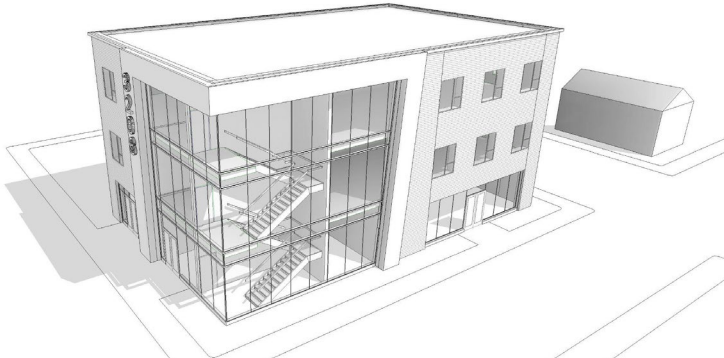




Connecting Industry to Mathematics Instruction

NSF ATE Award # 1954291

Solutions: Building Setbacks Student Activity Sheet



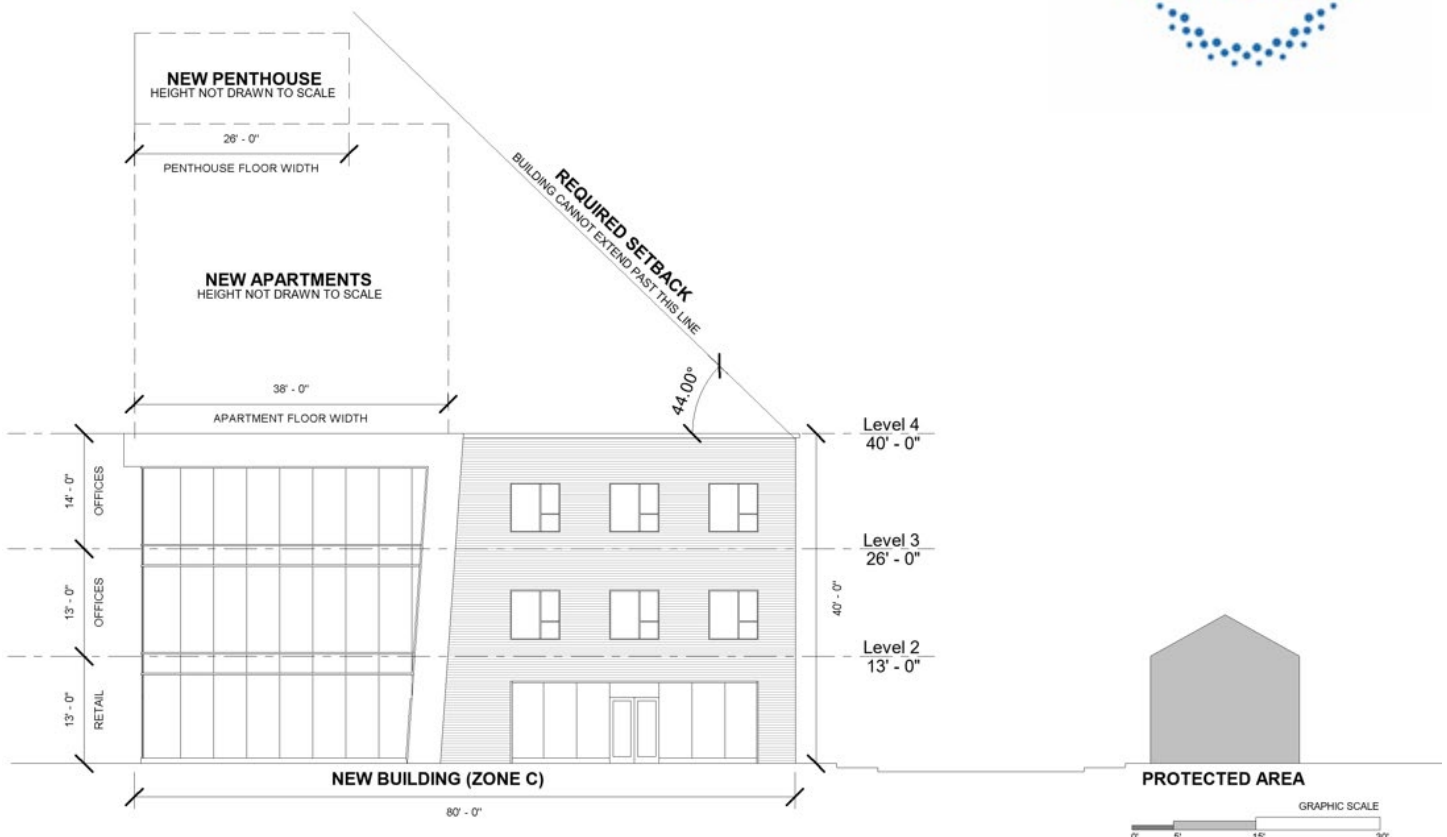
A developer is looking to add apartment buildings in a mixed use lot downtown. The developer wants to make sure they are maximizing the number of apartments they provide while complying with the city's municipal code with the protected areas nearby.

