EOC INTERFERENCE RATE OF DECAY WITH DISTANCE
May 14 to May 20 Data Capture and Analysis

Version 1.0
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Summary

Bottom line: Measurements in the front parking lot and near the SE corner of the EOC property indicate that **we can get enormously improved high frequency reception if we establish a simple antenna just a few scores of yards from the EOC building. Figure 1 shows that noise was reduced nearly to residential levels by moving less than 100 yards from the EOC.** Accordingly, tests should be performed among the oak trees south of the EOC, still on the EOC property, and in adjacent land southwest of the EOC. Very long coax runs are not a problem at all for a receiving antenna, and if the antenna can be used for both receiving and transmitting in either of those locations, we may have a very easy, and considerably effective, solution to our excess-20dB noise problem.

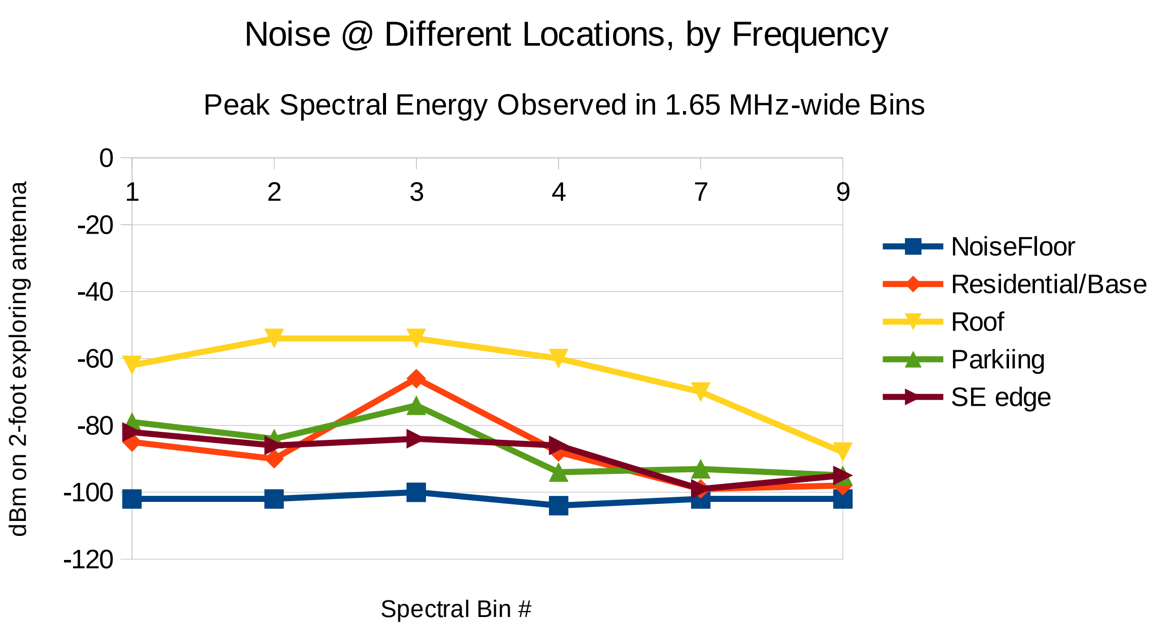

Figure 1. Graph of largest signal in each of 6 selected frequency segments, measured at different locations, using 2-foot dipole, 6dB external attenuator, appropriately taken into account. 100 kHz bandwidth for all measurements.

- Graph shows the Roof is roughly 20 dB more noisy than any of the other locations.
- **The fact that two other outside locations on EOC property are 20dB quieter proves that we could get 20 dB more receiver sensitivity by moving to an alternate receiver antenna.**
- Spectrum analyzer innate sensitivity for this setting is approximately -100 dBm (blue line)

- Residential driveway, EOC front parking, and SE property corner all have background/signal noise levels that are very similar, 5-20 dB stronger than spectrum analyzer sensitivity, may be related to unavoidable has from the battery powered Xantrex 120VAC inverter used for these tests

LONGER EXPLANATION

The spectra that I gathered on May 18 using a short 2-foot dipole at various locations, show very important results, **indicating we can get 20 dB less noise by just moving some antenna to the edges of the EOC property**, even though the full sensitivity of the spectrum analyzer couldn't be used due to some hash generated by my own Xantrex 120VAC inverter, which was needed to power the spectrum analyzer. (Shows how hard it is to deal with these problems…) ***Study Limitation: Cannot find the ultimate possible reduction in receiver noise, can only conclude that it should be 20dB or more.***

We need roughly 20 dB reduction in interference to have a reasonable chance of making backup HF (high frequency) radio connections directly from the EOC for either amateur radio or SHARES systems. This is because the hash that envelopes the EOC, including its roof (yellow plot below) is roughly 20 dB louder than baseline measurements at a residential house. 20 dB is a logarithmic measurement, another way of saying the roof antenna at the EOC is immersed in 100 times stronger interference than my residential antennas..

