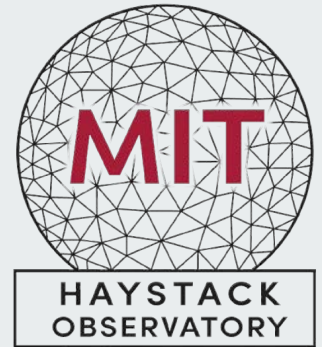




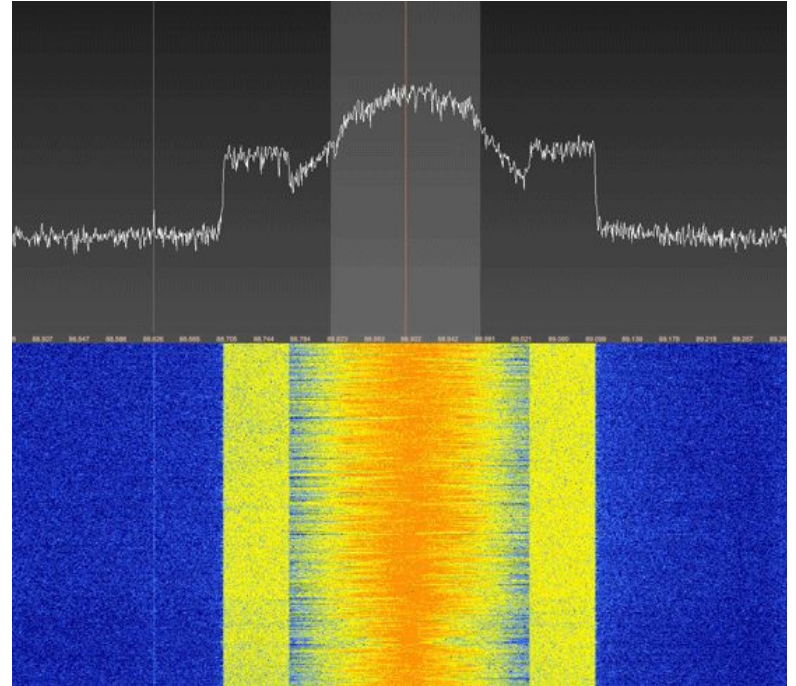
# The Great Haystack RFI Hunt

Brian Malkan



## Background

- RFI (Radio Frequency Interference)
- Fourier Transform / Waterfall Plots
- Motivation: Record and Annotate RFI Signatures





## Project Outline

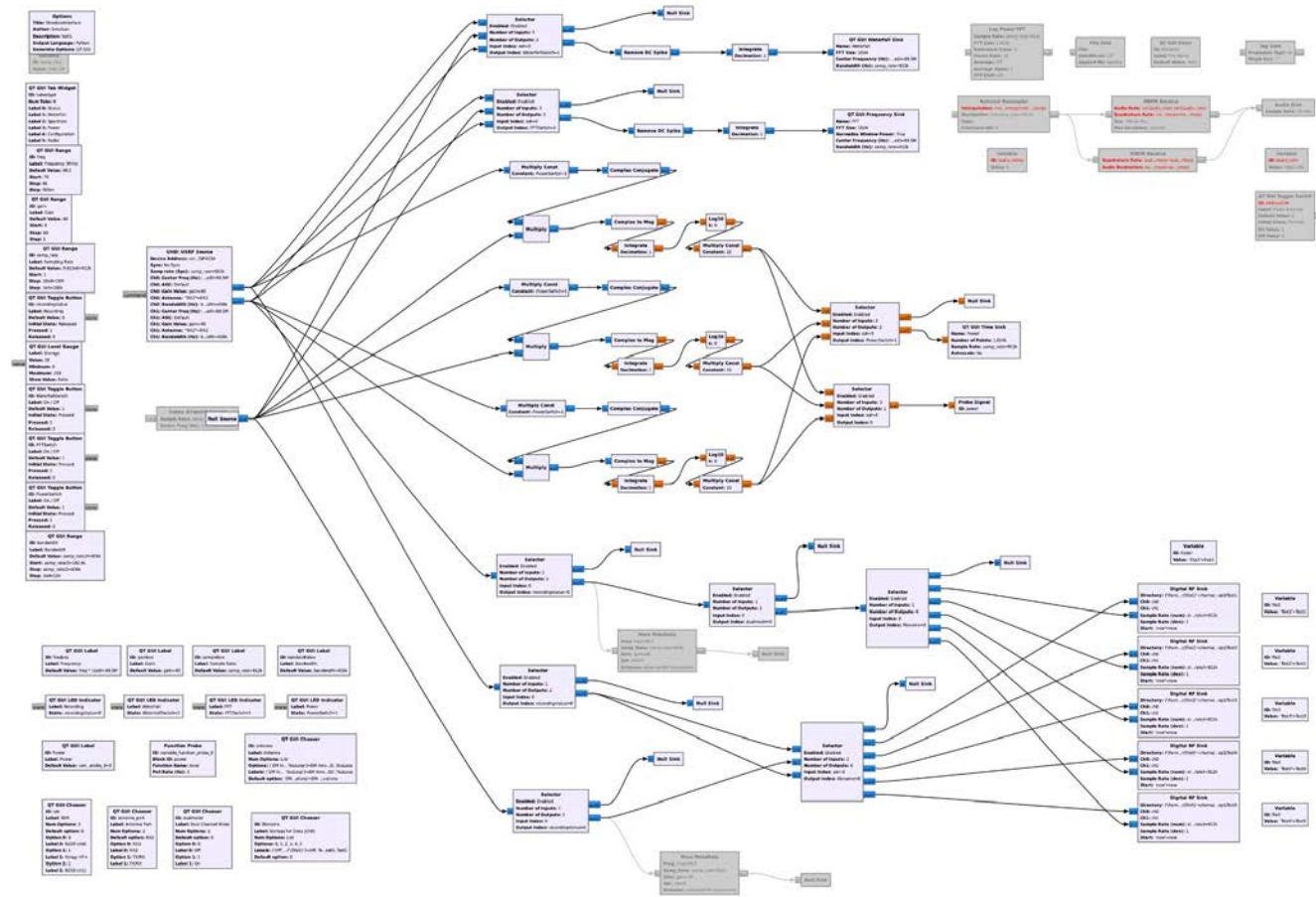
1. Making software
2. Assembling hardware
3. Finding / recording radio frequency interference
4. Viewing / annotating data through dash
5. Create training data for potential neural network

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## GNU-Radio

- Python Based software used for radio application
- Blocks, Flowcharts
- Make interface for using radios



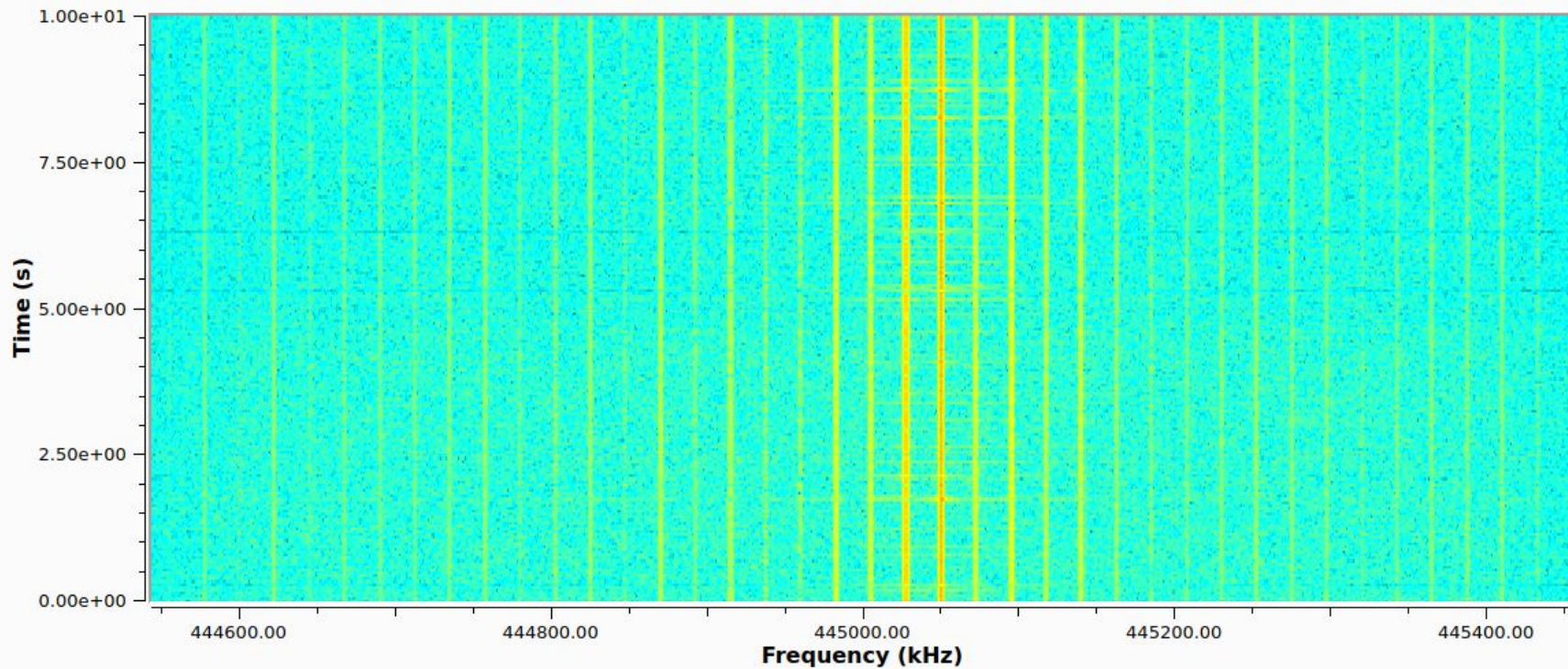


GNU Flowgraph for RFI Box

Status Waterfall Spectrum Power Configuration Radio

On / Off

## Waterfall



Frequency (MHz)

