Connecting Industry to Mathematics Instruction
NSF ATE Award # 1954291

The Missing Monument - Student Activity Sheet

In partnership with

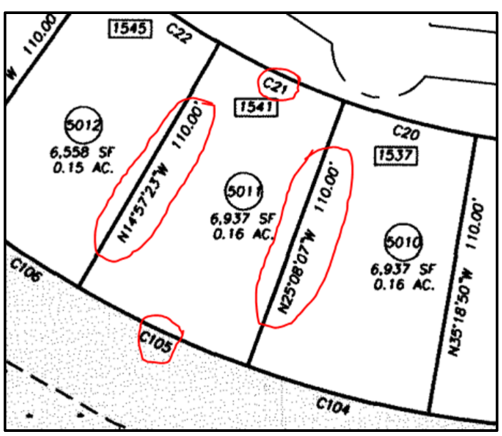
WAKE TECH

WAKE COUNTY PUBLIC SCHOOL SYSTEM

WakeEd PARTNERSHIP

A homeowner is looking into building a fence around their property. Before they start construction on the fence, they first want to confirm where their property lines are, so they don't accidentally build on their neighbor's land. Once the fence is built, they don't want to have to move the fence.

The homeowner decides to call Canoy Surveying to come and mark their property lines. In the image below, we have a map showing us the distance and bearing angles used to originally monument the property. This should help guide us to the property corners.



C21	53.30'	300.00'	S69°57'15"W	53.23'

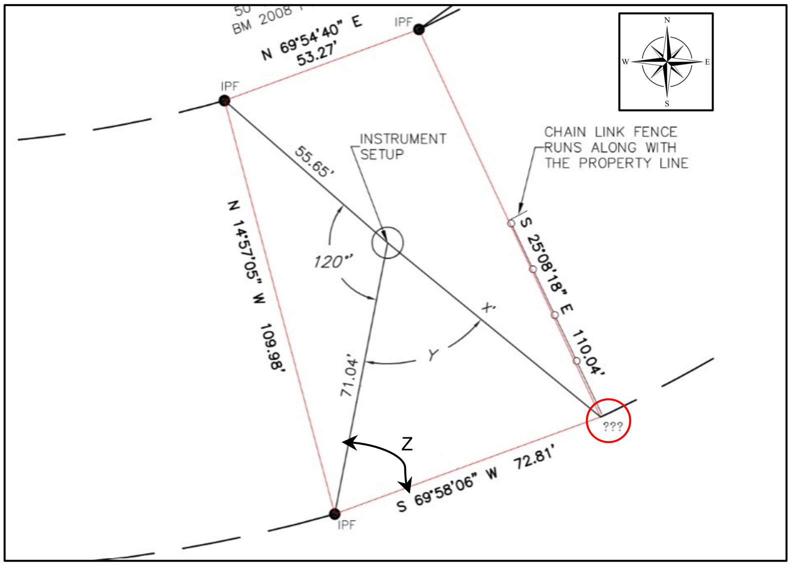
C105	72.84'	410.00'	S69°57'15"W	72.74'

When a property is monumented, it is marked by burying a stake. Most stakes are made of iron or some other metal, but there are some older properties where the stakes are made of wood or other nonmetal materials. This property has metal stakes monumenting the property.

Why do you think it is useful to have metal stakes monumenting a property vs. a nonmetal one?

TASK #1 Find the Missing Corner of the Property

Using a metal detector, we have been able to find and measure 3 of the points relatively easily. We are having trouble finding the final corner due to the chain link fence that follows the property line. The metal detector has been less effective since there is so much metal in the area.



We set up the Robotic Total Station within the property. This piece of equipment calculates distances and internal angles turned between two points very accurately. With that we can use trigonometric equations to calculate positions of points and additional angles needed. The equipment was able to give us some information to get us started.

To find the final corner point for the property, we need to find several missing pieces of information, so we can use our equipment to help us locate that final point. From the bottom left corner point to the bottom right, we are given the distance. But we don't actually know the location of that corner point since that is what we are trying to find.

Initial Question: Can we use that value to help us calculate the other unknowns? Why or why not?

1. Let's talk about a bearing angle.
    a. Based on your work in the Desmos activity, what makes a bearing angle different from a standard position angle?

    b. In the surveying world, we use bearing angles. How will the bearing angles given help us determine the measure of angle D?

2. Let's determine the missing side lengths and angle measures. Complete the tables below with work and answers. You do not have to find the side lengths and angle measures in the order listed, you can use Law of Sines, Law of Cosines, Bearing Angles, and Right Triangle Trigonometry as needed to determine the missing side lengths and angle measures. **Please use the following rules for rounding:**

   Do not round intermediate calculations. Round only final answers.

   Side lengths and angle measures should be rounded to the nearest hundredth (2 decimal places)

   Bearing Angles are given in degrees, minutes and seconds. To convert this to decimal degrees use this website (opens in a new window) and then round your angle to the nearest hundredth.

