.66	15.80	39.46	59.66	97.04

**DISTANCES TO PRESENT DAYTIME CONTOURS  
WGEE(AM), 1360 KHz, GREEN BAY, WI**

Coordinates: N 44°-25'-51", W 88°-04'-51"

Azimuth (deg.)	Radiation (mV/m at one km)	Distances to Contours in Kilometers :				
		Contour levels in mV/m.				
		1000.000	25.000	5.000	2.000	.500
205.0	690.92	.66	15.80	39.46	59.66	94.76
210.0	690.92	.66	15.80	39.46	59.66	92.93
215.0	690.92	.66	15.80	39.46	58.27	90.81
220.0	690.92	.66	15.80	39.46	55.95	88.49
225.0	690.92	.66	15.80	39.46	53.62	86.17
230.0	690.92	.66	15.80	35.68	49.38	81.93
235.0	690.92	.66	15.80	33.23	46.93	79.47
240.0	690.92	.66	15.55	31.32	45.02	77.56
245.0	690.92	.66	14.58	30.34	44.04	76.58
250.0	690.92	.66	12.40	28.16	41.86	74.41
255.0	690.92	.66	12.24	28.00	41.70	74.25
260.0	690.92	.66	12.20	27.96	41.66	74.20
265.0	690.92	.64	12.16	27.93	41.63	74.17
270.0	690.92	.64	12.16	27.93	41.63	74.17
275.0	690.92	.64	12.16	27.93	41.63	73.58
280.0	690.92	.64	12.16	27.93	41.63	72.97
285.0	690.92	.64	12.16	27.93	41.63	72.53
290.0	690.92	.64	12.16	27.93	41.63	72.19
295.0	690.92	.64	12.16	27.93	41.63	71.89
300.0	690.92	.64	12.16	27.93	41.63	71.71
305.0	690.92	.64	12.16	27.93	41.63	71.66
310.0	690.92	.64	12.16	27.93	41.63	71.73
315.0	690.92	.64	12.16	27.93	41.63	71.89
320.0	690.92	.64	12.16	27.93	41.63	72.11
325.0	690.92	.64	12.16	27.93	41.63	72.46
330.0	690.92	.64	12.16	27.93	41.63	72.95
335.0	690.92	.64	12.16	27.93	41.63	73.63
340.0	690.92	.64	12.16	27.93	41.63	74.17
345.0	690.92	.64	12.16	27.93	41.63	74.17
350.0	690.92	.64	12.16	27.93	41.63	74.17
355.0	690.92	.64	12.16	27.93	41.63	74.17



**Figure 5-B**

**DISTANCES TO PROPOSED DAYTIME CONTOURS  
WGEE(AM), 1360 KHz, GREEN BAY, WI**

Coordinates: N 44°-25'-51", W 88°-04'-51"

