

Alaska Planner Requirements for Hand Levels, Clinometers and Abney Levels

Hand Levels, Clinometers and Abney Levels

This course will provide an overview on the function and use of hand levels, clinometers, and Abney levels. All planners should be familiar with these tools and carry them when going into the field. These tools help you assess a site and evaluate it based on sound measurements rather than relying on your eyeball perception of the lay of the land. Measurements can be used for erosion equations, watershed evaluation, and hydrology. The data allows a planner to estimate waterflow and help develop alternatives when talking with the land user about practices and their applicability to the site.

Minimum ASK level Required 2

Hand levels

Video: Introduction to hand levels- <https://www.youtube.com/watch?v=76OHo7HjoBU> , Time Approx. 1 ½ min.

Note: The video moves fairly fast, but you can slow it to a suitable speed, if needed, in the settings.

- Description: A hand level is a sight instrument that consists of a telescope with a spirit level (bubble level) and a mirror/prism. The mirror/prism allows the user to view the level while looking through the instrument.
- Type
 - Magnification and non-magnifying
 - Fixed sight and adjustable
 - Electronic and bubble level
- Uses and limitations
 - Determining grade for watercourses or outlets for practice determinations for practices such as waterways, ditches, land leveling, water and sediment control basins, grade stabilization structures; determining capacity for culverts and other restrictions in a watershed analysis.
 - Using a simple topographic survey for Needs and Feasibility or locating a practice or alternative, such as feedlot or farmstead runoff patterns from buildings or other structures.
 - Establishing a field contour for practice analysis with a landowner during the conservation planning process.
 - Some hand levels are equipped with stadia hairs to enable measuring distance between the hand level and the survey rod. Video- **Reading Stadia Hairs:** <https://youtu.be/hnZJtVDMWSg> , Time Approx. 5 min.
- Accuracy
 - Dependent on the skill of the user. However, these tools are intended to be used for rough estimates and not precision measurements that would be used in practice design or construction inspection.
 - Most hand levels are accurate to ¼" in 20'
 - Improves with a monopod, staff, or forked stick.
 - Improved using proficiency exercises, below.

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Abney Levels

Video- Using an Abney level: <https://youtu.be/Knob0zezPz8> . Time Approx. 7½ min

- **Description:** An Abney level is similar to a Hand Level in that it is a telescope with a spirit level attached. The main distinction is that the spirit level on an Abney level is not set in a static horizontal position. An Abney level features a graduated arc, which can measure degrees or percent of slope

- **Uses and limitations**
 - The uses for the Abney level include all the uses listed for a hand level (above) plus measuring slope percentages directly and determining degrees of angles.
 - Other uses would include estimating the height of a tree to determine volume of lumber, heights of buildings or structures, or the height of a hill.
 - Measuring slope percentages to help predict erosion rates.
 - This tool is useful for conservation planning on practically all land uses including, Forest land, Cropland, Pasture or Rangeland, Wildlife land and Farmsteads or Urban land.
 - Some Abney levels are equipped with stadia hairs to enable measuring distance between the hand level and the survey rod. Video- **Reading Stadia Hairs** (above)

- **Accuracy**
 - Like the hand level, accuracy is dependent on the skill of the individual. This tool also is for general planning accuracy and not for design work or construction inspection.
 - Comparable to a hand level for reading a survey rod.
 - Improved using a monopod, staff, or forked stick.
 - Improved using proficiency exercises, below.

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Clinometer

- Description
 - A hand clinometer can be used as a hand level (see above) although most do not magnify. It is more commonly used to measure slope or tilt. This instrument requires both eyes to be used effectively.
- Uses and limitations
 - Like the Abney level, the clinometer is a common tool to determine slope percentages in a field, watercourse, or watershed when addressing resource concerns. It is used for soil loss equations to predict erosion rates and is quicker to read and easier to carry in the field than an Abney level.
 - Commonly used in forestry to measure the height of a tree by using simple trigonometric principles. In addition, it can help locate potential logging roads and staging areas.
 - Can be used for access roads and recreational trails and walkways, critically eroding areas, and as a measuring tool to determine sediment load for certain conservation practices.
- Accuracy
 - Like the hand level and Abney level, accuracy is dependent on the skill of the individual. This tool, like the others, is for general planning accuracy and not for design or construction inspection.
 - Improved using a monopod, staff, or stick.
 - Improved using proficiency exercises, below.

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Proficiency Exercises for Hand Levels, Abney Levels and Clinometers

Prerequisite: YouTube videos

Reading the Level Rod: <https://youtu.be/fbwEORw1c9Y>, Time Approx. 10 min

Leveling Part 1: <https://youtu.be/tNRZPHLwC7k>, Time Approx. 8 min

Leveling Part 2: <https://youtu.be/m52vUijOypE>, Time Approx. 9 min

Leveling Part 3: <https://youtu.be/Xtcu3YGS4g4>, Time Approx. 15 min

Leveling Part 4: <https://youtu.be/8WRnDsfdah0>, Time Approx. 14 min

Holding a survey rod plumb:

It is essential that the level rod be held in a “true” vertical position since it is measuring a vertical distance. If the rod is leaning, then the reading is not actually the true vertical distance. Leaning the rod forward, backward, or to the side will cause an error. Keeping the rod “plumb” is the rod person’s job because the person reading the measurements cannot readily tell if the rod is leaning.

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Level Accuracy Exercise (Abney and hand level)

Tools needed: Pocket rod or survey rod, Abney or hand level, clipboard, SCS-ENG-28 survey note paper or equivalent, monopod, 4'-5' staff or forked stick (optional). Requires two people for this exercise.