The building is designed with retail and offices on the bottom floors up to a 40' allowable height from street level. According to the city's code, at a height of 40' the building must meet a required setback zone created by a 44 degree angle measured from the edge of the building. **No part of the apartment building can cross the required setback line.**

In partnership with



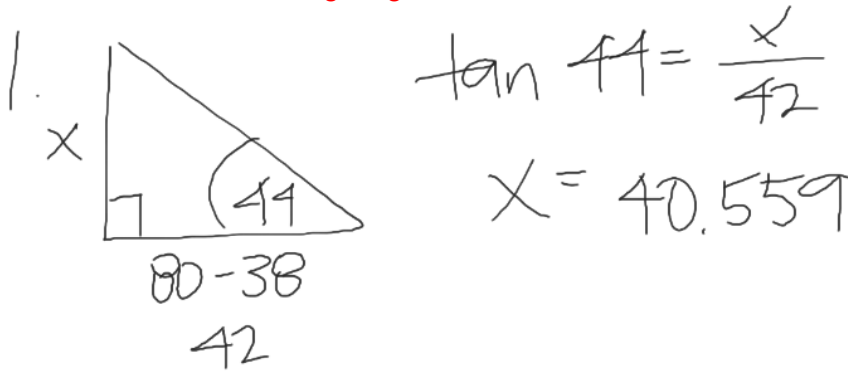
WAKE COUNTY
PUBLIC SCHOOL SYSTEM



Take a guess! How tall do you estimate the "NEW APARTMENTS" building can be? Why?

Task 1: When stacking apartment buildings for several stories, a minimal space of 3 feet is needed between the ceiling of the first story and the floor of the second story.

- a) If we put 14 feet between the floor of the first and second stories (the 14 ft includes the required 3 ft space between floors), what would be the ceiling height of the first floor apartments? Why is this 3 foot space needed between floor and ceiling? **14-3=11 feet; needed for air conditioning duct work, plumbing pipes, electrical conduits, etc**
- b) How many floors of apartments can be added without impeding in this restricted zone assuming each additional floor is 38' wide and 14' between adjacent floors? **2 floors**
- c) What maximum floor to floor height would allow for 3 stories of apartments? What would be the ceiling height of each apartment? Assume 3' is needed between ceiling and floor. **13.5 ft floor to floor height; 10.5 ft floor to ceiling height**



$$\frac{40.559}{14} = 2.897$$

2 floors

$$\frac{40.559}{3} = 13.520$$

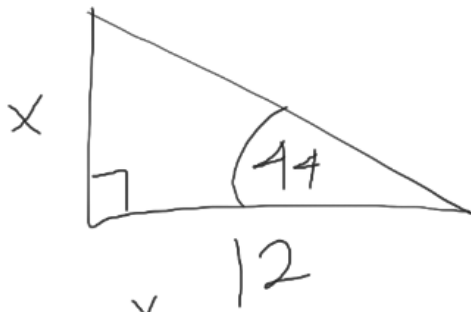
13.5 feet - 3 feet

10.5 ft floor to ceiling

Task 2: To utilize additional space above the 3 apartments, the designer is considering including a penthouse above the apartments.