Azimuth (deg.)	Radiation (mV/m at one km)	Distances to Contours in Kilometers :				
		Contour levels in mV/m.				
		1000.000	25.000	5.000	2.000	.500
-----	-----	-----	-----	-----	-----	-----
.0	1132.46	1.02	16.09	34.76	51.19	90.98
5.0	1115.09	1.00	15.96	34.53	50.86	90.40
10.0	1101.58	.99	15.86	34.35	50.60	89.95
15.0	1092.45	.98	15.78	34.23	50.43	89.64
20.0	1088.05	.98	15.75	34.17	50.34	89.49
25.0	1088.54	.98	15.75	34.17	50.35	89.51
30.0	1093.90	.98	15.80	34.25	50.45	89.69
35.0	1103.94	.99	15.87	34.38	50.65	90.03
40.0	1118.28	1.00	15.99	34.57	50.92	90.51
45.0	1136.34	1.02	16.12	34.81	51.26	91.10
50.0	1157.32	1.04	16.28	35.09	51.65	91.79
55.0	1180.21	1.06	16.46	35.39	52.07	92.53
60.0	1203.77	1.07	16.64	35.69	52.50	93.28
65.0	1226.61	1.09	16.80	35.98	52.91	94.00
70.0	1247.17	1.11	16.95	36.24	53.28	94.64
75.0	1263.82	1.12	17.07	36.45	53.58	95.16
80.0	1274.98	1.13	17.15	36.59	53.77	95.50
85.0	1279.17	1.14	19.11	38.56	55.77	97.55
90.0	1275.14	1.20	19.95	39.39	56.58	98.31
95.0	1261.97	1.19	20.66	40.03	57.15	98.71
100.0	1239.17	1.17	21.82	41.06	58.06	99.32
105.0	1206.73	1.14	22.45	41.91	58.74	99.56
110.0	1165.20	1.10	21.98	42.51	59.11	99.36
115.0	1115.66	1.06	21.41	43.48	59.81	99.36
120.0	1059.74	1.01	20.76	45.15	61.17	99.91
125.0	999.56	.95	20.02	46.93	63.81	101.65
130.0	937.62	.89	19.24	45.58	62.95	99.81
135.0	876.71	.84	18.44	44.18	61.32	97.19
140.0	819.67	.78	17.67	42.81	60.71	95.61
145.0	769.19	.74	16.96	41.54	60.68	94.69
150.0	727.46	.70	16.35	40.45	60.99	94.37
155.0	695.86	.67	15.87	39.60	59.85	95.13
160.0	674.71	.65	15.55	39.01	59.06	99.87
165.0	663.19	.64	15.37	38.68	58.63	101.00
170.0	659.59	.64	15.32	38.57	58.50	102.09
175.0	661.70	.64	15.35	38.63	58.58	102.22
180.0	667.21	.64	15.44	38.79	58.78	102.54
185.0	674.05	.65	15.54	38.99	59.04	102.94
190.0	680.51	.65	15.64	39.17	59.28	100.71
195.0	685.38	.66	15.71	39.31	59.46	98.51
200.0	687.85	.66	15.75	39.38	59.55	96.90

**Figure 5-B**

**DISTANCES TO PROPOSED DAYTIME CONTOURS  
WGEE(AM), 1360 KHz, GREEN BAY, WI**

Coordinates: N 44°-25'-51", W 88°-04'-51"

Azimuth (deg.)	Radiation (mV/m at one km)	Distances to Contours in Kilometers :				
		Contour levels in mV/m.				
		1000.000	25.000	5.000	2.000	.500
205.0	687.57	.66	15.75	39.37	59.54	94.61
210.0	684.58	.66	15.70	39.28	59.43	92.65
215.0	679.31	.65	15.62	39.14	57.97	90.28
220.0	672.66	.65	15.52	38.95	55.48	87.66
225.0	665.94	.64	15.42	38.76	52.98	85.03
230.0	660.94	.64	15.34	35.12	48.61	80.56
235.0	659.78	.64	15.32	32.65	46.12	78.05
240.0	664.79	.64	15.28	30.83	44.34	76.37
245.0	678.13	.65	14.44	30.10	43.71	76.00
250.0	701.34	.67	12.51	28.35	42.13	74.88
255.0	735.02	.70	12.69	28.79	42.80	76.18
260.0	778.64	.74	13.08	29.51	43.81	77.98
265.0	830.63	.76	13.54	30.34	44.98	79.64
270.0	888.67	.81	14.07	31.26	46.27	80.58
275.0	950.02	.86	14.61	32.20	47.57	81.52
280.0	1011.82	.91	15.13	33.10	48.84	82.60
285.0	1071.34	.96	15.62	33.94	50.02	83.74
290.0	1126.14	1.01	16.05	34.68	51.07	84.81
295.0	1174.19	1.05	16.41	35.31	51.96	85.71
300.0	1213.97	1.08	16.71	35.82	52.69	86.50
305.0	1244.51	1.11	16.93	36.21	53.23	87.18
310.0	1265.36	1.13	17.08	36.47	53.60	87.75
315.0	1276.65	1.13	17.16	36.61	53.80	88.18
320.0	1278.95	1.14	17.18	36.63	53.84	88.45
325.0	1273.26	1.13	17.14	36.56	53.74	88.66
330.0	1260.88	1.12	17.05	36.41	53.52	88.87
335.0	1243.31	1.11	16.92	36.19	53.21	89.13
340.0	1222.18	1.09	16.77	35.92	52.84	89.51
345.0	1199.07	1.07	16.60	35.63	52.42	90.05
350.0	1175.53	1.05	16.42	35.33	51.99	90.85
355.0	1152.93	1.03	16.25	35.03	51.57	91.65

