Modeling the J-Pole Antenna

A Qualitative Presentation

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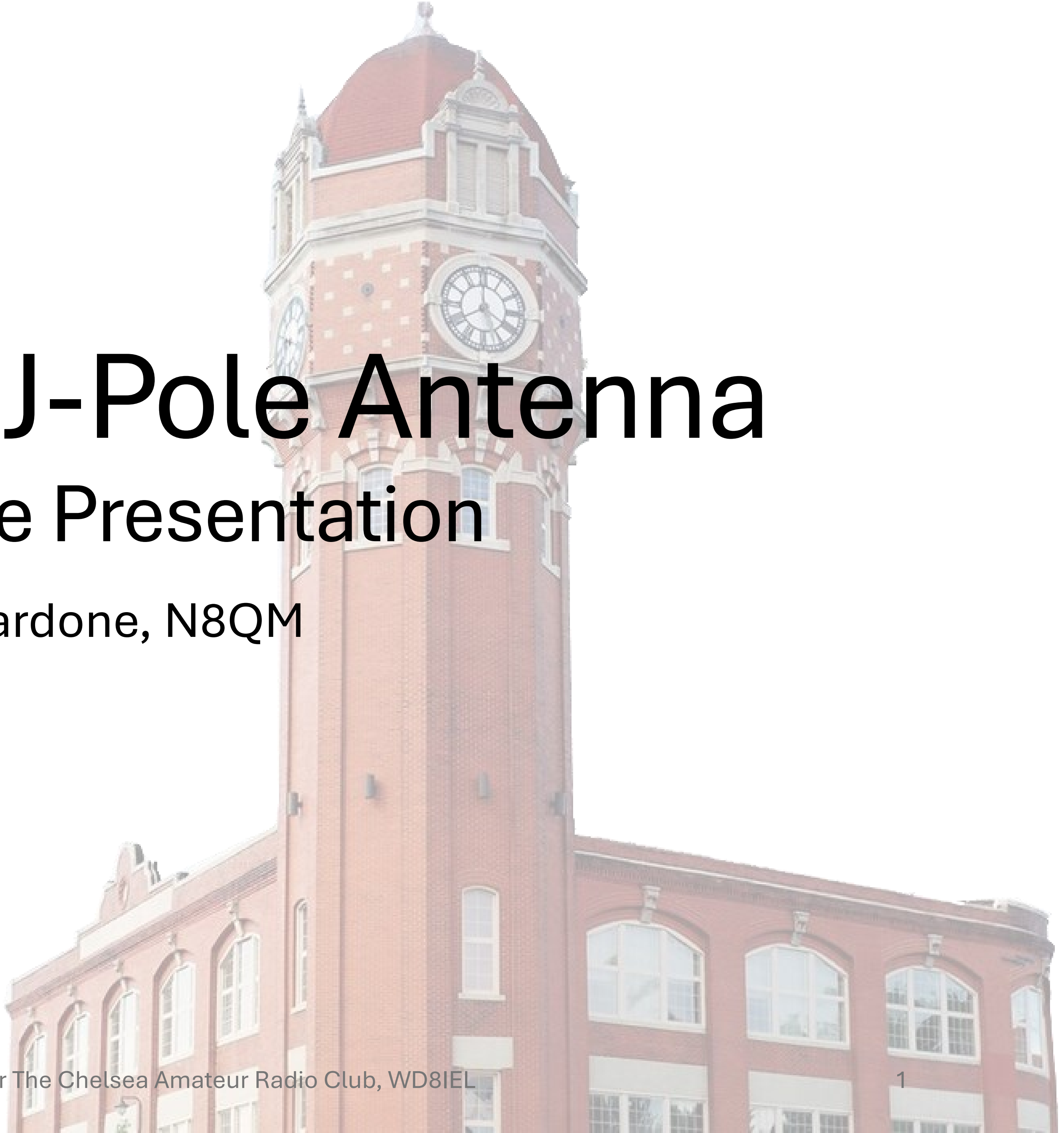