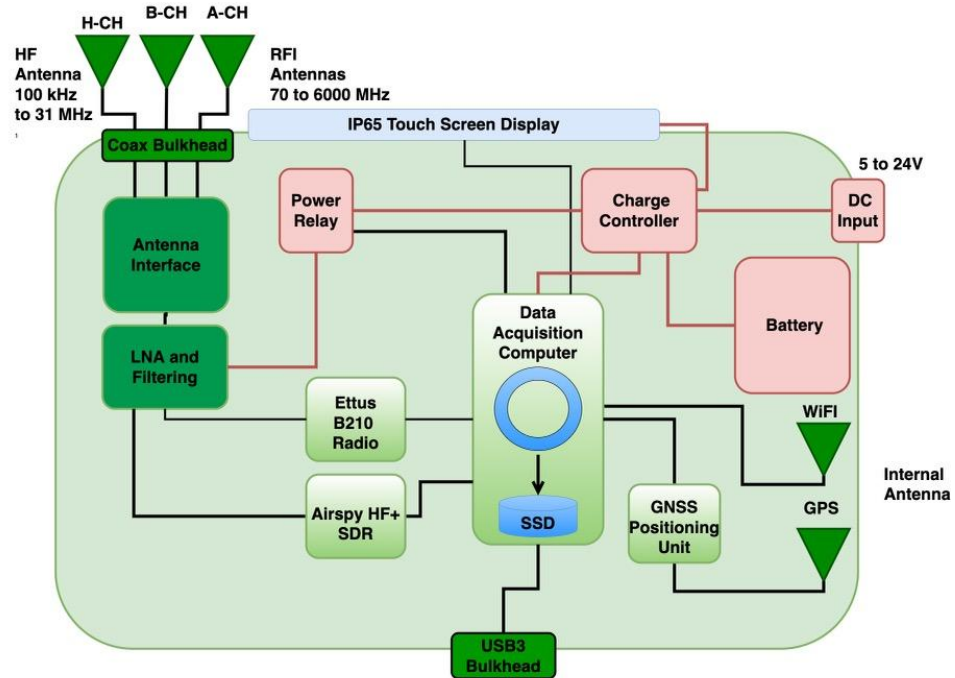


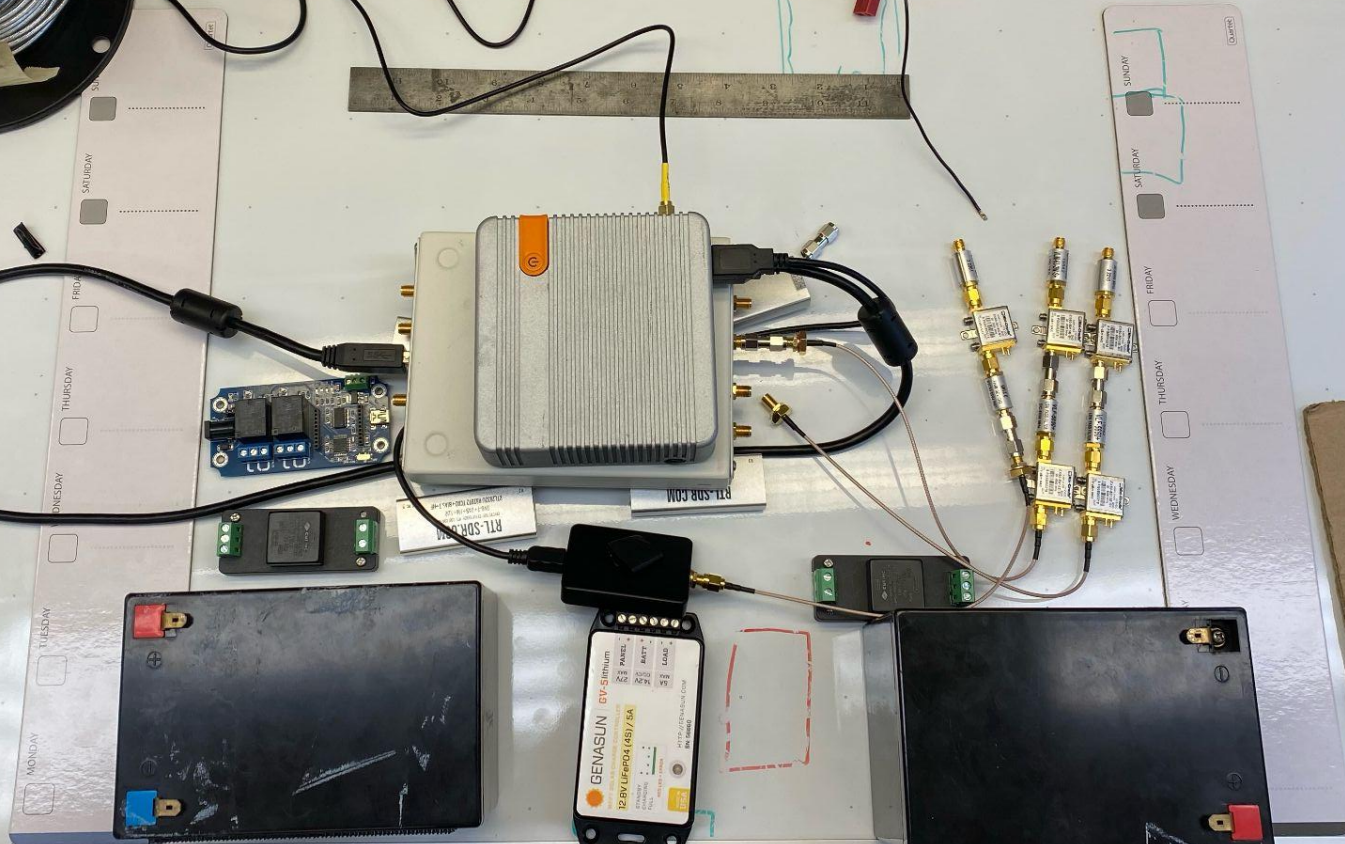
445.000



# Assembling RFI hunting tools

- Portable Software Radio  
“Shoebox receiver”
- Two Radios (HF + UHF)
- Interactive Display and Controls







**GENA** GV-5lithium  
12.8V LiFePO4 (4S)  
STANDBY CHARGING PAUL  
PANEL BATT LOAD

**PowerStream.com**  
LiFePO4 Battery Pack  
MODEL: 12.8V12Ah BATTERY  
WARNING: DO NOT DISASSEMBLE/MAY EXPLODE IF DISPOSED IN FIRE  
DO NOT EXPOSE TO TEMPERATURE ABOVE 80°C OR 140°F  
USE ONLY RECOMMENDED BATTERY CHARGER