   NOTE: In the picture on the last page of this document, the sum of the angle labeled 120° and angle E is NOT 180°.

Angles	Answer	Work
A		
B		
C		
D		
E		

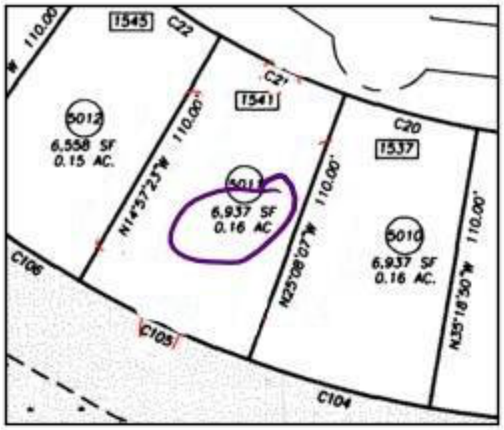
Angles	Answer	Work
F		
G		
H		
I		
J		
K		
L		

Angles	Answer	Work
M		
N		
O		

Sides	Answer	Work
d		
f		

3. Based on your answers above, where should the final monument be placed? Explain your choice using complete sentences.

TASK #2 Confirming the Area of the Property



The original property document shows the original square footage and acreage for the lot. The plot was measured to be 6,937 square feet and 0.16 acres.

Now that you have calculated or been given the various angles and side lengths of the property, calculate the area of the plot, and then convert that and determine the acreage.

Some important formulas and conversion factors are:

$$A = \sqrt{s(s-a)(s-b)(s-c)},\ where\ s\ = \frac{a+b+c}{2}$$

1 acre = 43560 square feet

1. The plot of land is divided into four triangles. Use your calculations from Task 1 to determine the area of each of the four triangles and the total area (in both square feet and acres).

Triangle	Area	Work
Triangle 1		
Triangle 2		
Triangle 3		
Triangle 4		

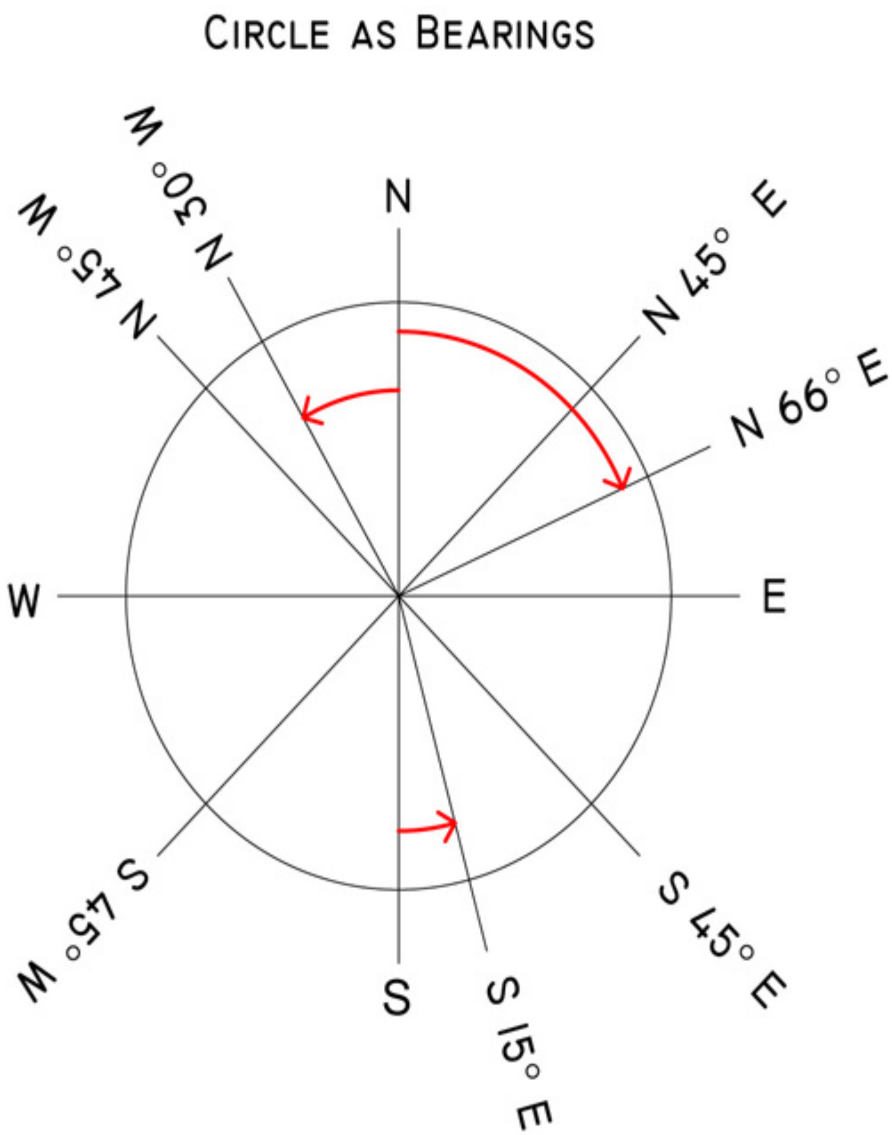
2. How does your calculated area compare to the area given? Do you think you were able to correctly place the monument? Use complete sentences to support your answer.