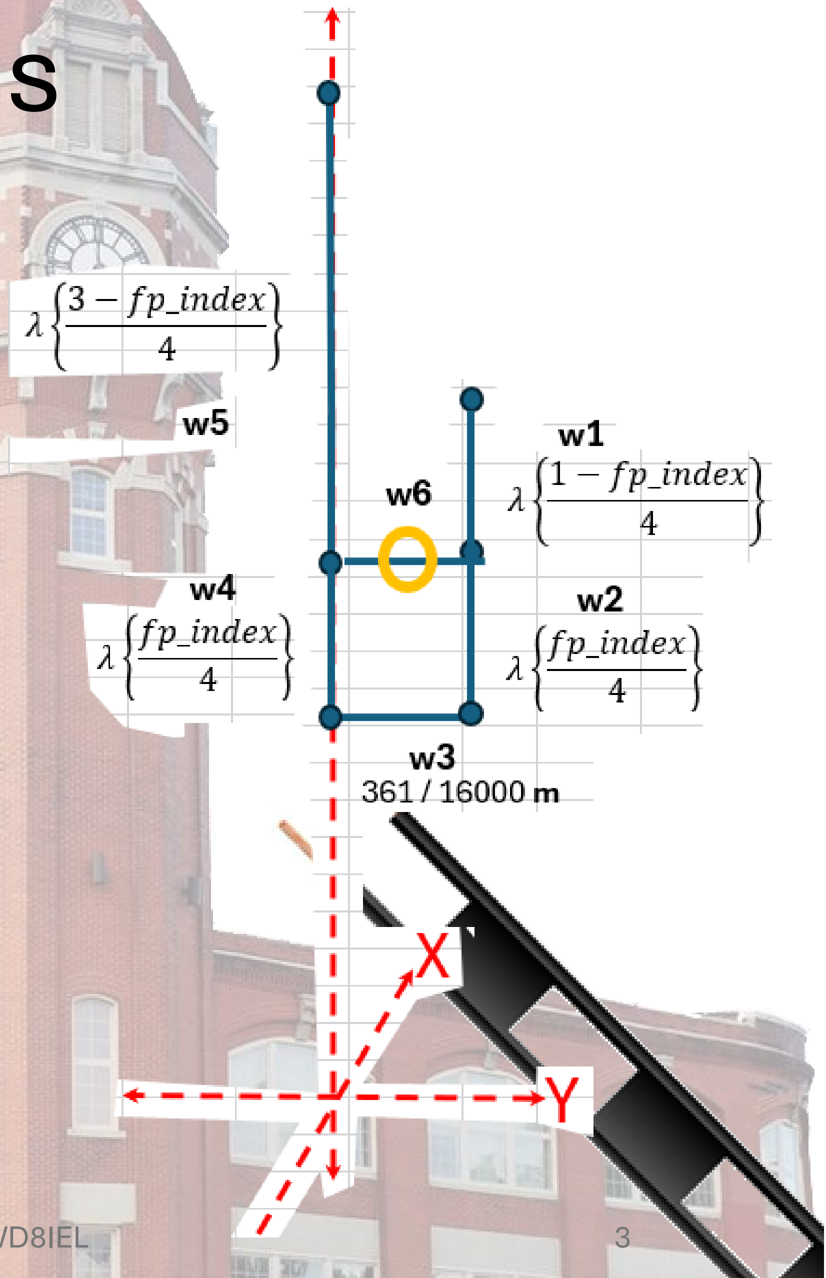
Proposed:

- A J-Pole antenna will be modeled for computer simulation using the NEC antenna simulation engine developed by the Lawrence-Livermore Laboratory in the 1970s.
- We will be using the EZNEC implementation of the NEC engine.
- This presentation will be qualitative in nature.
    - We will present in 30 minutes or less the basics of modeling the J-Pole for simulation.
    - Tomorrow we will do a deep-dive into this doing the actual modeling.
    - An Excel spreadsheet will be presented at that time for modeling.
    - Please visit the Chelsea Amateur Radio Club website for last-minute scheduling and details.
    - It is anticipated that the notes for that session will be put up on the website before the meeting.