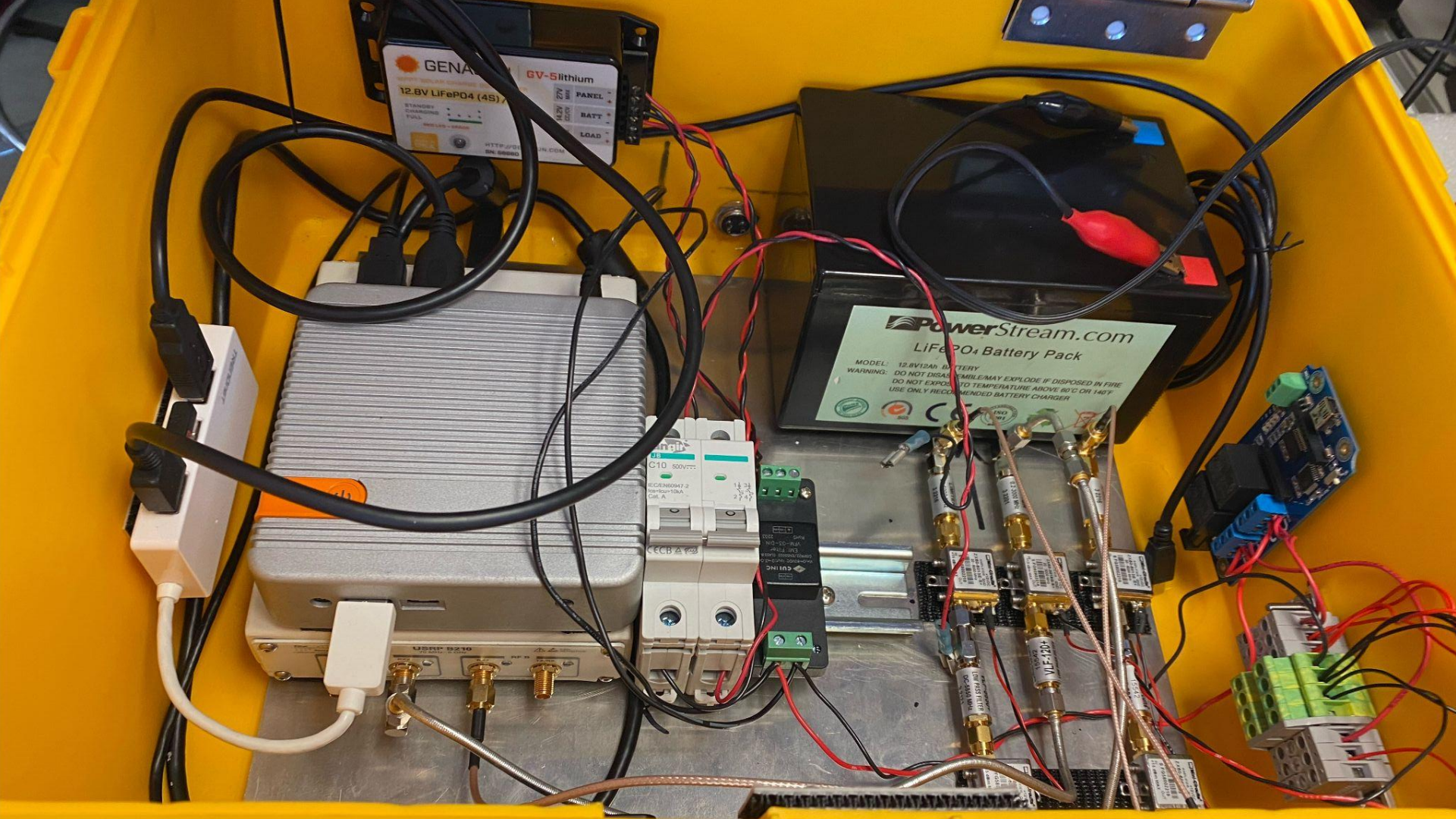
USDP B210

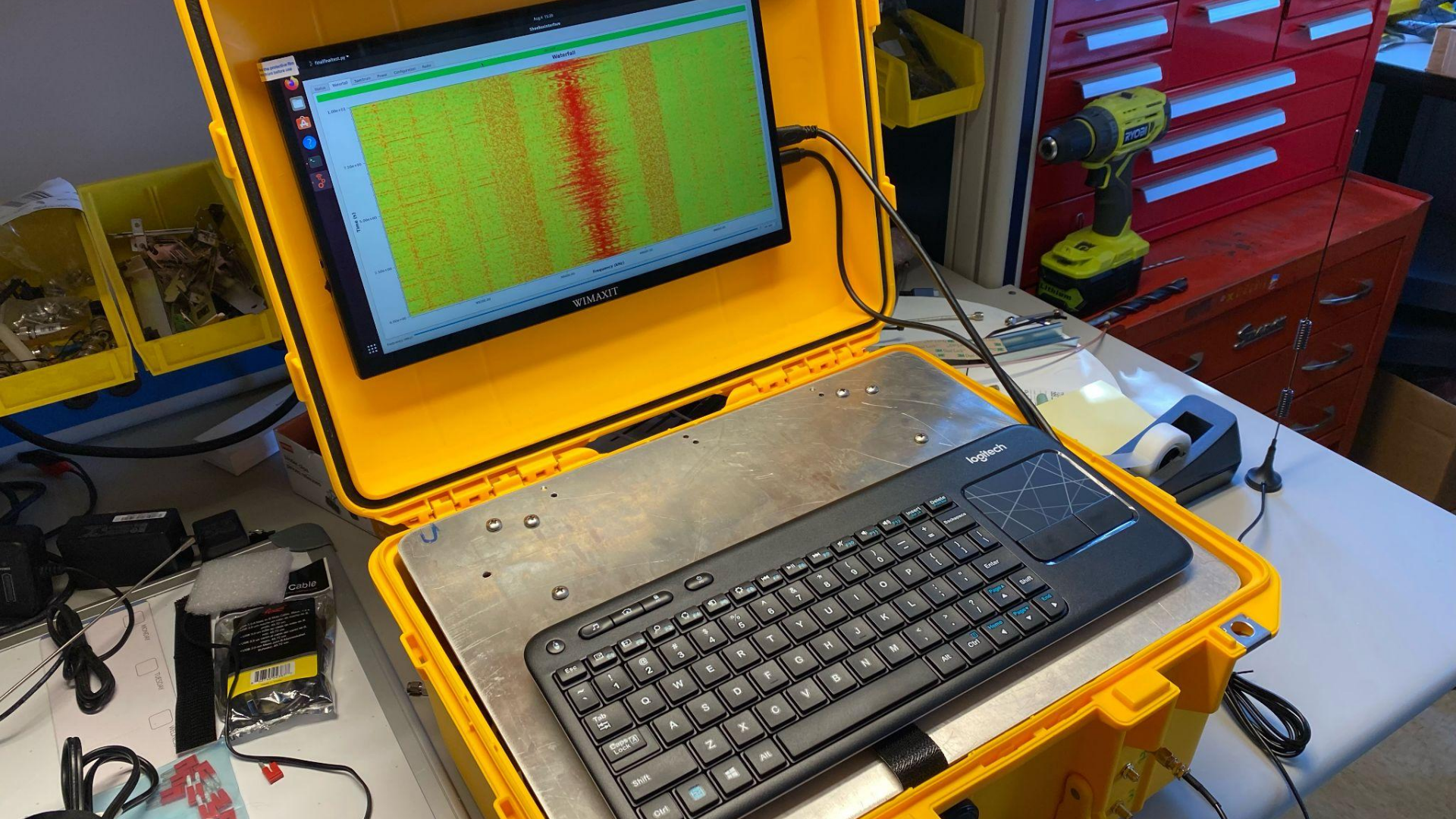
CCCB 2  
C10 500VDC  
RECEN00047.2  
1000VDC/10A  
CH. A  
GWINC

Power supply unit with two black power cables and a white USB cable.

Blue PCB module with various electronic components and connectors.

Green terminal block with multiple wires connected to it.