While we may be able to mitigate the production of that hash at the current location (with difficulty) or at a future location (by planning EMI filters as part of the power installation), there may be a work-around by developing a secondary antenna (for receiving or for both receiving and transmitting) some yards away from the EOC building and its power wiring. Measurements in a parking spot outside the front door were markedly better than on the roof; as were measurements on 27th Street SE, at the southeast edge of the EOC property.

Next Action Goal: Measurements among the oak trees on EOC property, south (behind) the EOC should be completed to see if an antenna can be placed there, and measurements south west of the EOC building on already-owned county land should also be made to see if an antenna could be placed there.

Is Coax Length A Problem?

Not for HF Receiving. The coax length needed to get a receiving antenna quite far away from the EOC is not a problem, because on lower HF frequencies, there is an abundance of both lightning and signals; the real limitation is to get the signal-to-noise ratio optimized. Because our signal to noise ratio is 20 dB worse than expected, we literally could use up to a mile of RG-8 coax and still have a better receiving situation (just not a better transmitting situation at that length).[1] (It would cause a very significant loss of transmitter power.)

NOTE: An increase of 20dB means the signal power increased by 100 times.
An increase of 40 dB means the signal power increased by 10,000 times

Bin #	Frequency Range
1	3.5 – 5.15 MHz
2	5.15 – 6.8 MHz
3	6.8 – 8.45 MHz
4	8.45-10.1 MHz
7	14.4 – 15.05 MHz
9	16.7 18.35 MHz

TABLE 1: Frequency limits of each "bin" or frequency segment utilized in Figure 1.

1Example: 7 MHz, Belden 9913 cable, 2:1 SWR assumed, 5000 feet, total loss 16.7 dB, https://www.qsl.net/co8tw/Coax_Calculator.htm

DETAILED EXPLANATION OF MEASUREMENT PROCESS

Previous measurements had indicated that the EOC HF receiver endures something on the order of 20 dB excess noise, over even what galactic/lightning noise levels normal are on the frequencies below 10 MHz. [2] Measurements on May 14th indicated that the most likely cause of this is not a misconnected transmission line, but actual locally-radiated noise from equipment within the EOC, which is present throughout much of the building and on the roof area. The existing antenna has inappropriately low-impedance problems that beset TRANSMISSION that are likely due to inadequate clearance from the roof, also, a separate issue.

To conveniently measure this added HF noise, a small 2-foot portable dipole hand-probe was developed, and used to make background measurements at a residential house, as well as inside the EOC and on the roof of the EOC, documenting vastly higher noise signal strength at the EOC. Narrow-band (3kHz bandwidth) measurements there showed pickup of noise with the portable dipole on the order of -114 dBm;[3] corrected to a 100kHz bandwidth, if the noise were "white noise" this would equate to -98 dBm received noise in the 80 meter band. (When a wider bandwidth is received, more noise is received, so a mathematical correction is required.)

The same 2-foot portable dipole was used to measure noise across a wider range of frequencies, arbitrarily chosen to be 3.5 – 20 MHz (as this covers the majority of emergency communications HF frequencies) with 100 kHz bandwidth (to allow rapid spectra capture), generally using a protective 6 dB physical external attenuator 50 ohm pad, and 0 – 10 dB (as required) internal attenuator to protect the spectrum analyzer A-to-D converter.

When this measurement was carried out on the roof of the EOC, an astonishingly noisy spectrum was revealed as shown in the following spectral plot.