Define the Antenna Specifications

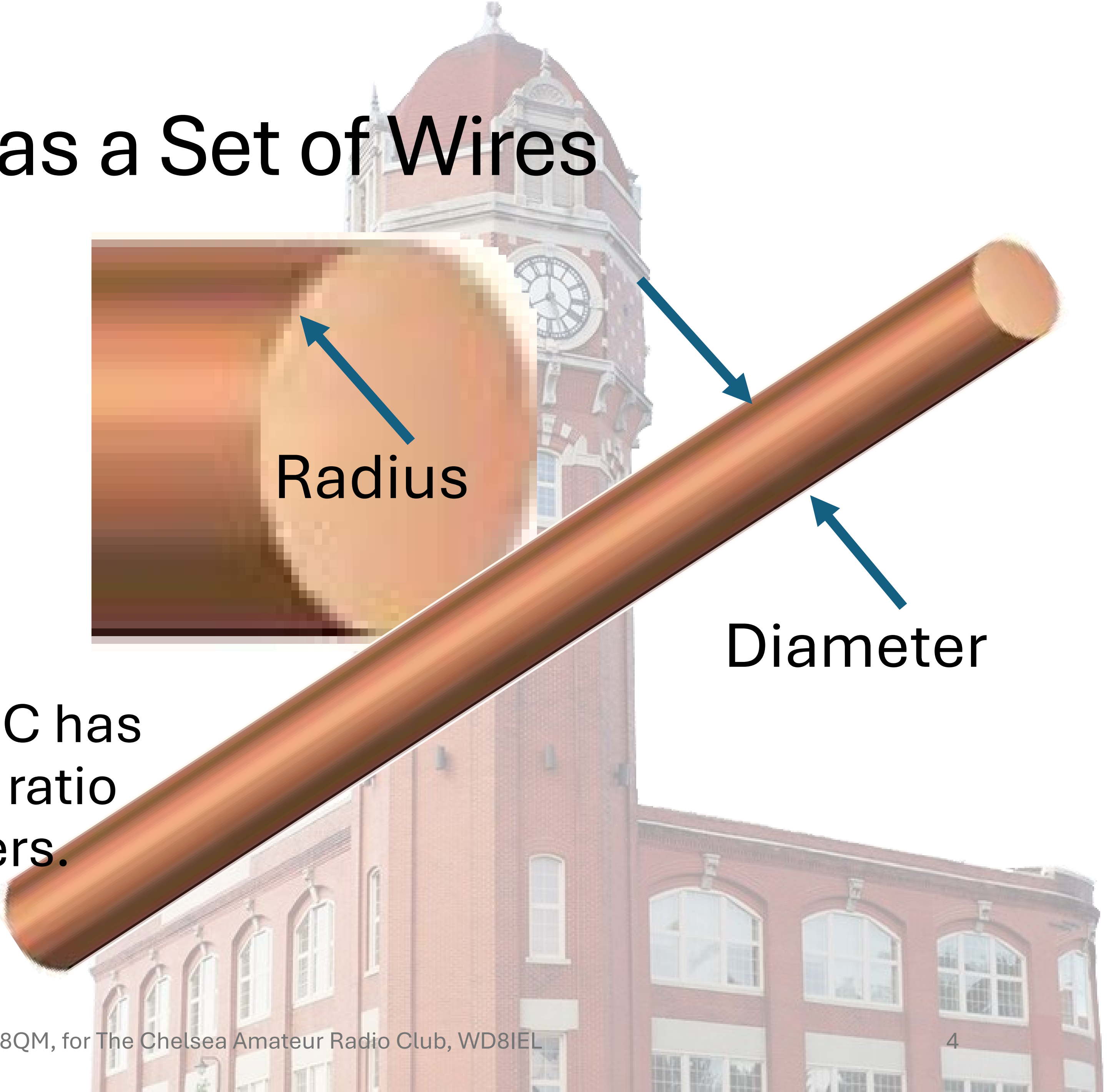
- Resonant frequency: 146 MHz
- Velocity factor: 1.0

  Note: For purposes of the NEC modeling software, we will ignore velocity factor. But that is only for now and for simplification purposes because of the nature of the NEC software.
- Composition: Ladder Line – X = 450 Ohms
- Antenna input Z:50 Ohms
- Use AWG #12 Wire
  - Diameter = 0.002052 meters