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## Satcom interference

- Known interference at ~ 467MHz
- Interferes with the Westford UHF Satcom band





Groton Transfer Station

Haystack Observatory

Cow Pond Soccer Fields

Cow Pond Baseball Fields

Firepond

Millstone Rd

Millstone Rd

Millstone Rd

Keyes Rd

N

W

E

S

Flavell Rd

Hoys Wharf Rd

Cow Pond Brook Rd

Hop St

Millstone Rd

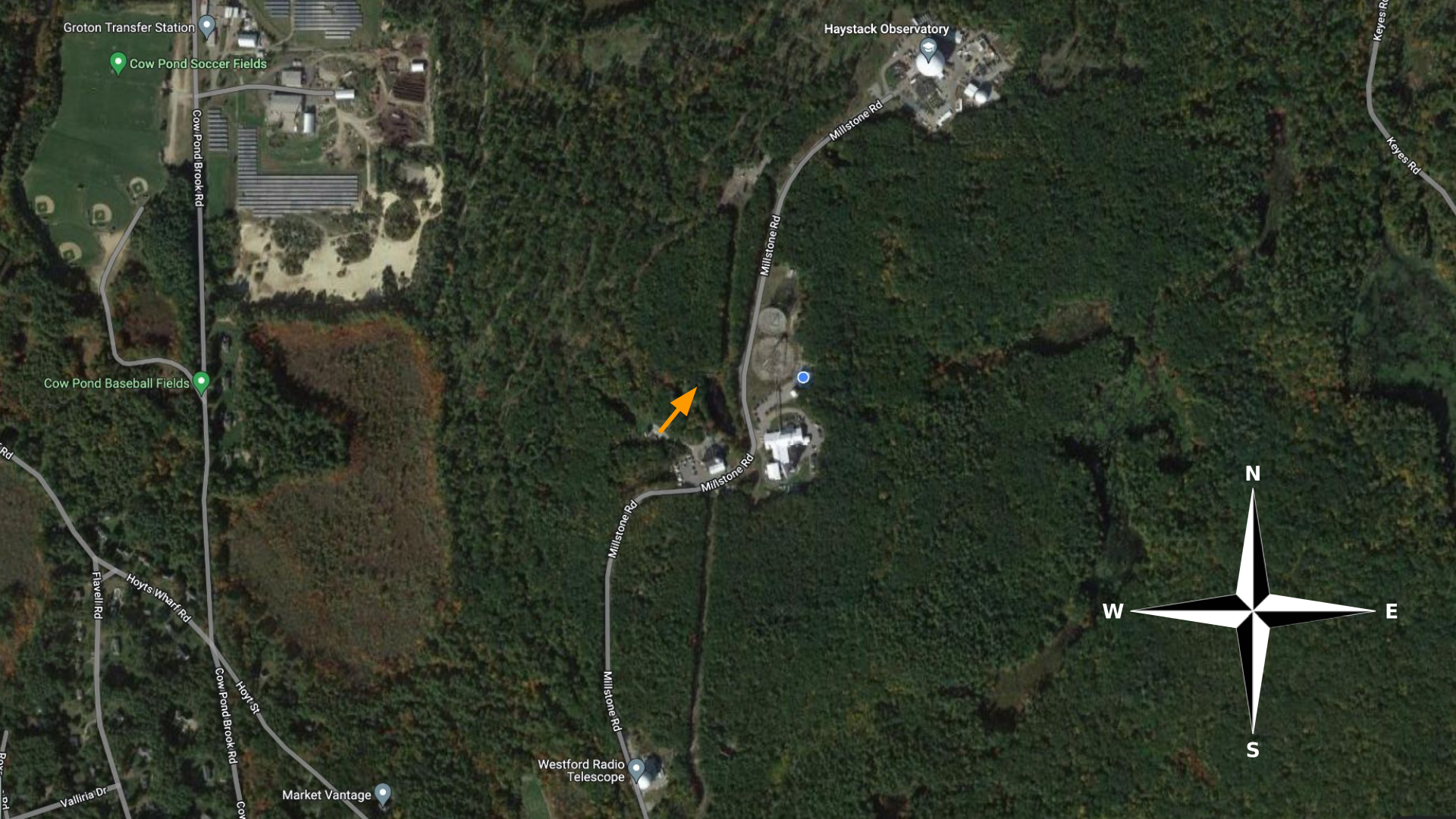
Millstone Rd

Westford Radio Telescope

Market Vantage

Vallina Dr



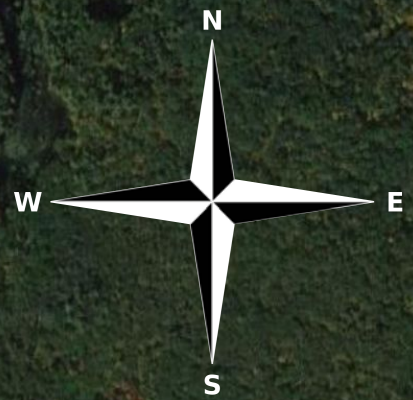


Groton Transfer Station

Cow Pond Soccer Fields

Haystack Observatory

Cow Pond Baseball Fields



Market Vantage

Westford Radio Telescope

Cow Pond Brook Rd

Millstone Rd

Keyes Rd

Millstone Rd

Millstone Rd

Millstone Rd

Flaxwell Rd

Hoyts Wharf Rd

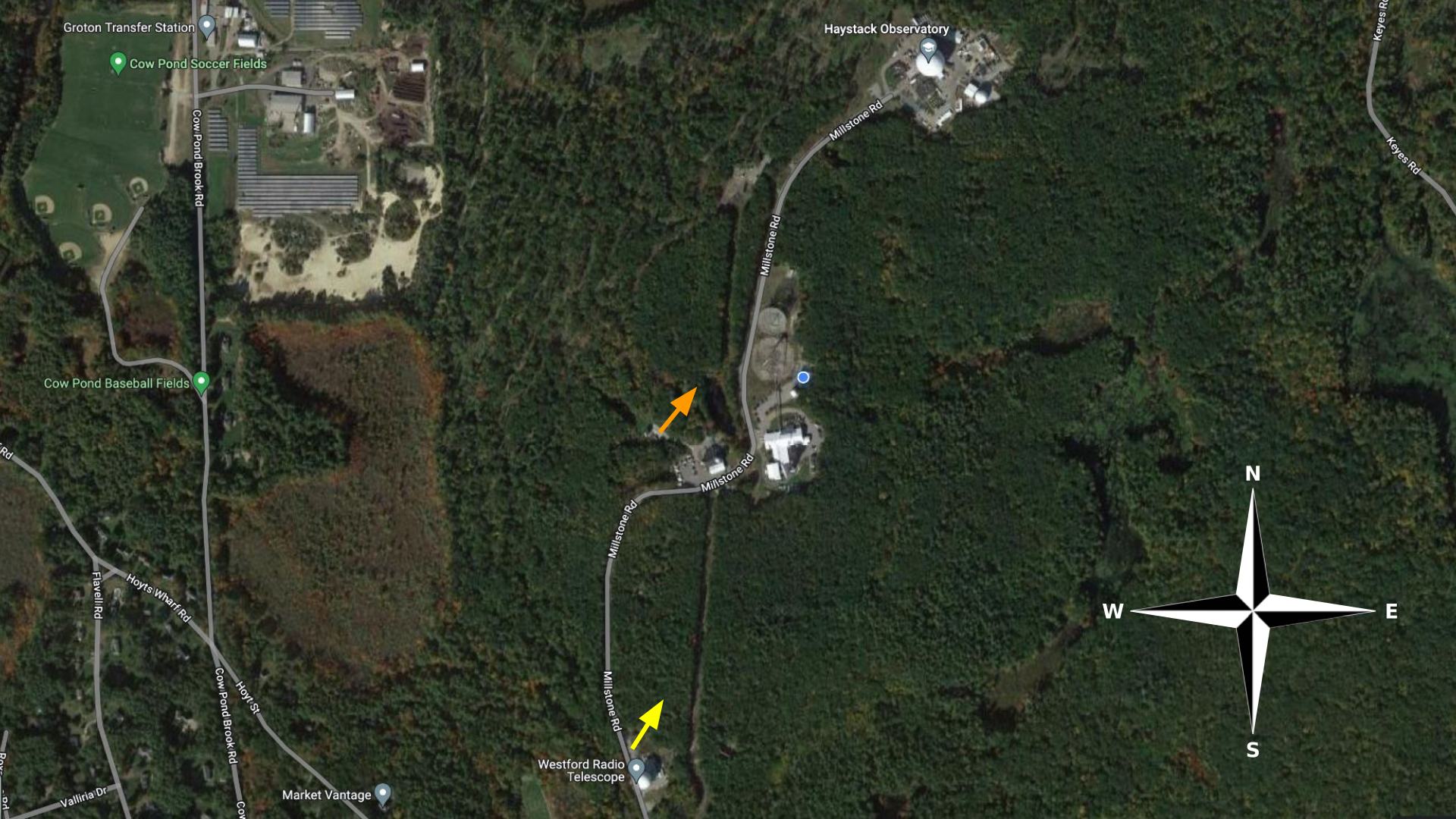
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Hop St