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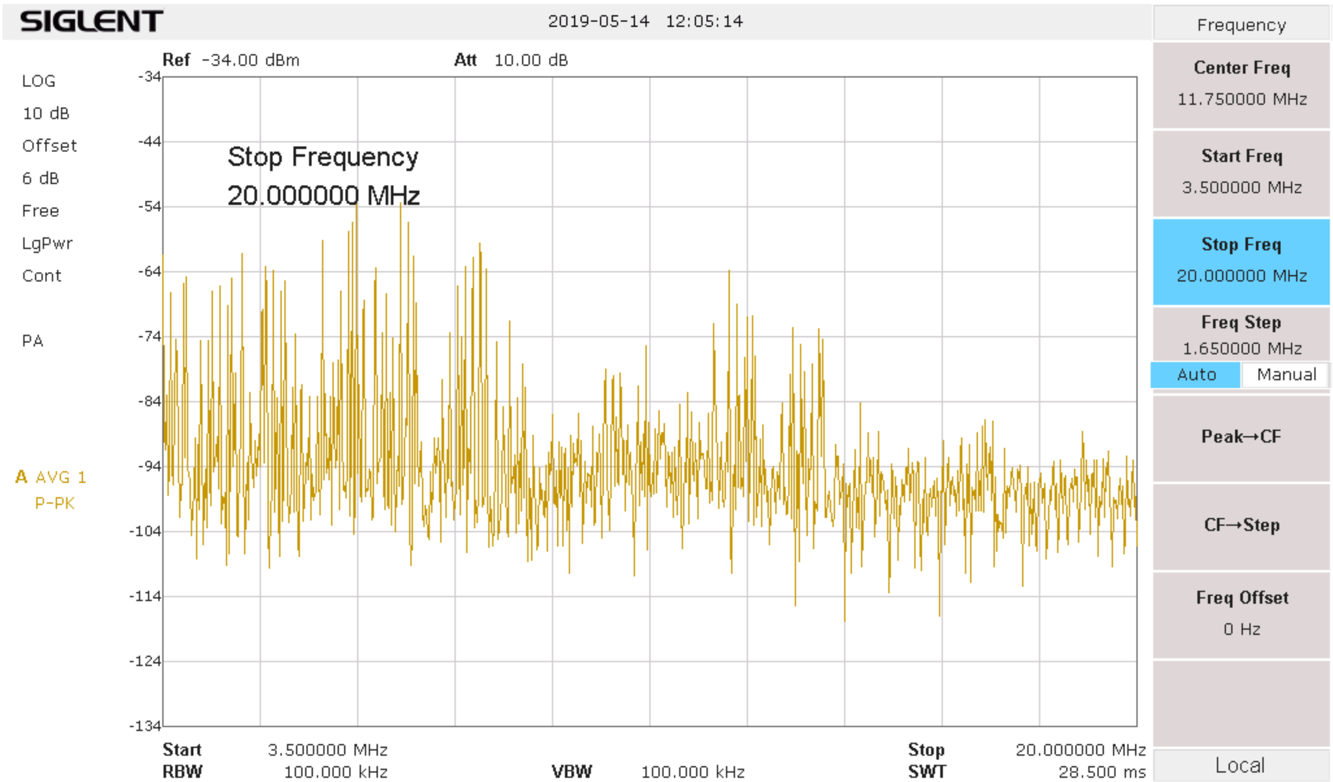
2 Compare the received spectra from a residential antenna https://qsl.net/nf4ac/2019/GibbyAntennaBaselines042232019/GibbyHouseAntenna181540metertune04232019.jpg with those of the roof-top EOC antenna: https://qsl.net/nf4ac/2019/EOCResults04232019/EOCAntennacs40mtune.jpg demonstrating dramatic differences in noise background (15 dB or more) and signal pickup.

3 See: https://qsl.net/nf4ac/2019/GibbyEFieldBaseline042232019/GLGHouseE-Field2ftwand10AM04232019.jpg

EOC Roof Top 2-foot dipole measurement
100kHz bandwidth, 3.5-20 MHz: (Measurement made May 14th)



NOTABLE:
HUGE NOISE SPIKES to -54 dBm (even with the 2 foot antenna) in the first four divisions to the left; 20 dB stronger than baselines in the Gibby driveway. Then signals in the 6th & 7th division from the left 13.4 MHz – 16.7 MHz), into the -64 to -74 dBm range. Baseline to the 2/3 of the screen is running just below -94 dBM, because the internal attenuator was at 10 dB due to overloading. Unable to make any comment about signals below that level.

CONCLUSION: Lots of noise from 3.5 MHz all the way to 10 MHz, and then from 13.4 MHz to 16.7 MHz that are generally 20 db or more stronger than the Gibby driveway.

Frequency Range: 3.5 – 20 MHz
Attenuation Total: 16 dB
Bandwidth: 100 kHz

COMPARISON PLAN

There are so, so many signals in each frequency segment it is difficult to know how to characterize such a plot. Average? Median? A simple data-reduction technique of measuring the STRONGEST signal in each segment and tabulating that for comparison with other locations was chosen. See Table 2 for the full comparison. This tends to emphasize the "worst" of each frequency segment, rather than some sort of average or median, but it is a simple comparison ploy.

NOTE: These signal levels are much lower than the signals that would be received from a full size (but awkward to transport) HF antenna of 60-120 foot length.[4]

	Highest Signal Peak in Spectrum Analyzer Major Division from the Left Edge #						
	First 3.5-5.15 MHz	Second 5.15-6.8 MHz	Third 6.8-8.45 MHz	Fourth 8.45-10.1 MHz	7th 14.4 – 15.05 MHz	9th 16.7 – 18.35 MHz	
Location / Setting							Comment
Residential Driveway, Spectrum Analyzer **internal noise floor**	-102	-102	-100	-104	-102	-102	0 dB internal att
Residential Driveway, Xantrex Inverter Power 5/20 (expected "quiet" location)	-85	-90	-66	-88	-99	-98	0 db Internal att.
EOC ROOF	-62	-54	-54	-60	-70	-88	10 db internal att (required!)
EOC parking lot	-79	-84	-74	-94	-93	-95	0 dB internal attenuator allowed greater sensitivity
EOC SE corner of property, on 27th St. SE	-82	-86	-84	-86	-99	-95	0 db internal attenuator allowed greater sensitivity

TABLE 2: Simple comparison of highest signal level noted in each of selected frequency segments from 3.5 MHz to 20 MHz. Selected bins were #1, #2, #3, #4, #7, and #9 so as to avoid overwhelming comparisons.