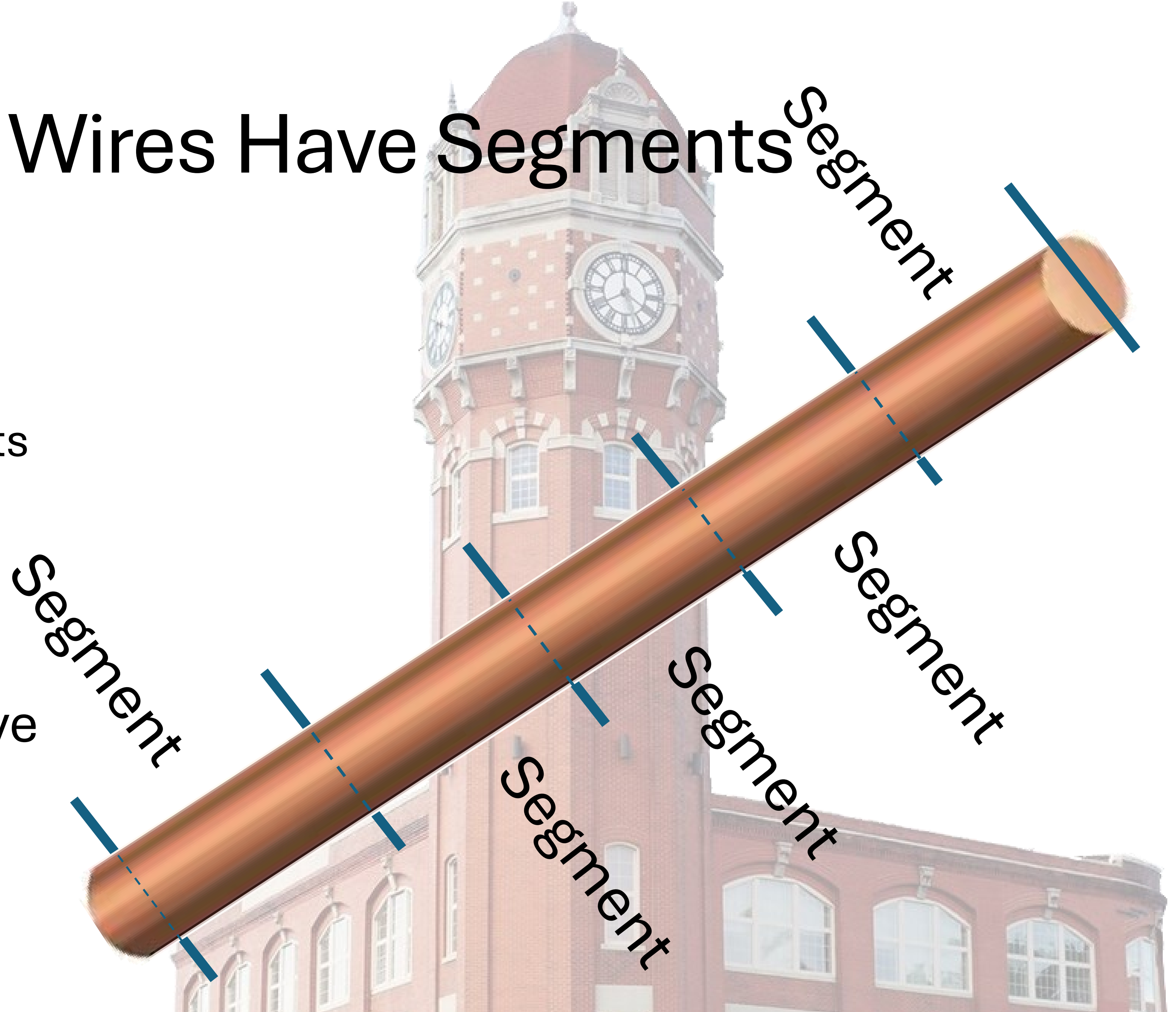
Antenna is Defined as a Set of Wires

- Wires define the antenna
- These have specifications
  - Diameter
  - Composition (molecular structure)
  - Length
- The numerical engine of NEC has requirements regarding the ratio of lengths and wire diameters.