Vallinia Dr

Cow Pond Brook Rd

Millstone Rd



Groton Transfer Station

Cow Pond Soccer Fields

Haystack Observatory

Cow Pond Baseball Fields

Millstone Rd

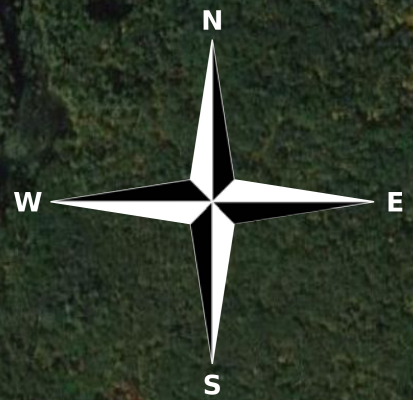
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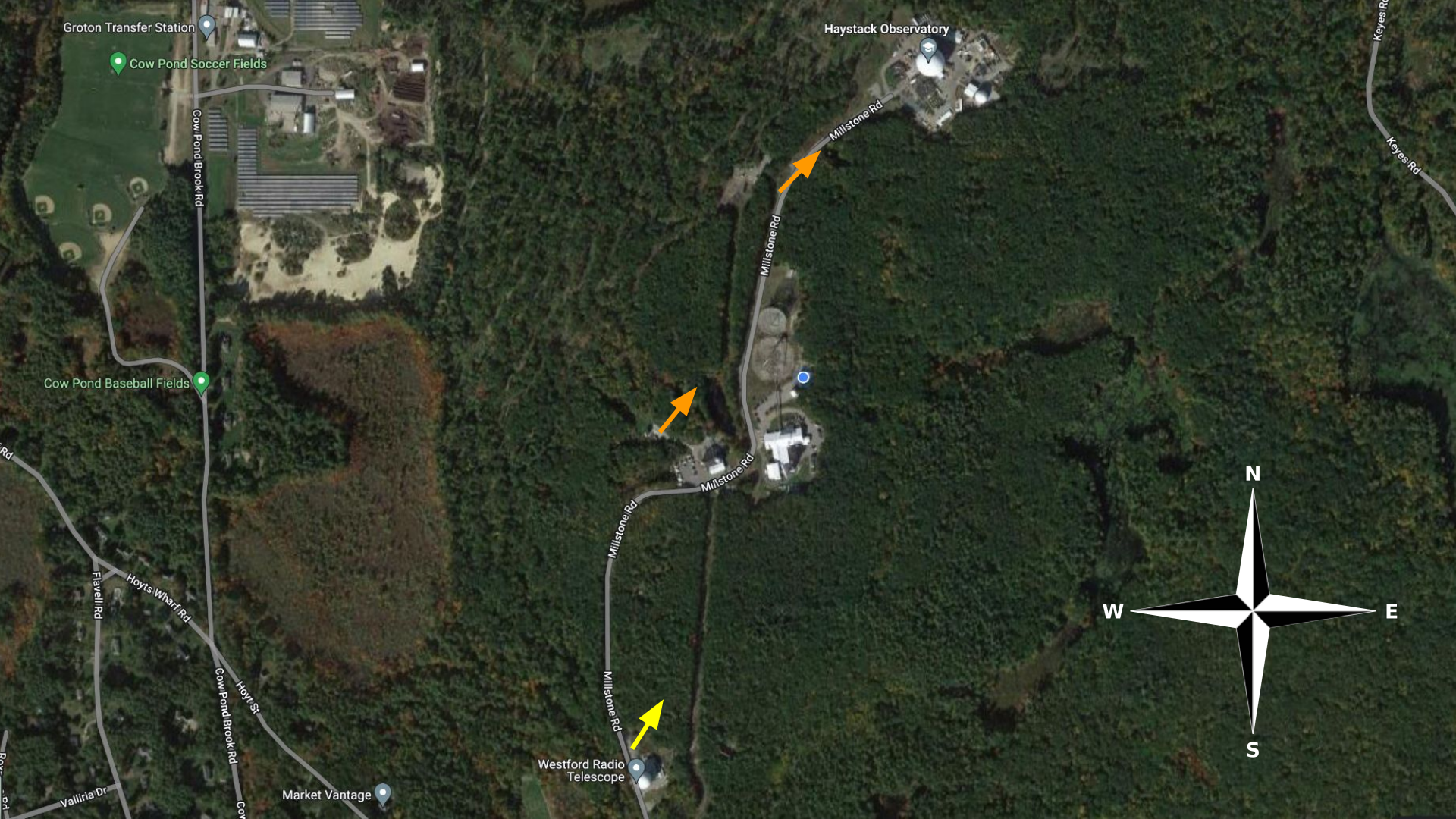
Millstone Rd