4 See, for example, the signals all the way to -30 dBm on a residential full size ham antenna here: https://qsl.net/nf4ac/2019/GibbyAntennaBaselines042232019/GibbyHouseAntenna181540metertune04232019.jpg

The remaining questions were to find what was the baseline in a quiet residential neighborhood, and what was the rate of decay of these signals as one moved farther away from the noisy EOC. In order to power the 110-VAC spectrum analyzer, a portable setup of a car battery and 2kw Xantrex pure sine wave inverter were utilized, but it became obvious that there is some radiated noise from that 120 VAC power supply system also.

The remaining spectral plots which were obtained and are recorded as part of this data are:

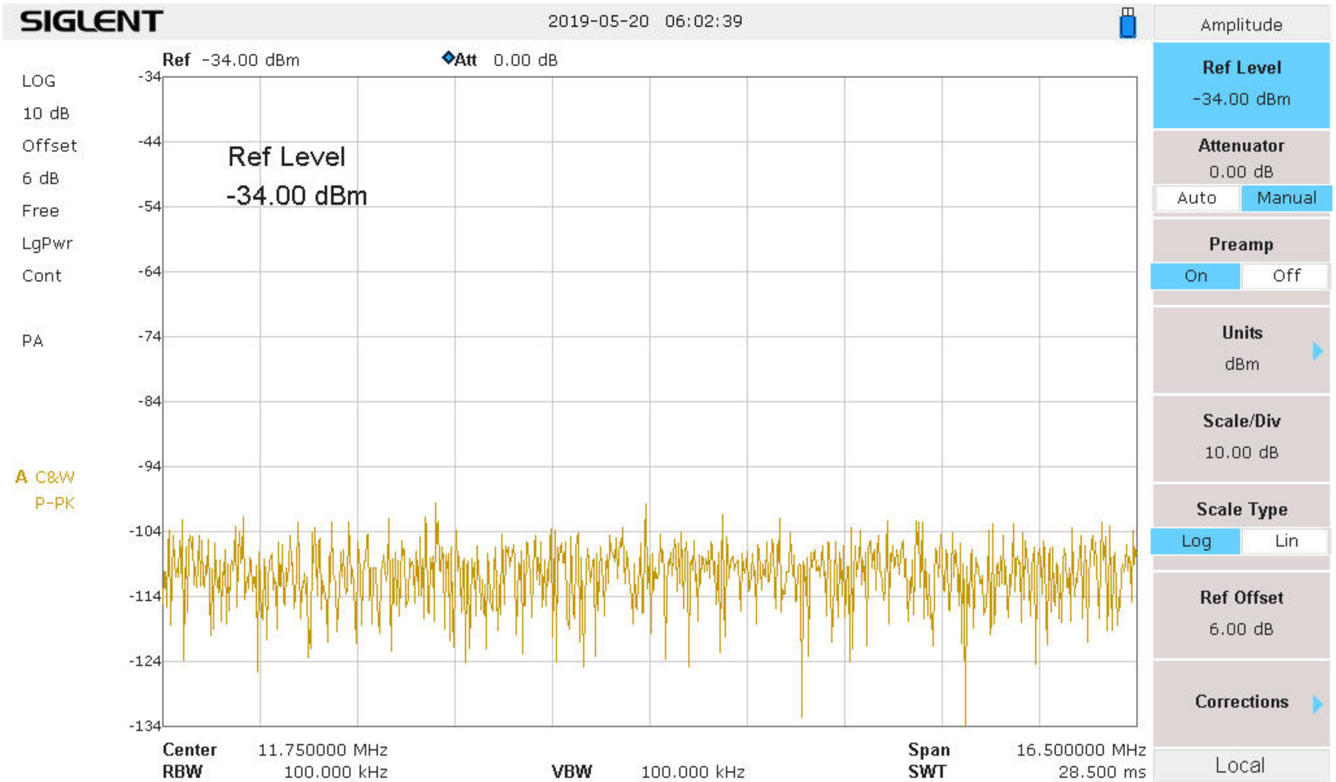
	Spectral Plot	Page
	Spectrum Analyzer innate sensitivity for 100 kHz bandwidth	8
	Residential Driveway measurement (Gibby household)	9
	North EOC parking lot, right outside doors	10
	South East EOC property Corner, parked on SE 27th Street	11
	South East corner of 7Acre property just south of EOC, on SE 27th Street	12
	Residential Driveway, powered by 4 kw Generator in bed of truck	13

LIMITATIONS OF THIS STUDY:

All of the plots are “typical” – they represent one screen, one moment in time judged to be typical; there is no averaging. A simple data capture technique.