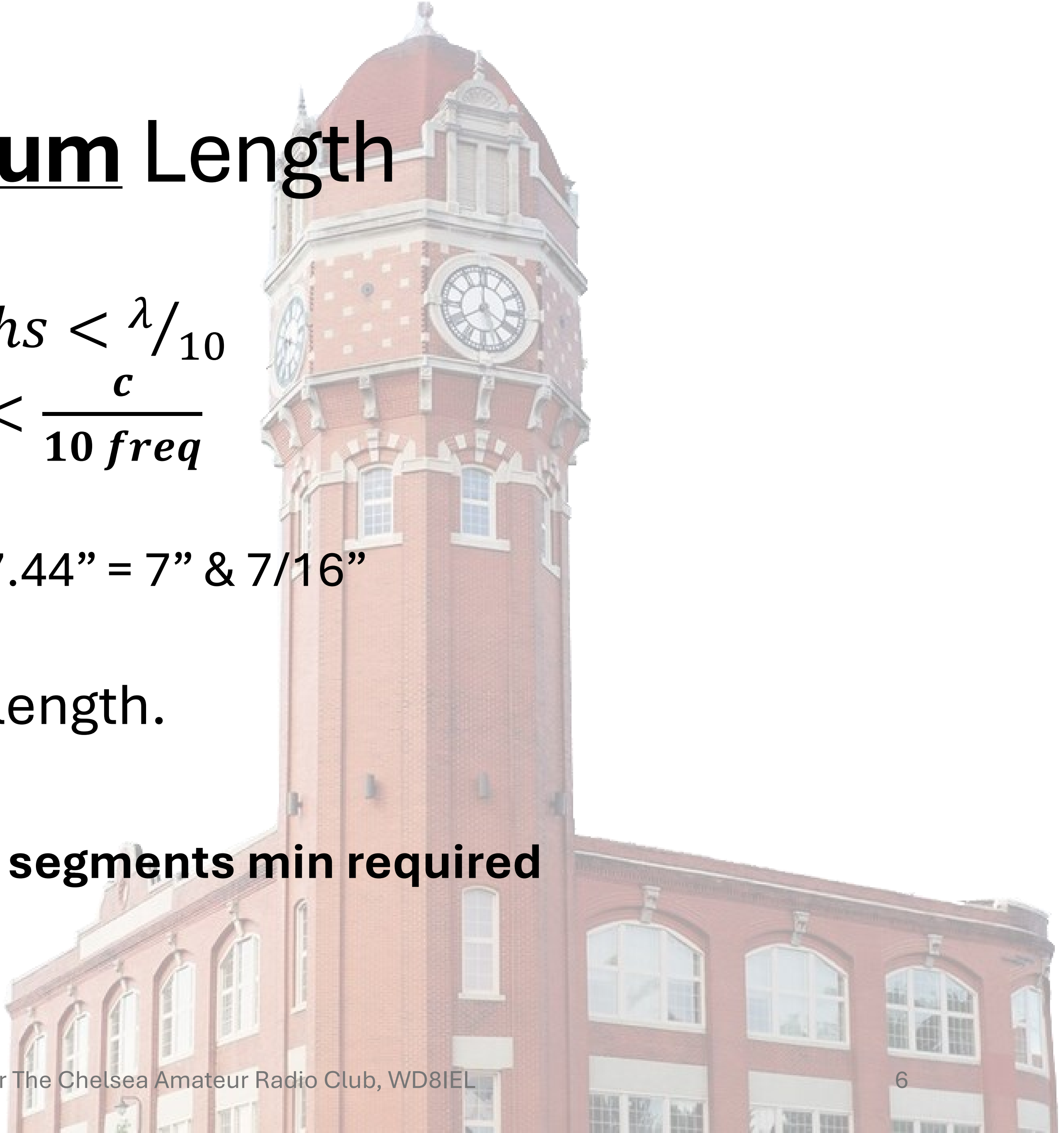


Critical Concept: Wires Have Segments

- A wire
  - may have any length.
  - Is composed of segments
- The length of a segment
  - Has a minimum
  - Has a maximum
- A very long wire may have many segments.
- Each segment has a min/max limitation.



Wire Segment **<u>Maximum</u>** Length



- NEC requires: $Segment\ Lengths < {}^{\lambda}/_{10}$
  - For convenience: $\boldsymbol{SegLen < \dfrac{c}{10\, freq}}$
  - Let freq (MHz) = 146 MHz
  - λ / 10 = 1.89 m / 10 = 0.189 m = 7.44” = 7” & 7/16” max length <u>per segment.</u>
- Example: A wire is to be 22” in length.
- How many segments needed?
  - 22” / 7.44” = 2.96 segments ➔ **3 segments min required**