Millstone Rd

Westford Radio Telescope

Market Vantage





Groton Transfer Station

Cow Pond Soccer Fields

Haystack Observatory

Cow Pond Brook Rd

Millstone Rd

Keyes Rd

Cow Pond Baseball Fields

Millstone Rd

Millstone Rd

Millstone Rd

N

W

E

S

Flavell Rd

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Hop St

Westford Radio Telescope

Market Vantage

Vallina Dr





Haystack Observatory

Millstone Rd

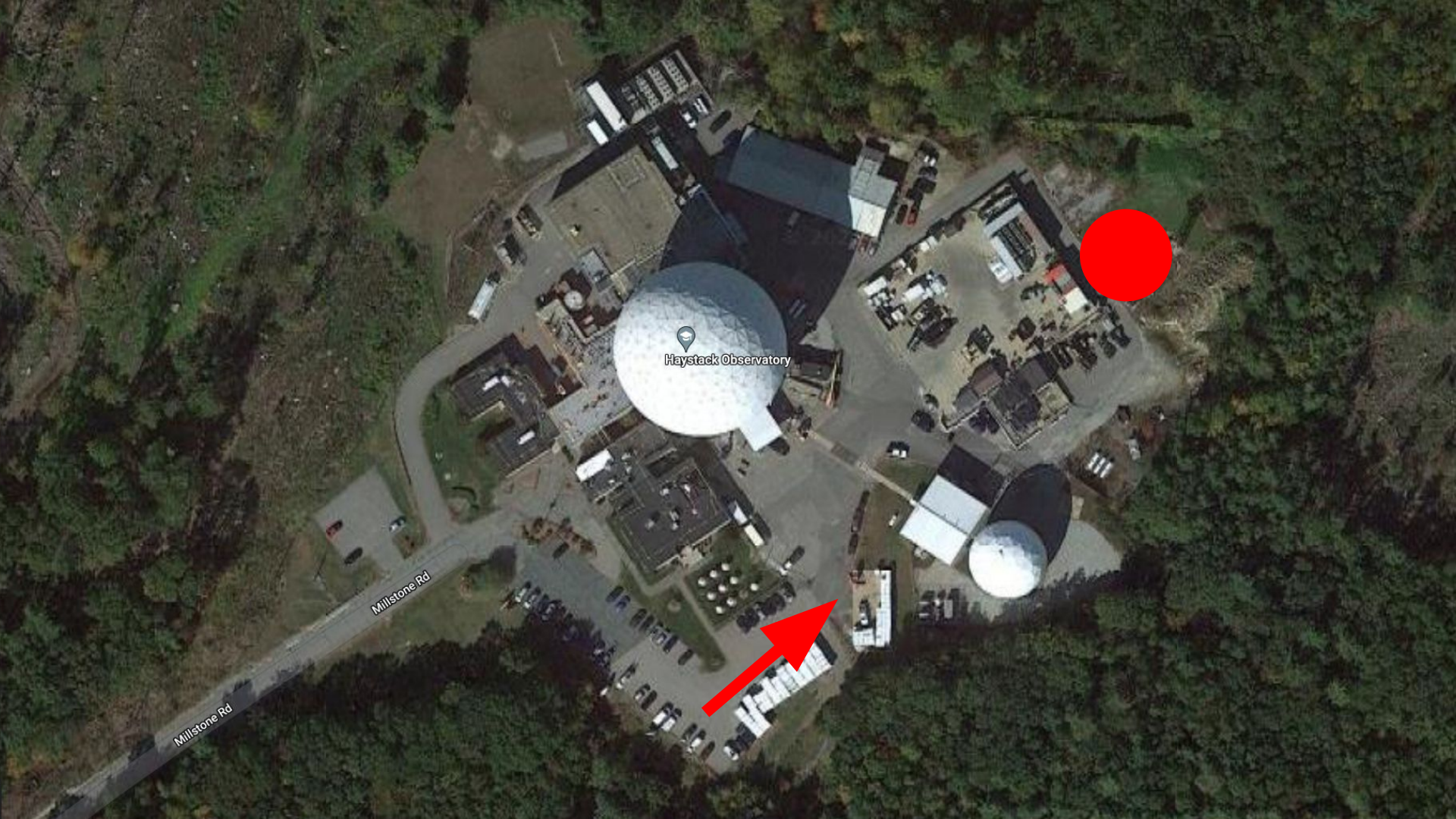
Millstone Rd



Haystack Observatory

Millstone Rd

Millstone Rd

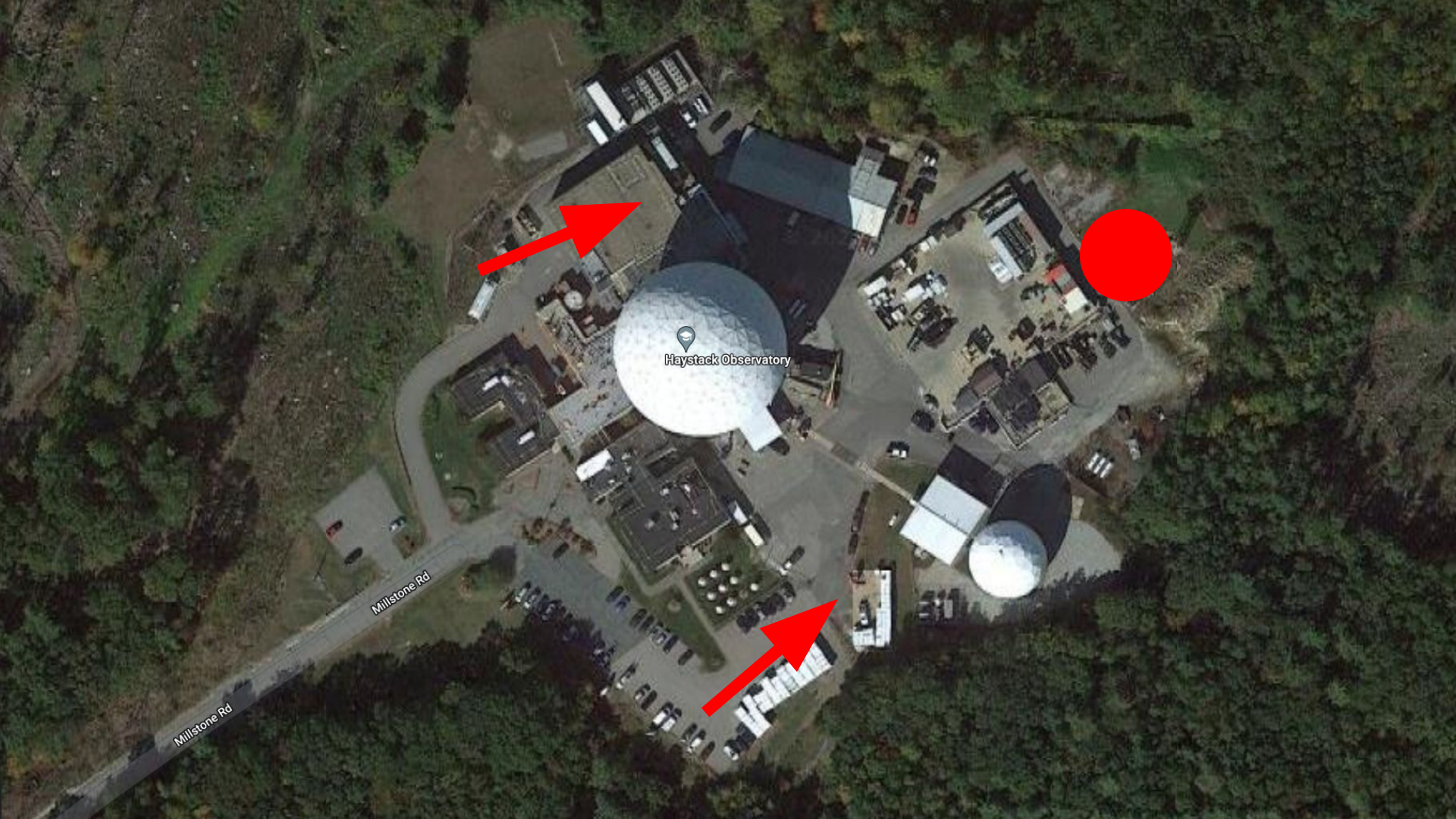


Haystack Observatory

Millstone Rd

Millstone Rd

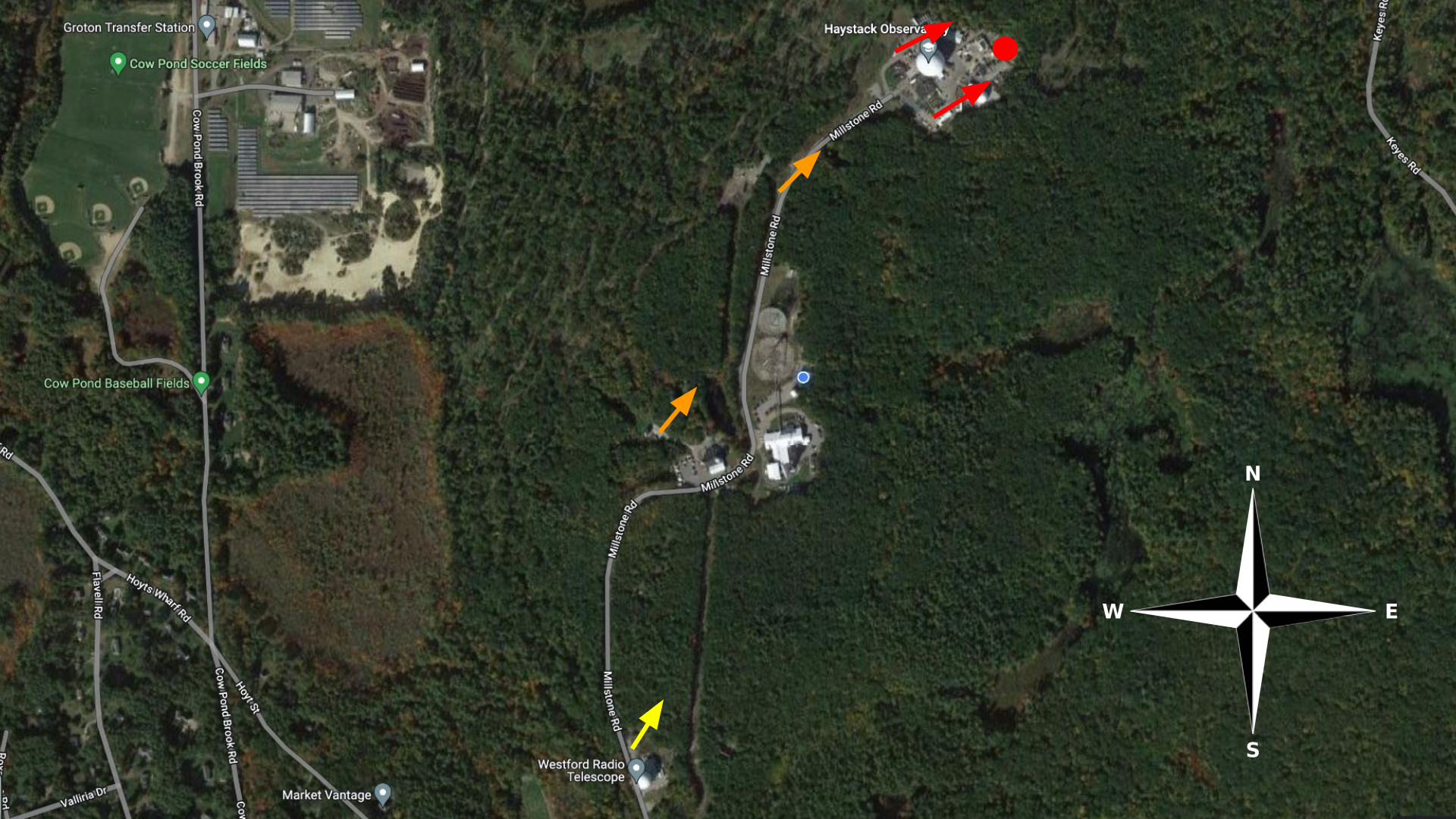




Haystack Observatory

Millstone Rd

Millstone Rd



Groton Transfer Station

Cow Pond Soccer Fields

Cow Pond Baseball Fields

Haystack Observa

Westford Radio Telescope

Market Vantage

Cow Pond Brook Rd

Millstone Rd

Keyes Rd

Millstone Rd

Millstone Rd

Millstone Rd

Millstone rd

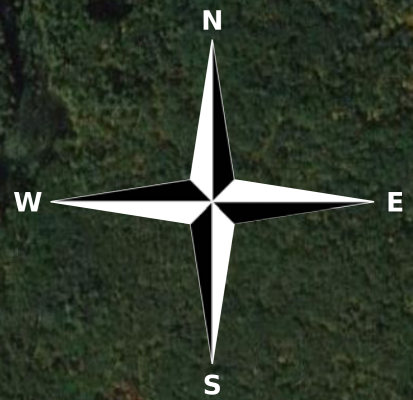
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Hop St