The Spectrum Analyzer will not run on DC power. It requires 120VAC, so some form of Inverter was required to operate it in a vehicle to make measurements at all these locations. The Xantrex pure sine way inverter is one of my “quieter” sources, but it still has some RF hash output which is hard to avoid, due to the heavy wiring and large size of the battery & connections. Using a 4kW generator would not be a great improvement. Because of this unavoidable noise source, it is possible that measurements hit a “plateau” of self-generated noise. That plateau is clearly far lower than the noise we have been fighting...but it obscures our ability to find locations much more than 20 dB quieter than the rooftop – a larger antenna (such as the full size one on my travel trailer) would be required to make a better investigation.

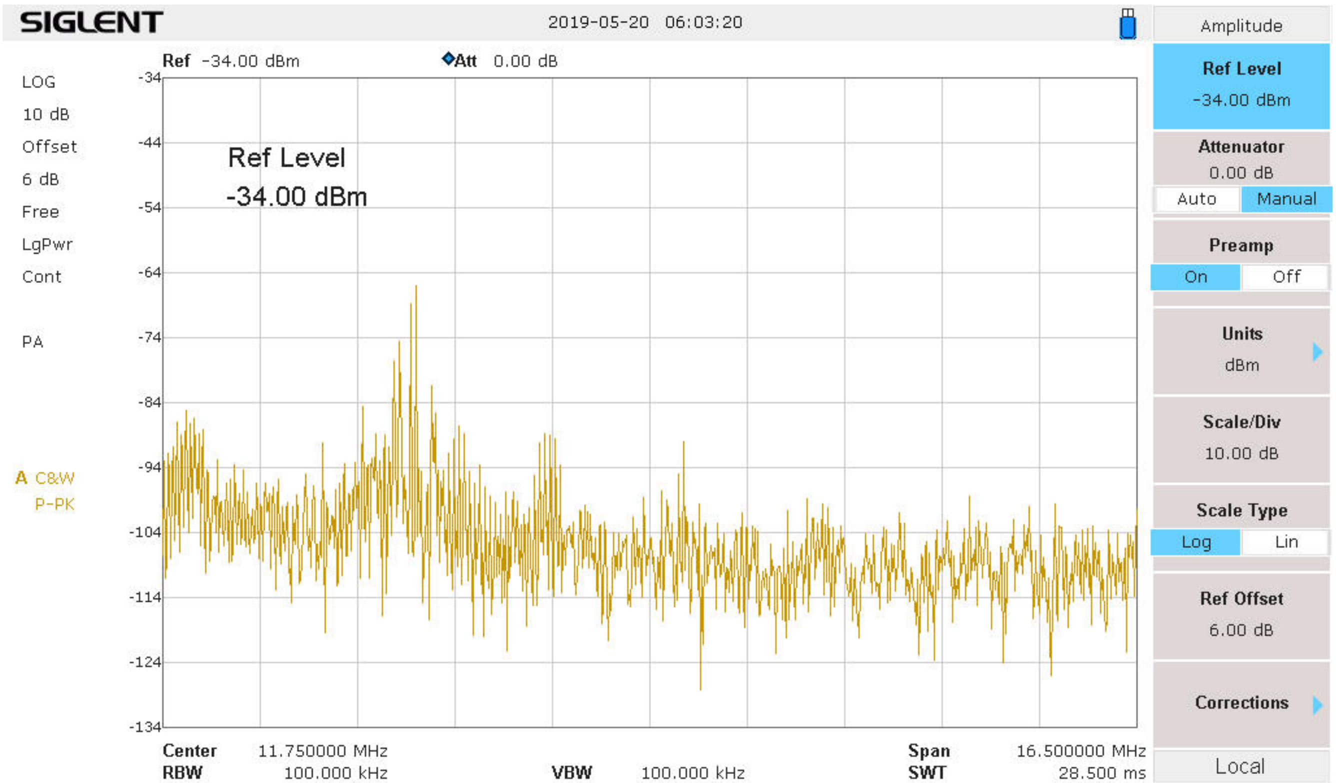
Spectrum Analyzer Baseline (running from Xantrex)



No antenna connected.
3.5 – 20 MHz
100 kHz baseline
6 db external attenuator
0 dB internal attenuator

Signals below this strength cannot be measured by this spectrum analyzer in this configuration; a smaller bandwidth would be needed to increase sensitivity.