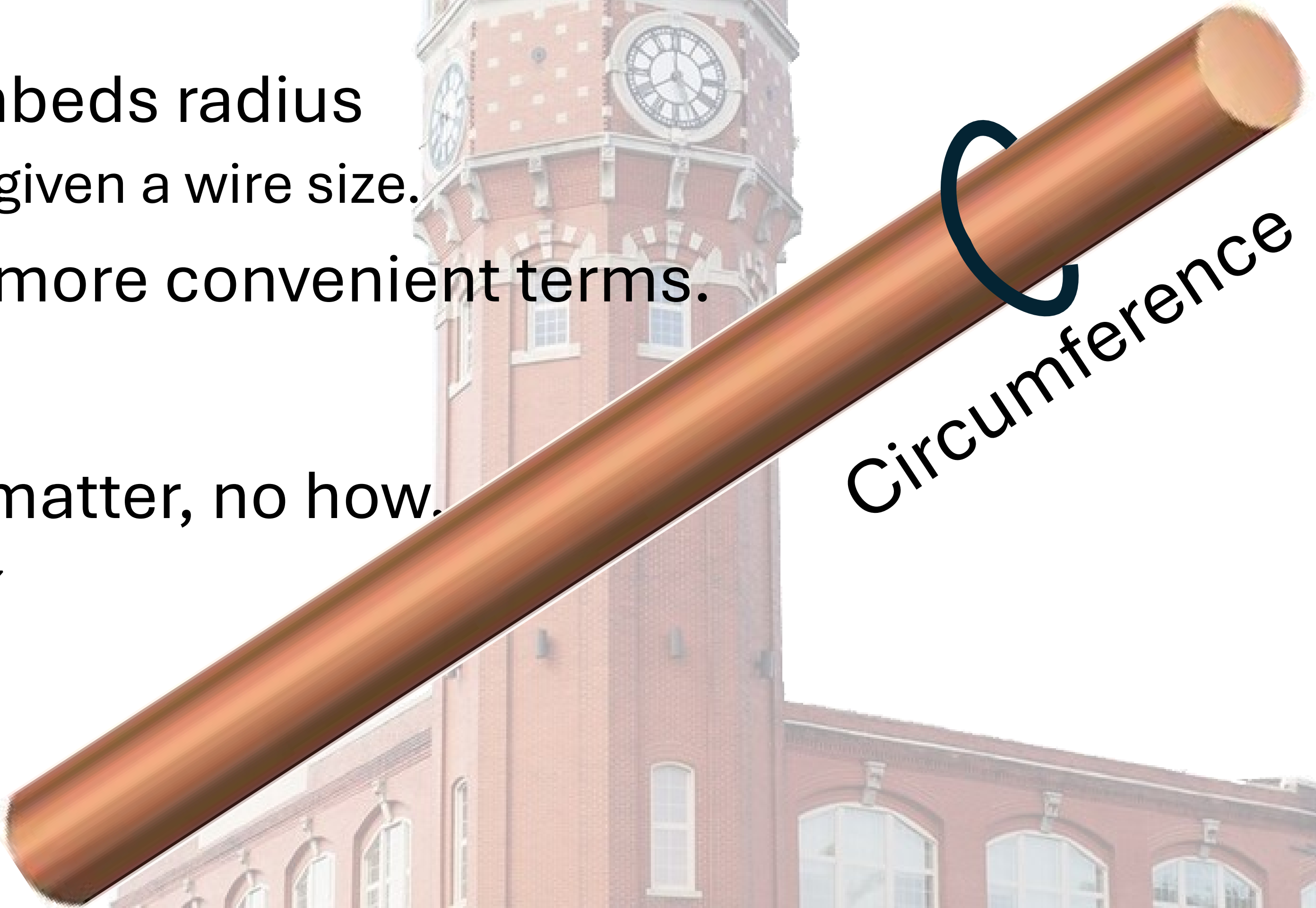
Wire Segment <u>**Minimum**</u> Length

- NEC has two MINIMUM segment length requirements:
  - $\lambda/_{1,000}$
  - $4\ Wire\ Diamete$

  $< \quad Segment\ Length$
- λ remains 2.053356 meters
- Min len #1: $\lambda/1{,}000$ = 0.002053 meters
- Min len #2: 4*Dia #12 wire = 0.008100 meters
- Segment Lengths must be: > 0.0081 meters
- Given: a 22” #12 AWG wire.
  - Can have as few as one (1) segment for this 22” #12 AWG wire.