## **Directional Antenna Design Formula**

**For**  
**Proposed WGEE 1360 KHz - Day**  
**Green Bay, Wisconsin**

### **PATTERN SHAPE DATA**

(See Radiation Pattern Polar Plot for Information on Tower Nomenclature)

$$1) \quad E(\varnothing, \theta)_{\text{theo}} = \left| E_r \sum_{i=1}^n F_i f_i(\theta) \frac{S_i \cos \theta \cos(\varnothing_i - \varnothing) + \psi_i}{\quad} \right|$$

$$2) \quad E(\varnothing, \theta)_{\text{std}} = 1.05 \sqrt{E(\varnothing, \theta)_{\text{theo}}^2 + Q^2}$$

where:

$n$  = number of towers employed; for this application = 2.  $r$  is reference tower.

$i$  =  $i^{\text{th}}$  element in the array

$\theta$  = vertical elevation angle from the horizontal plane

$\varnothing$  = azimuth angle from array vector reference (true north).

$E_r$  = field radiated by reference tower

$E(\varnothing, \theta)_{\text{th}}$  = theoretical inverse distance field at one mile for  $\varnothing$  and  $\theta$ .

$E(\varnothing, \theta)_{\text{std}}$  = theoretical field augmented by standard pattern, where  $Q$  is the greater of:

$.025g(\theta) E_{\text{rss}}$  ---- value for  $\theta = 0^\circ$  is \_\_\_\_\_ mv/m at 1 km

or  
 $10.0g(\theta) \sqrt{P_{\text{kw}}}$  ---- value for  $\theta = 0^\circ$  is 31.62 mv/m at 1 km

where:  $g(\theta)$  is the vertical plane distribution factor  $f(\theta)$  of the shortest element. If  $>180^\circ$  then

$$g(\theta) = \sqrt{f(\theta)^2 + .0625/1.030776}$$

$E_{\text{rss}}$  = root-sum-square of radiated fields of individual elements.

$P_{\text{kw}}$  = nominal power in kilowatts (if less than one, then  $P_{\text{kw}} = 1$ ).

$f(\theta)_i$  = vertical radiation characteristic of  $i^{\text{th}}$  element, equal to:  $\frac{\cos(G_i \sin \theta) - \cos G_i}{(1 - \cos G_i) \cos \theta}$

where  $G_i$  = electrical height of element  $i$ , in degrees.

### ARRAY PARAMETERS

$F_i$  = field ratio of  $i^{\text{th}}$  element with respect to reference element.

$\psi_i$  = electrical phase of  $i^{\text{th}}$  element with respect to reference element.

$S_i$  = electrical spacing of  $i^{\text{th}}$  element from reference point.

$\theta_i$  = orientation of  $i^{\text{th}}$  element, measured from true north, with respect to reference point.

### ARRAY PARAMETERS:

<u>Twr #</u>	<u>FIELD</u>	<u>PHASE</u>	<u>SPACE</u>	<u>ORIENT</u>	<u>G</u>
2	1.000	0.0	0.0	0.0	94.5
4	.320	-62.4	138.2	22.0	94.5

Space Reference = Tower #1

Orientation Reference = True North through Tower #1

### PATTERN SIZE DATA

#### SELF-LOOP RESISTANCES OF ELEMENTS:

**$R_o = 42$  ohms (all towers)**

Assumed Loop Loss per Element = 1 ohm

#### MUTUAL IMPEDANCES OF PAIRS OF ELEMENTS:

Calculated using the formulas in paper entitled "Theory and Design of Directional Antennas" by Carl E. Smith, E.E., ©1949 by NAB, First Edition, Page 2-1-19.