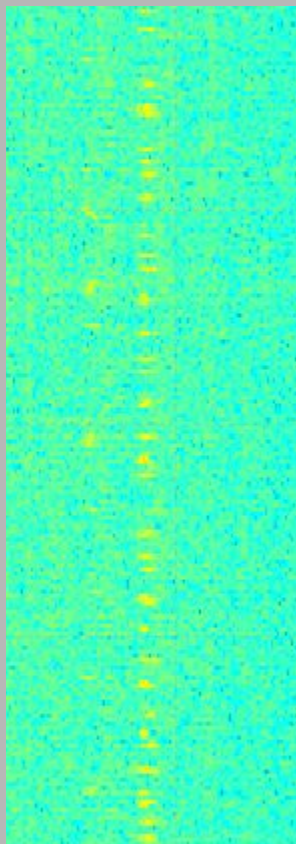
Hayys Wharf Rd

Flaxwell Rd

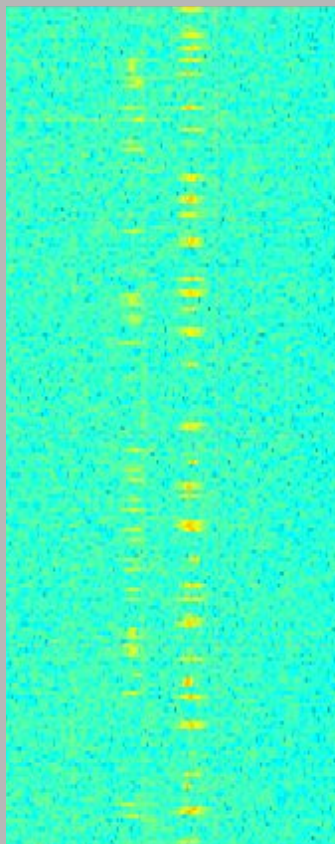
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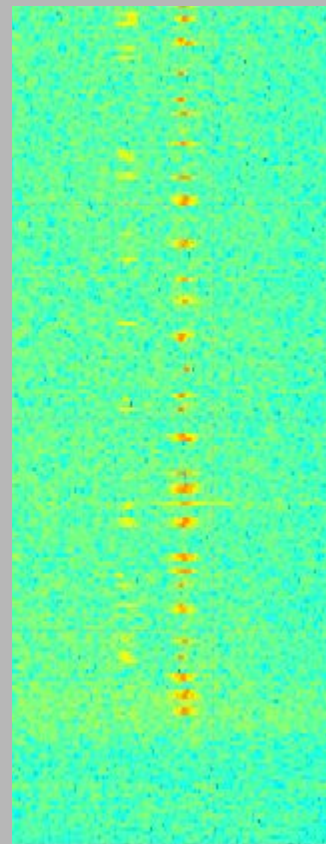
Time