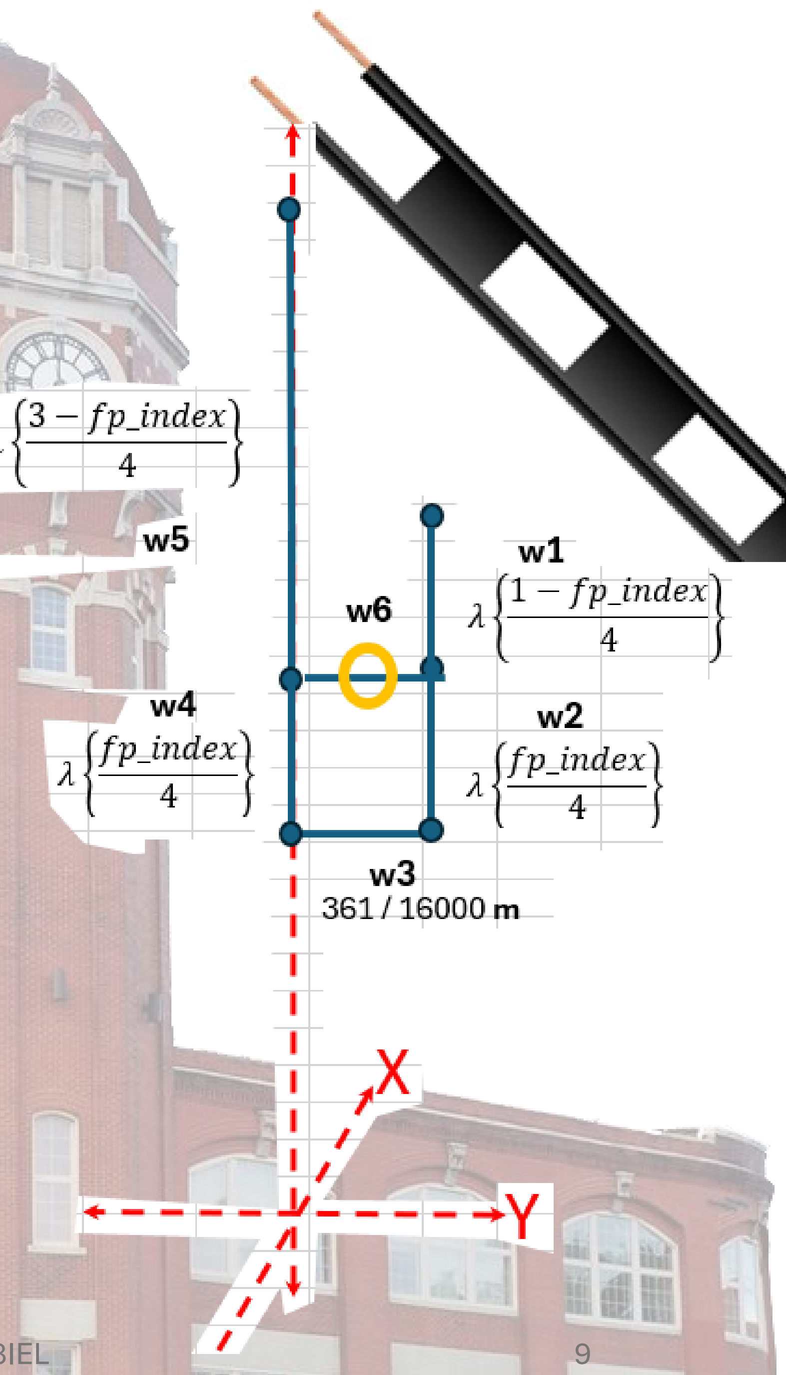
Wire Circumference ➔ $\frac{circumference}{\lambda} \ll Unity$

- Because circumference embeds radius
  - Max f_o NEC may be used for given a wire size.
- This can be re-defined into more convenient terms.
  - $f_{o\,max(GHz)} \ll {}^{\frac{3e8m}{s}vf}\!/_{\pi\ Dia_m}$
- But how much less? Don’t matter, no how.
  - #1 AWG wire: $fo < 0.82\ GHz$
  - #30 AWG wire: $fo < 75\ GHz$