GLOSSARY of TERMS

Bearing Angle in Surveying - surveying rarely uses degrees. They usually use a system of bearings based on deviation from north or deviation from south.

For example in the image below:

- N 66° E means 66° to the east of North,
- N 30° W means 30° to the west of North
- S 15° E means 15° to the east of South



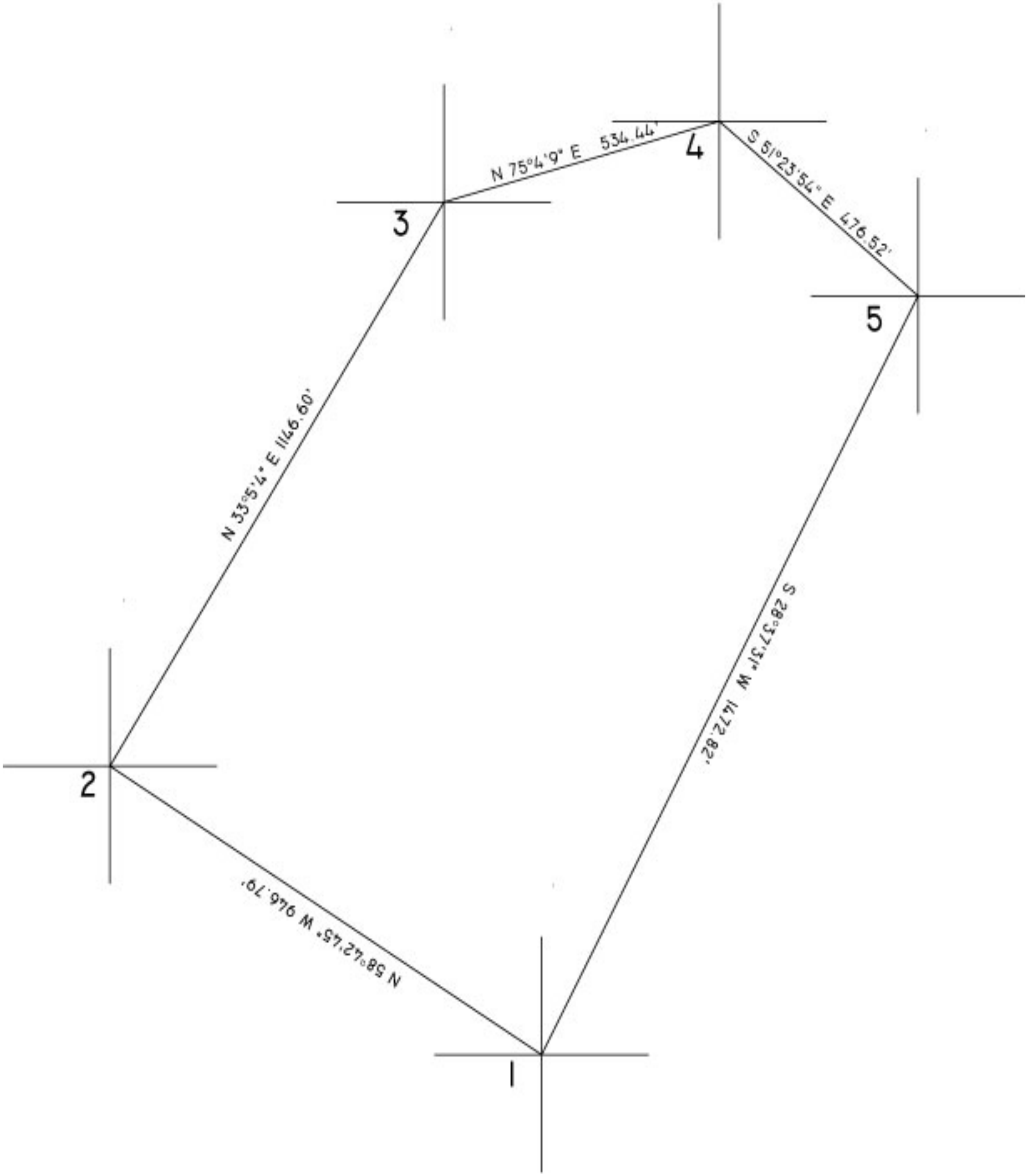
Surveying - or land surveying is the technique of determining two-dimensional or three-dimensional positions of points and the distances and angles between them.

Monument - a physical structure which marks the location of a corner or other survey points.

Robotic Total Station - can measure angles and distances electronically. It uses trigonometry to give us the position of coordinates in space or the viewing plane.

Helpful Image for understanding bearing angles in context

This image shows how we can orient each property corner relative to due North to help us find the various angle measurements within a property.



Enlarged image for student use