Westford 



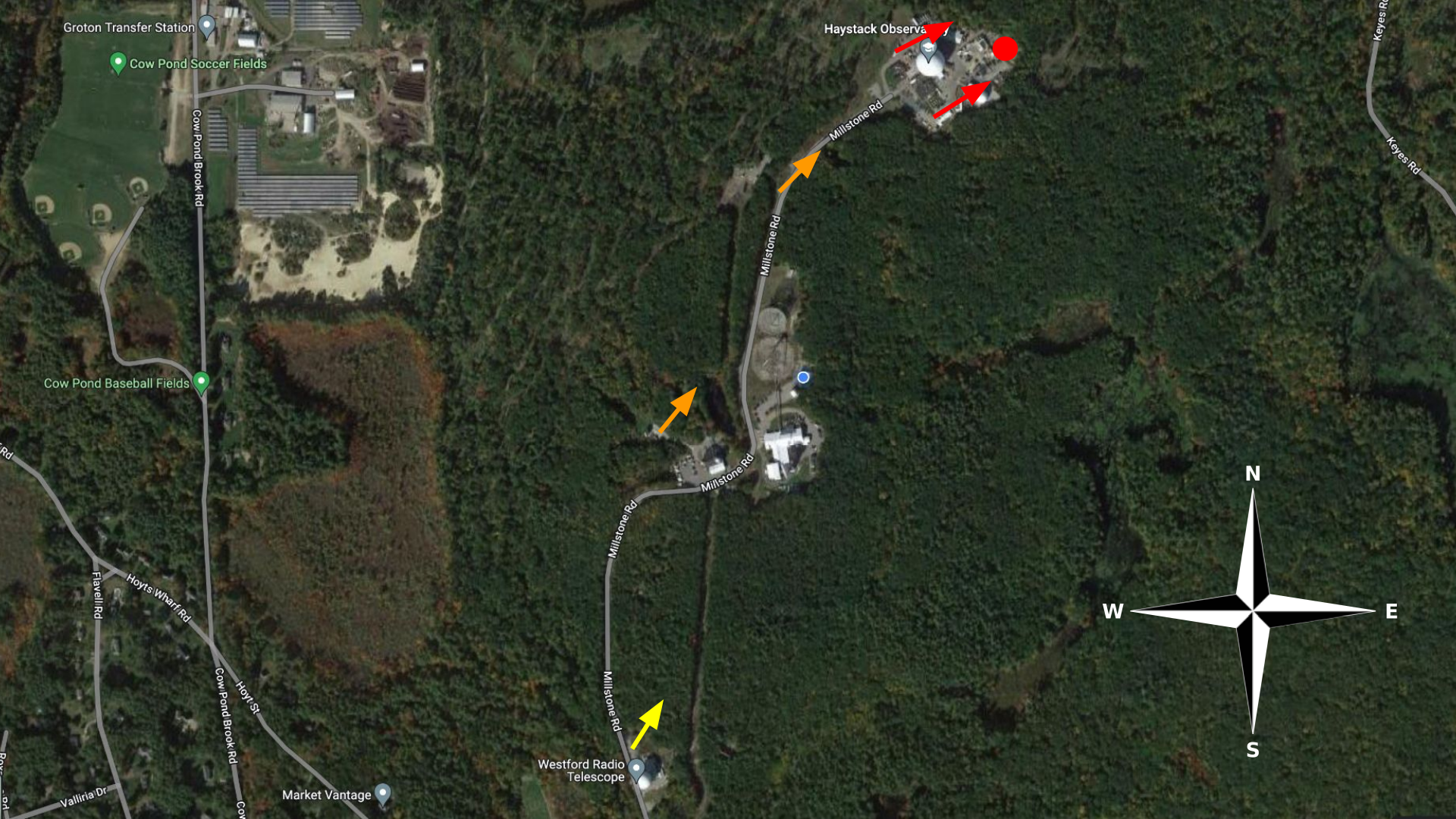
Firepond 



Haystack 







Groton Transfer Station

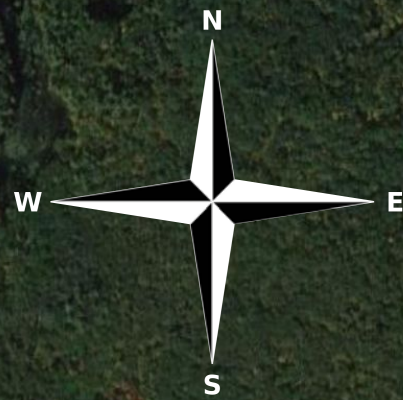
Cow Pond Soccer Fields

Cow Pond Baseball Fields

Haystack Observa

Westford Radio Telescope

Market Vantage



Cow Pond Brook Rd

Millstone Rd

Millstone Rd

Millstone Rd

Millstone Rd

Millstone Rd

Flavell Rd

Hoys Wharf Rd

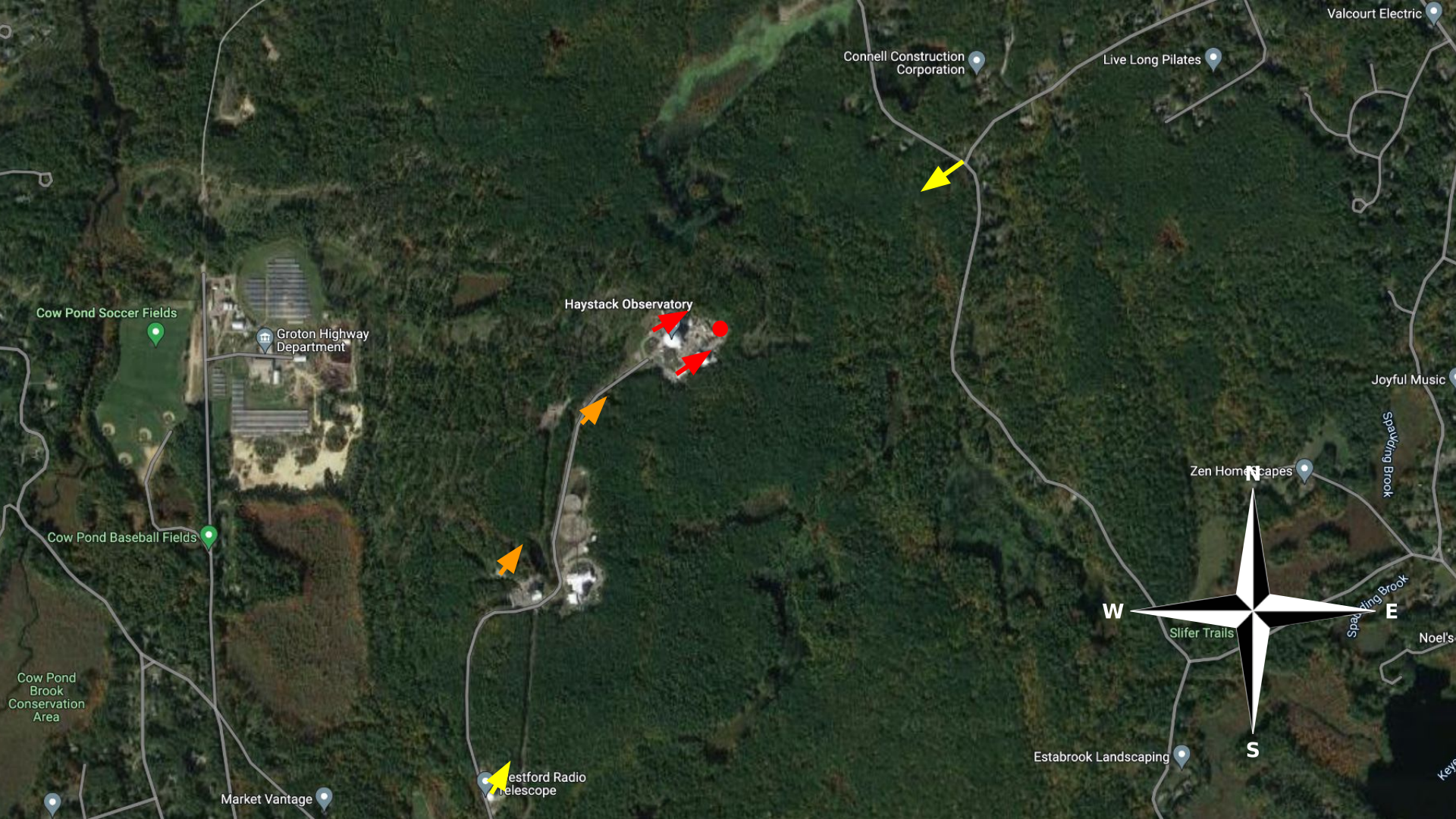
Cow Pond Brook Rd

Hop St

Vallina Dr

Keyes Rd

Keyes Rd



Connell Construction Corporation

Live Long Pilates

Valcourt Electric

Cow Pond Soccer Fields

Haystack Observatory

Groton Highway Department

Cow Pond Baseball Fields

Zen Home Escapes

Joyful Music

Spaulding Brook

Cow Pond Brook Conservation Area

W

E

Slifer Trails

Spaulding Brook

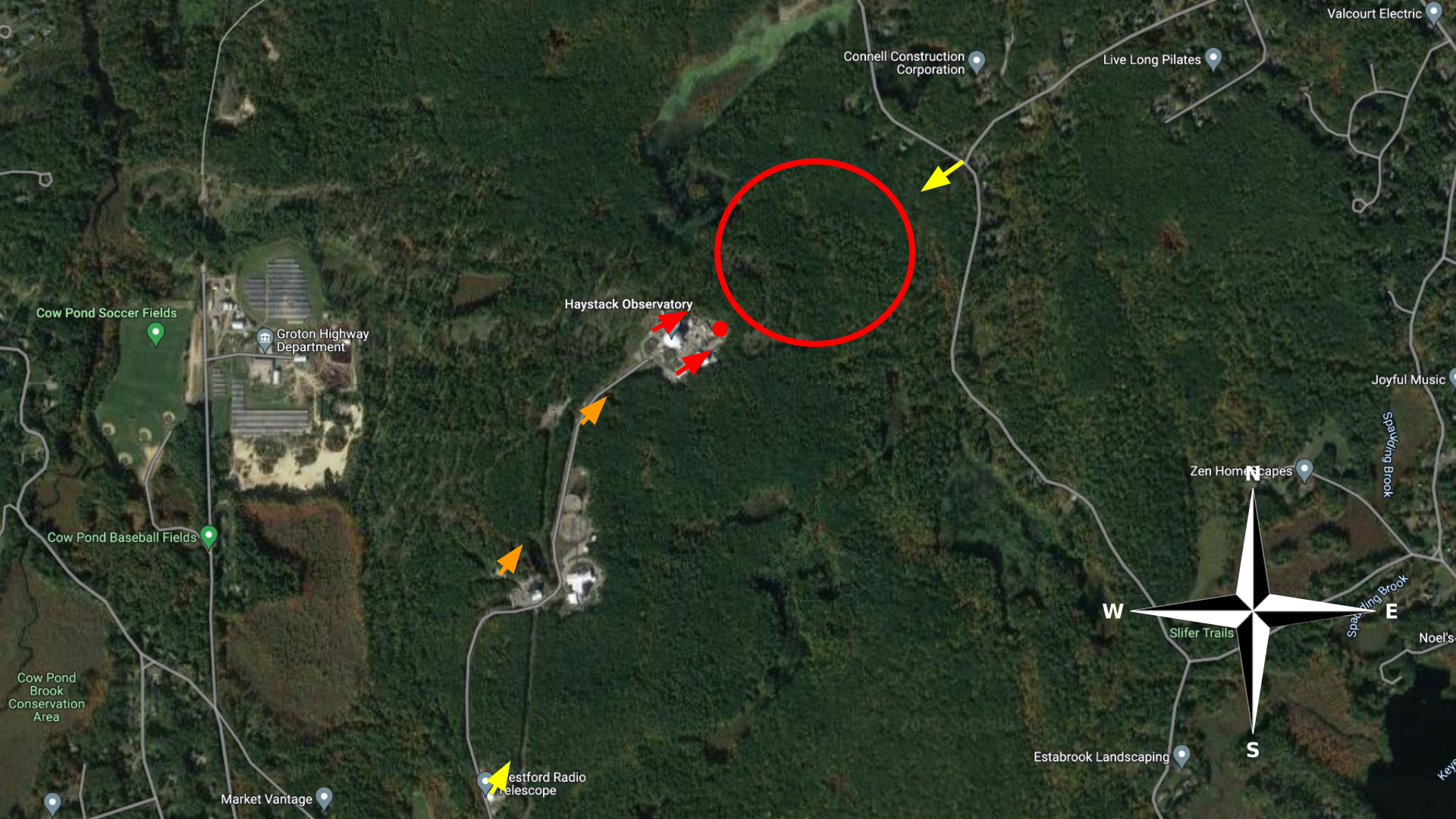
Noel's

S

Estabrook Landscaping

Westford Radio Telescope

Market Vantage



Cow Pond Soccer Fields

Groton Highway Department

Haystack Observatory

Connell Construction Corporation

Live Long Pilates

Valcourt Electric

Cow Pond Baseball Fields

Zen Home Escapes

Joyful Music

Spaulding Brook

Cow Pond Brook Conservation Area

Westford Radio Telescope

W

E

Slifer Trails

Spaulding Brook

Noel's

Market Vantage

Estabrook Landscaping

S

Key...



# Dash / Plotly Data Visualization and Annotation

## Data Sample

Select File:

Test1

## NFFT:

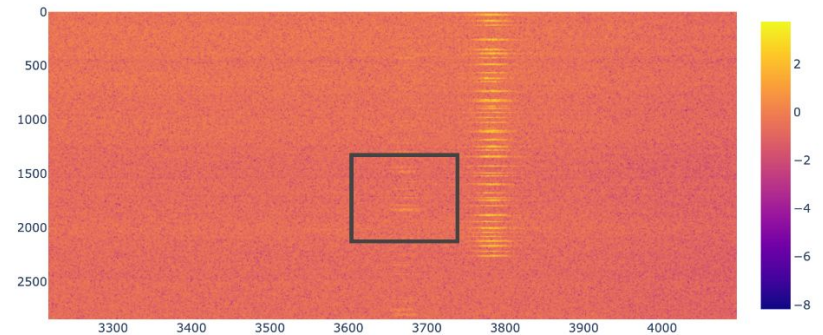
512  1024  2048  4096

## Channel:

ch0  ch1

## Metadata

Center Frequency	Gain	Sample Rate	Date	Location
467 MHz	20	912000	8-8-22	42.6820 -72.9183





## Future Improvements

- Improved Data Visualization and Annotation
- A Faster Spectrum Analyzer like mode
- More efficient battery usage
- Improved construction with shielding to reduce self - interference
- Incorporation of RF and position data into RFI 'heatmaps'



# Acknowledgements

## Mentors:

Dr. Frank Lind

Dr. Sharanya Srinivas

## Technicians / IT

Will Rogers

Joe, Chris

Drew, John S, John T, Ryan