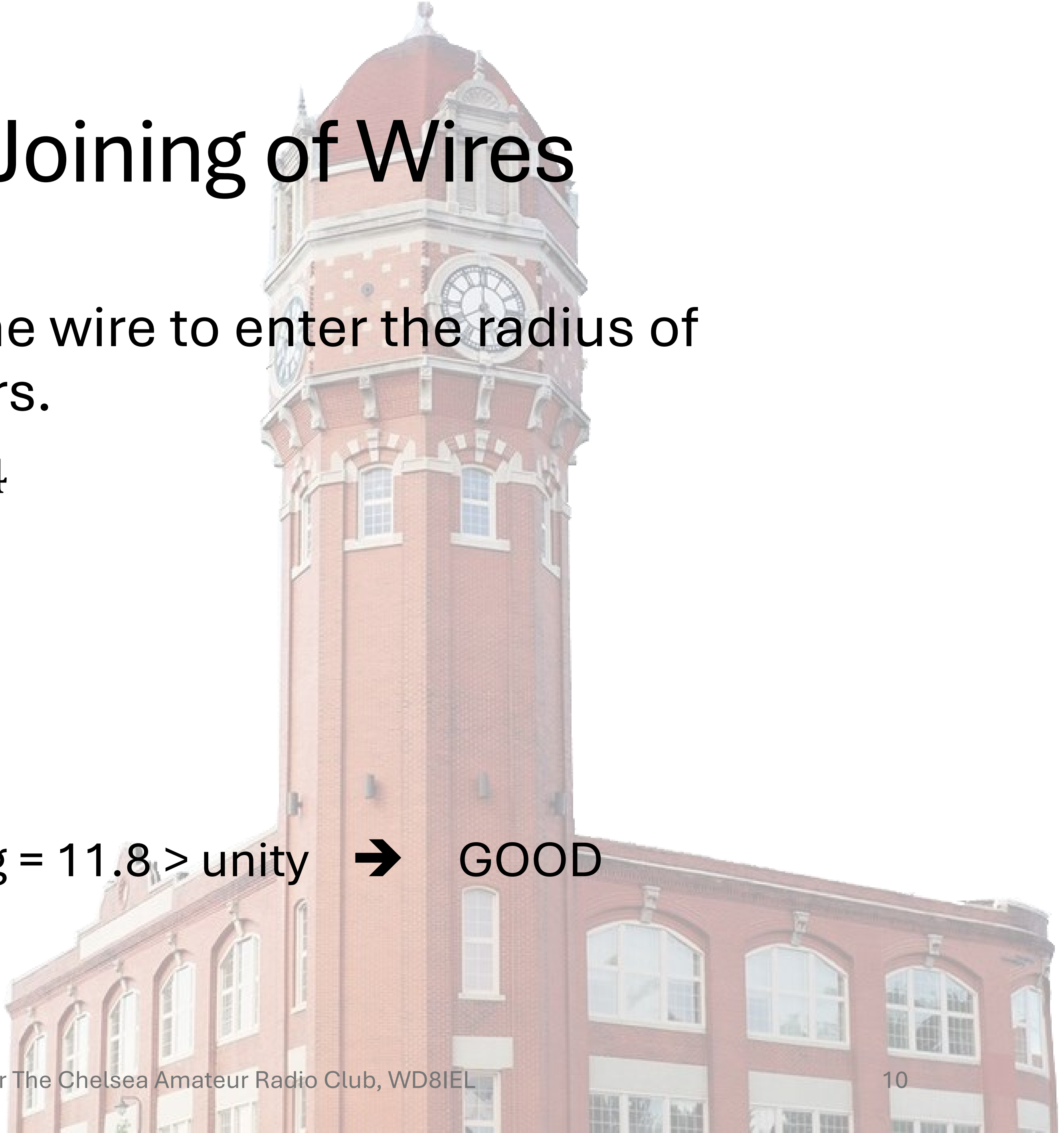


Define the Antenna

- Resonant frequency: 146 MHz
- fp_indx = 0.05 *(feed point index—a guess for now)*
- Velocity factor (vf) = 1.0 *(ignoring for now)*
  - λ = 299.79 / 146 MHz = 2.0533561 meters
  - $\lambda/4$ = 0.5133390 meters
- $W2_{len} = W4_{len}$ = 0.513(0.05) = 0.025667 m
- $W1_{len}$ = 0.513(1-0.05) = $W3_{len}$ = 0.47577 m
- $W5_{len}$ = 0.513(3-0.05)/4 = 1.5144 m
- $W3_{len}$ = 15/16”*2.54/100 = 0.025667 m



Special Case: Angled Joining of Wires



- Must not allow the center of one wire to enter the radius of another wire—these are corners.
  - Satisfied with: $\frac{Segment\ Length}{Wire\ Diameter} > 4$
- Re-written for convenience:
  - $\frac{Segment\ Length}{4\ Wire\ Diameter} > unity$
- For w1
  - Will be using 5 segments
  - 0.4873m/ (4 * 0.002052m) / 5seg = 11.8 > unity ➔ GOOD

This Has Been a Qualitative Presentation

- Tomorrow (March 12, 2024) at 7 PM by video conference we will present a deep-dive into this model.
- “Deep Dive” is not intended to mean “for rocket scientists only.”
- Nothing beyond what is expected of amateur extra class licensees will be presented.
- Please visit the Chelsea Amateur Radio Club website for last-minute details on the video conference meeting.