- a) Using the maximum floor height to include 3 floors (result of task 1c), is this possible to fit the penthouse within the required area assuming the penthouse is 26' wide and 14' tall (this is the floor to floor measure, including the 3' buffer)? Explain why or why not. **No, it can only be 11.588 ft tall.**

2.

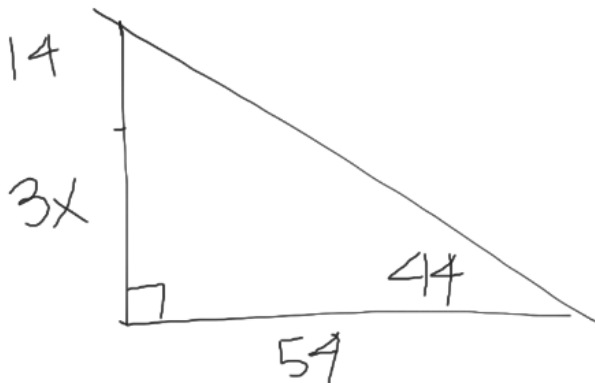


$$\tan 44 = \frac{x}{12}$$

$$x = 11.588$$

not possible

- b) What is the maximum possible height for a floor, assuming 3 floors total, if the developer wants to include a penthouse suite 26' wide and 14' tall and also stay below the restricted zone? 9.716 ft

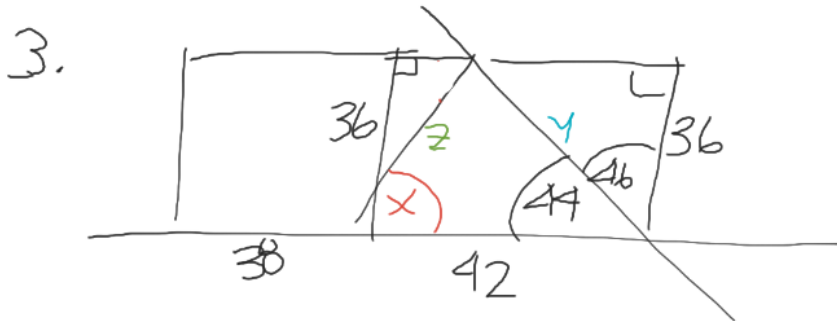
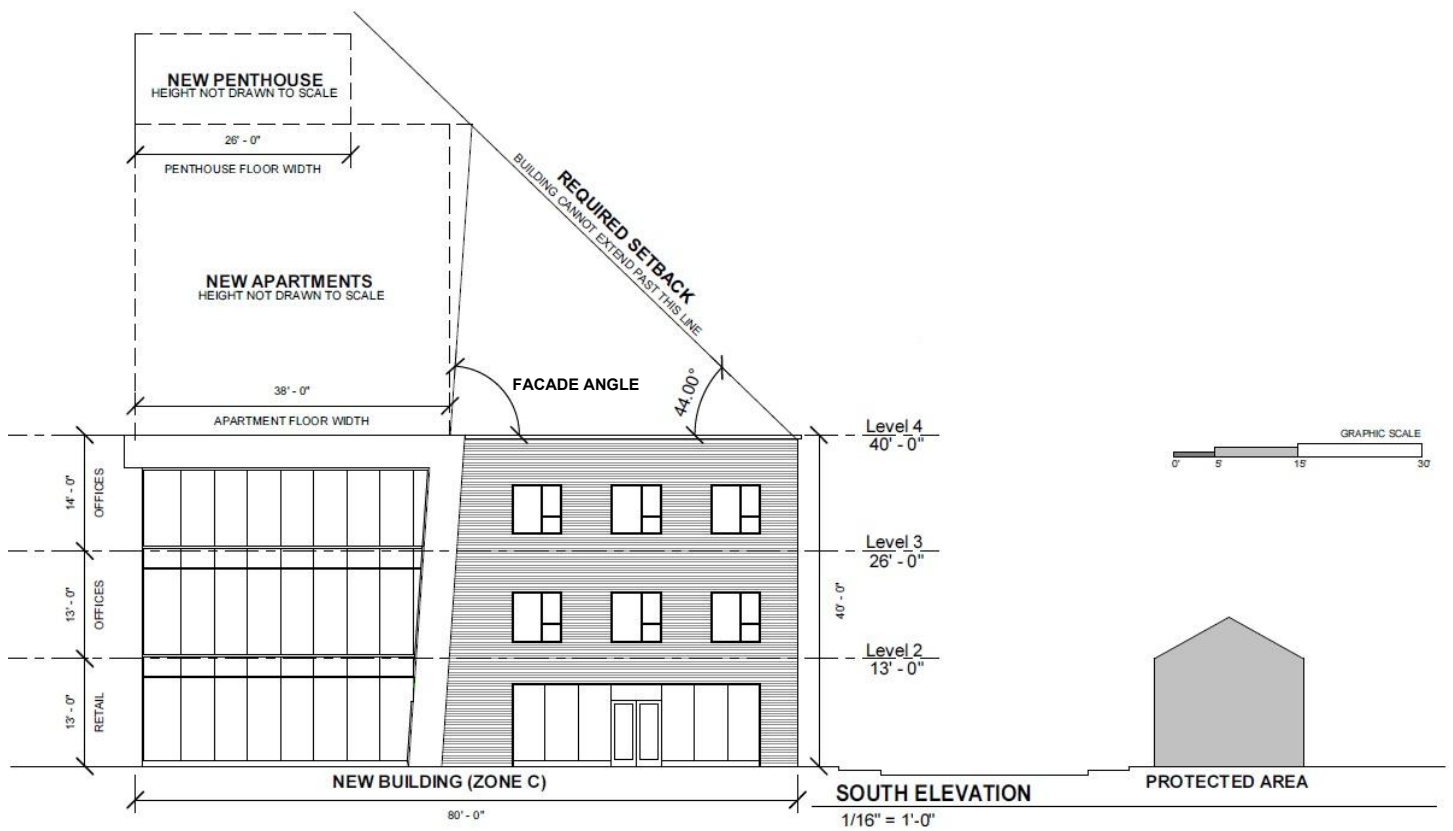