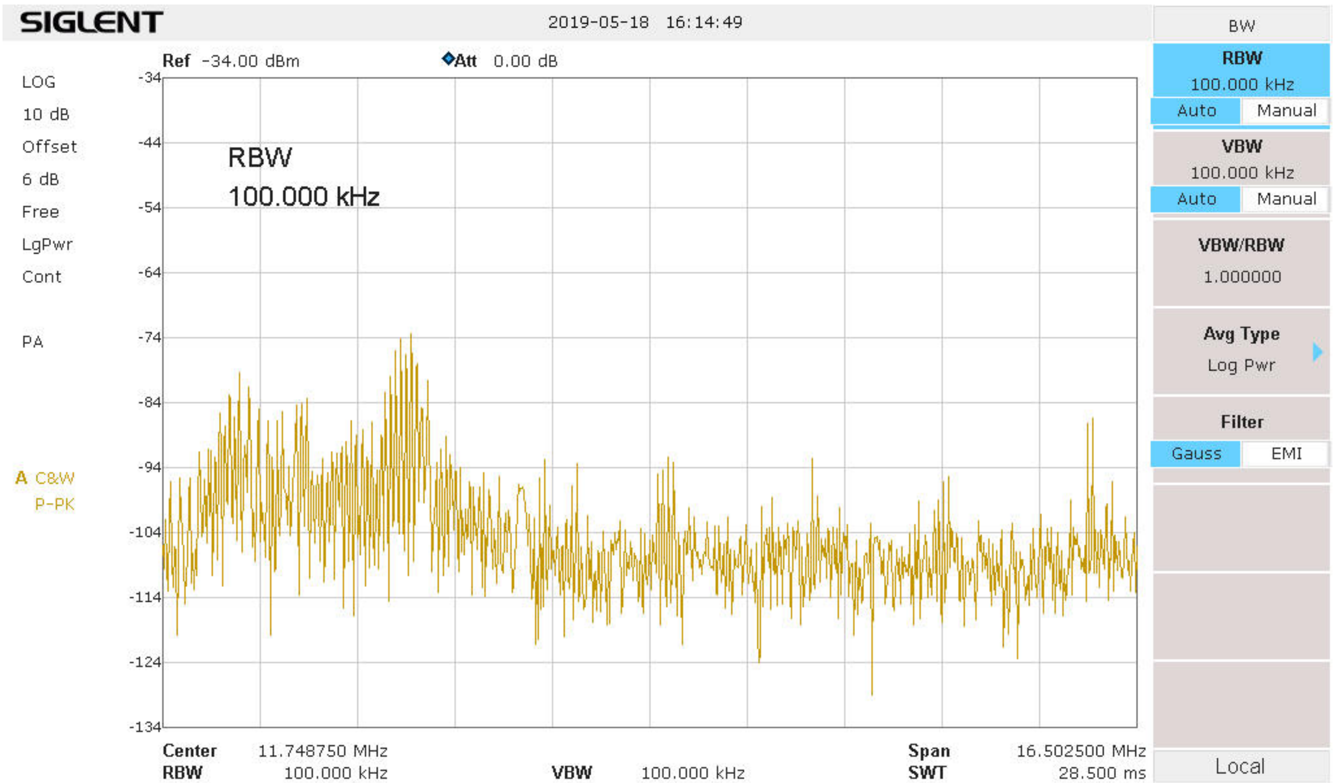
Residential (Gibby Driveway), 2 foot dipole, Xantrex Power, 0 dB internal attenuator



2 Foot Antenna Added
6 dB external attenuator
0 dB internal attenuator
3.5 – 20 MHz
100 kHz bandwidth

Unclear whether the noise visualized is all from the Xantrex generator or from other sources (including real signals!), but this is the lowest noise that could be measured at the residential neighborhood.

North parking lot of EOC, right in front of their doors:

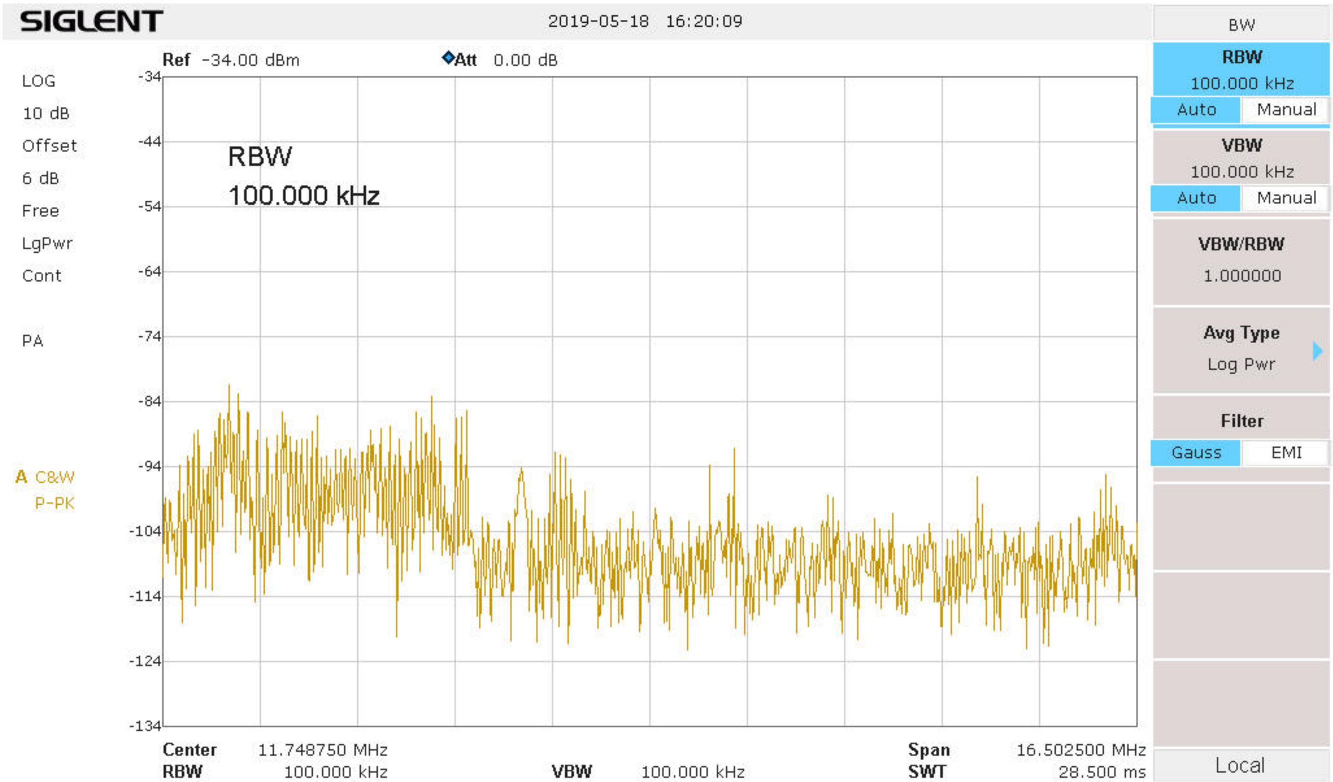


Frequency Range: 3.5 – 20 MHz
Attenuation Total: 6 dB (0 dB internal, 6 dB external)
Bandwidth: 100 kHz

NOTABLE:
Peak about -74 dB about 3 divisions from the left
Baseline in the right 2/3 of the screen running below -104 dBm except for some notable individual signals that aren't present in the Gibby Driveway.

Conclusion: ***Not terribly different from the Gibby Driveway.***

Now at the SE Corner of the EOC property, just off the road:

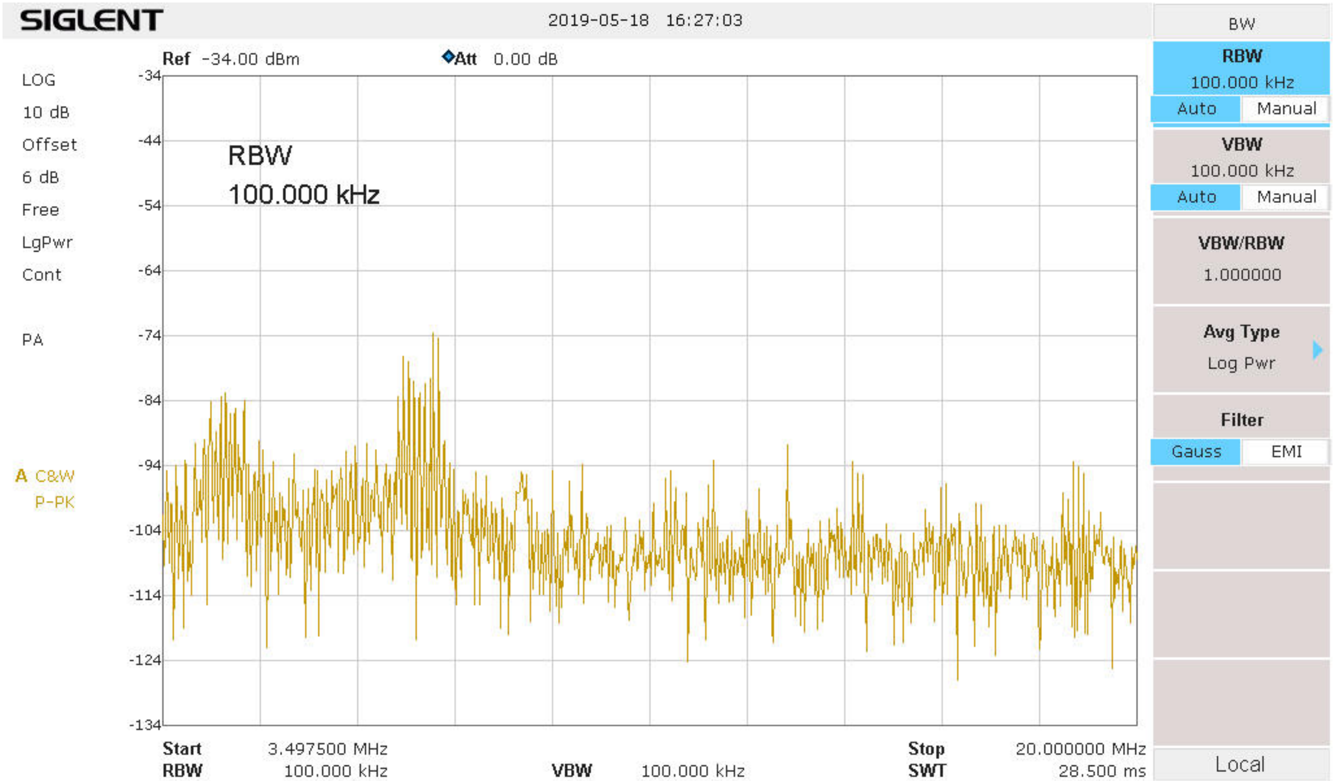


Fairly similar to that it is at the south edge of the 5 acre property

NOTABLE:
Peak about 84 dBm in the left 3-4 divisions – actually quieter than the Gibby driveway
Baseline in the right 2/3 of the screen running below -104 dBm

