### Surveying Terms

- **Bench Mark (BM)** – a permanent object whose elevation is assumed or known.
- **Elevation (EL)** – the vertical distance from a datum to a point or object.
- **Mean Sea Level (MSL)** – average height of the sea’s surface for all stages of tides. The EL = 0 at this location.
- **Height of Instrument (HI)** – the elevation at the line of sight when the surveying instrument is level.
- **Back Sight (BS)** – the rod reading taken on a bench mark with a known elevation.
- **Foresight (FS)** – the rod reading taken on any point for which the elevation is to be determined.
- **Turning Point (TP)** – a temporary BM such as a nail in tree or an object. It is used to re-locate the instrument.
Benchmarks

- a point of reference for a measurement

- If EL is “known” - height above Mean Sea Level

- If EL is “assumed” – not tied into any established reference system

Examples of Known Elevations

- Mt. Frissell (Salisbury) highest point in CT EL = 2,380 ft
- Bradley Airport Runway EL=173 ft
- Mystic Sea Aquarium EL= 10 ft
- Mt. Washington (NH) highest peak in NE US EL = 6,288 ft
Benchmarks

Examples of Unknown Elevations

Assumed BM
EL= 100.0'
(no established reference system)

What is a good benchmark?

- Can I find it?
- Is it stable?
- Can I put a level rod on it?
- Does it have to be removed during site construction?
- Is it too far from the construction area?
Benchmarks

- Usually set by the engineer in a permanent location (top of catch basin or foundation). Occasionally a nail in a tree, however not recommended.
- Plans must have accurate topography.

Benchmarks

- Plans prepared by a Professional Engineer must have vertical and horizontal controls.
- Field staking is acceptable.

Types used for SSDS Installations

- Transit
  - Two persons needed to operate
  - Not self leveling
Types used SSDS Installations

- Laser level transit
  - Typically self leveling
  - Electronic receiver
  - One person can operate

The Rod

- Hold rod vertical, not leaning in any direction and flush to the object.
- Adjust receiver until a constant tone is heard.
- Read the rod and record the data

Problems?

- Reading the wrong number on the level rod.
- Writing down wrong number on your notes.
- Add/subtract incorrectly.
- Level rod sections not locked into place.
- Place rod on correct BM.
Reading a Stadia Rod

What is the Rod Reading? 4.07
Reading a Stadia Rod
What is the Rod Reading? 6.34
The whole number is 6.

Reading a Stadia Rod
What is the Rod Reading? 13.71
The Whole Number is 13.

Reading a Stadia Rod
What is the Rod Reading? 21.06
Determining Elevations using a Transit or Laser

What is the Instrument Height? 105.42
100.00
+ 5.42
105.42

What is the Bench Mark Elevation? 100.00
102.25
- 2.25
100.00
What is the Bench Mark Elevation? 89.88

95.30
- 5.42
89.88

What is the Instrument Height? 97.09

85.82
+ 11.27
97.09

What is the Ground Elevation? 738.15

750.50
+ 2.28
752.78
- 14.63
738.15
Field Checks

- Take a shot on a second point with a known elevation.
- Take a few shots on the ground in the proposed leaching system area.
- Be sure the cuts and fills match contours.
Ending check of elevation

- The instrument can get moved during inspection
- The last elevation taken on each job should be the bench mark.

Slope or Hydraulic Gradient

How to Calculate:
Vertical (Rise)/Horizontal (Run)
Slope(%) = Rise/Run x 100

Slope Calc. Example
Slope = Rise/Run x 100
= 8'/100' x 100
= 8%
**Slope Calc. Example**

Slope = Rise/Run x 100

= 3'/122' x 100

Slope = 2.45% or 2.5%

\[ \text{Slope} \]

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X=4', Y=6.5' and Z=50'

What is the slope?

\[ \text{Slope} \]

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X=4', Y=6.5' and Z=50'

Rise = 6.5 - 4 = 2.5'

Run = 50'

Slope = 2.5'/50' x 100 = 5%

\[ \text{Slope} \]
Horizontal Surveying Objectives

Use and read an engineer's scale

- Most plans drawn at 1"=10' or 20'
- Be sure the plan you are reading has not been changed or reduced
- Check the scale by scaling a distance given on the plan first

Horizontal Surveying Objectives

You must know how to convert inches into feet, and feet into inches.

- Example: 8" = 0.67' [8'/12]
- Example: 0.75' = 9" [0.75' x 12]

For horizontal distances, round to nearest tenth of foot

Horizontal Surveying Objectives

When are horizontal measurements typically required?

- As-built drawings (installer or PE)
- Confirm separations distances (wells, drains...)
- Field Checks (length of the leaching system or building sewer pipe)
Horizontal Surveying Objectives

Proper measuring techniques

• Hold the tape level and with proper tension
• No bends in measuring tape
• Tape is not broken
• Check measurements in both directions
• Write down accurate numbers

Horizontal Surveying Objectives

Establishing cross ties (a.k.a. swing ties)

• Use existing physical features that are unlikely to be removed or altered (at least 2)
• Make sure there are no obstructions
• Be clear on what you have established a cross tie to (tank cover, d-box, end of LS row)
### Horizontal Surveying Objectives

#### Field Checks

- Check the plan and scale distance that are listed on plan
- Search plan onsite looking for errors
- Look at contours and grades on plan to see if they are correct