$$\tan 44 = \frac{3x + 14}{54}$$

$$x = 12.716 \text{ feet}$$

9.716 ft floor to ceiling

Task 3: To improve the architectural appearance, the developer wants to add an angled facade to the apartments to align with the retail and office building below. What minimum angle of the facade will allow 3 stories of apartments assuming a 12' floor to floor height is used? 82.531 degrees



$$\cos 46 = \frac{36}{y}$$

$$y = 51.824 \text{ ft}$$

$$z = \sqrt{42^2 + 51.824^2 - 2 \cdot 42 \cdot 51.824 \cdot \cos 44}$$

$$z = 36.308 \text{ ft}$$

$$\frac{\sin 44}{36.308} = \frac{\sin x}{51.824}$$

$$x = 82.531^\circ$$

Glossary of Terms

Allowable Height – max height from ground level that a building is allowed to be constructed.

Building Area – the sum of all occupied floor area on all levels of a building, often in square feet

Mixed Use – a zoning type that allows for a blending of residential, commercial, entertainment, and other building classifications into one space

Municipal Code – ordinances enforced by city or local government that must be followed in addition to building code. The intent is often that these help with the development of different areas in the city and protect established areas from being negatively impacted by new construction or development.

Setback – the distance a building must be pushed back from the property line before construction can begin. A building is not allowed to pass into these areas.

Façade – face or exterior skin of a building

International Building Code (IBC) – Written building code that preserves and protects the health and safety of the public in the built environment. Adopted and usually amended by each state to ensure a building is safe when designed and constructed.

References:

International Building Code available through UpCodes: https://up.codes/codes/north_carolina

City of Raleigh Municipal Code available at: <https://raleighnc.gov/services/government/city-code>