Frequency Range: 3.5 – 20 MHz
Attenuation Total: 06 dB
Bandwidth: 100 kHz

South edge of 7 Acre property just south of the EOC, on 27th Street side of the road:

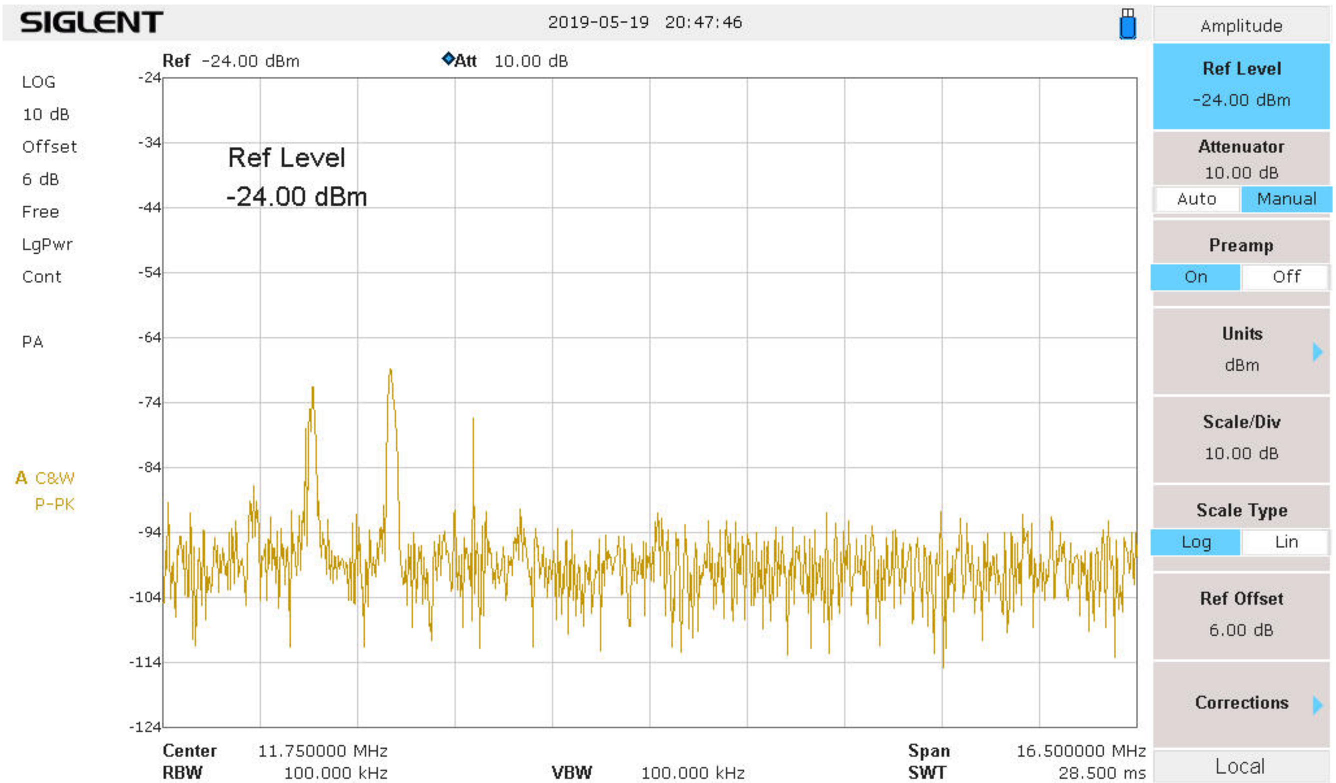


Signals are basically the same as being in the north parking lot

NOTABLE:
Peak about -74 dB about 3 divisions from the left
Baseline in the right 2/3 of the screen running below -104 dBm
RELATIVELY THE SAME AS GIBBY DRIVEWAY-- unable to distinguish any further due to possible noise from the Xantrex inverter powering the Spectrum Analyzer

Frequency Range: 3.5 – 20 MHz
Attenuation Total: 6 dB
Bandwidth: 100 kHz

Gibby Driveway, Green Generator power (EMI filter):



Surprisingly in the first division to the left this is actually quieter than either the AC power or the Xantrex!!! You can't see it in this static plot, but there were periodic signals moving back and forth through the left third of the plot with time.

Frequency Range: 3.5 – 20 MHz
Attenuation Total: 16 dB
Bandwidth: 100 kHz