3) Operating theoretical loop resistance of antenna  $i$ , for zero reactance:

$$R_i = R_{oi} + \sum_{\substack{k=1 \\ k \neq i}}^n F_{ki} \cos(M_{ki} \angle \frac{\alpha_{ki} + \psi_{ki}}{2}) - \text{where } M_{ki} \angle \frac{\alpha_{ki}}{2} = \text{mutual impedance between elements } k \text{ and } i.$$

4) Reference tower loop current  $I_r$ :

$$I_r = \sqrt{\frac{P}{R_r + \sum_{\substack{k=1 \\ k \neq r}}^n F_k^2 R_k}} \quad \text{Where } R_r = \text{loop resistance of reference tower}$$

5) Field radiated by reference tower:

$$E_r = 37.282 I_r (1 - \cos G_r)$$

$$E_{rss} = \underline{968.70} \text{ mv/m at one kilometer (by computer calculation).}$$

$$E_{rms (th)} = \text{theoretical pattern RMS} = \underline{968.21} \text{ mv/m at one kilometer (by computer calculation, using numerical integration in the hemispherical field).}$$

$$E_{rms (std)} = \text{standard pattern RMS} = \underline{1017.16} \text{ mv/m at one kilometer.}$$

$$\text{Power Level} = \underline{10.0} \text{ KW}$$

$$E_r = \underline{573.28} \text{ mv/m at one mile, or } \underline{922.61} \text{ mv/m at one kilometer}$$

$$I_r = \underline{14.3} \text{ amps}$$



**Figure 7**

## SPECIFICATIONS OF PROPOSED DAYTIME PATTERN

Call: WGEE                      Frequency: 1360.0 kHz

Power:    10.000 kW

ERSS:    968.70 mV/m at 1 km

Multiplying Constant (K factor):    922.61 mV/m at 1 km

Q Factor (elevation angle = 0 degrees):    31.62

Theoretical Pattern RMS:    968.21 mV/m at 1 km

Standard Pattern RMS: 1017.16 mV/m at 1 km

### ANTENNA TOWER PARAMETERS:

Twr #	Field Ratio	Phase (degs.)	Spac. (degs.)	Bear. (degs.)	TL SW	HT (degs.)	TLA (degs.)	TLB (degs.)	TLC (degs.)	TLD (degs.)
2	1.000	.0	.0	.0	0	94.5	.0	.0	.0	.0
4	.320	-62.4	138.2	22.0	0	94.5	.0	.0	.0	.0

CALCULATED STANDARD PATTERN RADIATIONS (in mV/m at 1 km)							
Elevation Angle = 0°							
Az.(°T)	Rad.(mV/m)	Az.(°T)	Rad.(mV/m)	Az.(°T)	Rad.(mV/m)	Az.(°T)	Rad.(mV/m)
.0	1132.46	90.0	1275.14	180.0	667.21	270.0	888.67
5.0	1115.09	95.0	1261.97	185.0	674.05	275.0	950.02
10.0	1101.58	100.0	1239.17	190.0	680.51	280.0	1011.82
15.0	1092.45	105.0	1206.73	195.0	685.38	285.0	1071.34
20.0	1088.05	110.0	1165.20	200.0	687.85	290.0	1126.14
25.0	1088.54	115.0	1115.66	205.0	687.57	295.0	1174.19
30.0	1093.90	120.0	1059.74	210.0	684.58	300.0	1213.97
35.0	1103.94	125.0	999.56	215.0	679.31	305.0	1244.51
40.0	1118.28	130.0	937.62	220.0	672.66	310.0	1265.36
45.0	1136.34	135.0	876.71	225.0	665.94	315.0	1276.65
50.0	1157.32	140.0	819.67	230.0	660.94	320.0	1278.95
55.0	1180.21	145.0	769.19	235.0	659.78	325.0	1273.26
60.0	1203.77	150.0	727.46	240.0	664.79	330.0	1260.88
65.0	1226.61	155.0	695.86	245.0	678.13	335.0	1243.31
70.0	1247.17	160.0	674.71	250.0	701.34	340.0	1222.18
75.0	1263.82	165.0	663.19	255.0	735.02	345.0	1199.07
80.0	1274.98	170.0	659.59	260.0	778.64	350.0	1175.53
85.0	1279.17	175.0	661.70	265.0	830.63	355.0	1152.93

Figure 8 : Multiple Ownership Study - WGEE(AM) Green Bay WI