1. Stand at one point and hold yourself upright in a fixed position (as much as possible) and make sure the Abney level scale is set to zero. Have a second person locate a fixed object approximately 25' away as a temporary benchmark (labeled TBM with an assumed elevation of 100'). Then have them place the survey rod on the fixed object (TBM) vertically. Read off the survey rod while the hand level indicates a level bubble and record the number as a backsight (BS). Make sure the survey rod is always held vertically for an accurate reading. The person with the hand level remains stationary for step 2.
2. Next, have the rod person locate a second fixed point or object, called a turning point (labeled TP), roughly the same distance from the person with the hand level, as the person with the hand level is from the TBM, but in the opposite direction. Make sure the turning point is stable and not readily moved (a 2" square driven wood hub, flat rock or other similar object). With the hand level bubble centered, take a reading on the survey rod at the turning point. Record the reading as a foresight (FS) on the TP. The rod person stays stationary at this point for step 3.
3. Move to another spot, off to one side, that is roughly equidistance from the TBM and TP. Stand fast and upright again, and sight back on the turning point. Record that shot (rod reading) as a BS on the TP.
4. Without moving from your position, have the rod person go back to the TBM and hold the rod vertically. Sight on the rod and record the shot.
5. Reduce the notes and see how close you are to the Temporary Benchmark assumed elevation of 100'. Are you within 0.1 (tenth) of a foot?
6. Optional: now use a monopod or straight stick at the same center spot you were standing on in the previous exercise. Use the monopod to steady the level on, like a tripod holding the survey instrument. Repeat the exercise and compare accuracy.

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Onsite Topographic Map Exercise (Abney level and/or Hand Level)

Prerequisite: Above Training, plus:

Video- **How to draw contour lines**, <https://youtu.be/CdGY3CSVJBo>, Time Approx. 4 min

Refer to attachments 1-6 when working on this exercise.

Tools needed: Pocket rod, Abney or hand level, SCS-ENG-522 or other grid paper and pencil, survey flags, phone (for calculator), clipboard, monopod or 4'-5' staff or forked stick (optional). Requires two people for this exercise.

1. Locate a +/- 4% sloping ground and visualize a roughly 50' x 50' square area and mark the corners with survey flags. If you are using an Abney level, make sure it is set to "zero" on the arc scale.
2. Standing in the approximate center of the flagged area, have the rod person set a TBM (temporary benchmark) outside the grid and assign it an elevation of 100'. Have the rod person hold the rod vertically and take a BS reading on the TBM. Record it on the grid sheet.
3. Now, have the rod person pace off the area around you in rows starting at a flag and moving to the next flag, stopping every 10' for a FS rod reading. Move down 10' to the next row and repeat to make a grid pattern of 10'. Keep doing this until you have 36 readings ending at the final (4th) flag.
4. At each point, mark the FS rod reading on the grid paper as you estimate the location using an engineering computation grid sheet or other grid paper with each main square representing a 10' x 10' area. Your shot "point" should be the decimal in the recording i.e. 99.1 (see example).
5. Continue to do this with each point, ending with thirty six equally-spaced shots in the estimated 50' x 50' area.
6. Once you have all the points positioned and marked on the grid sheet, it should represent your area, and you are now ready to estimate the locations of topographic lines.
7. Each point is referenced to all adjoining points. Your job is to look at the elevation difference and determine the location of a topographic line. For example, if one shot is recorded as 99.7 and the next shot is recorded as 100.3, you would be able to go halfway (since each reading is 0.3 of a foot from 100') between the points to start a topographic line of 100'. As you do this for all the points you will see a map develop of the lay of the land. Typically, each contour will represent an even foot using a solid line contour. You can also add half foot contours using a dash line.
8. Options- If your hand level or Abney level is equipped with stadia hairs, use them to calculate the distance from the instrument (person with hand level) to each rod reading. Use it to see how different it is from the paced distance.

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Measuring a slope (Abney Level and Clinometer)

Prerequisite: Above training, plus:

Video-**Determining Landscape slope**: <https://youtu.be/bOouNoX8WfU>, Time Approx. 5 ½ min

Tools: Clinometer or Abney level, slope pole or extra person, a monopod, 4'-5' staff or stick (optional), clipboard with paper.

1. Locate a slope in the 6-12% range to measure.
2. Locate the "break" in the slope near the top. This is generally where erosive forces from water erosion begin.
3. Locate the end of the slope. This is generally referred to as the "toe" or the area of deposition. Drive a slope stake or have your partner stand at that point.
4. From the top, focus on your partner, slope stake or imaginary point that is the same height of your eye level at the toe of the slope. Read and record from the percent scale on your instrument. Locate a slope stake or have your partner stand at the spot where you were and pace the distance downslope. Read back up the slope focusing on the slope stake, partner or imaginary line of sight equal to the height of your eye. Record the second measurement.
5. Compare the readings; both measurements should be the same. With practice, it will not be necessary to take two readings.
6. Using a monopod to steady the instrument, compare the accuracy using the same steps above.

Measuring the height of a tree (Abney and/or Clinometer)

Prerequisite: Above training, plus:

Video- Using a Clinometer to Measure Tree Height: <https://youtu.be/X6QaHaoInh4>, Time Approx. 4 min

Tools needed: Clinometer or Abney level, 100' cloth tape, clipboard and paper.

1. Using a tape, mark off either 100' or 50' from the tree. On steeper hillsides, insure the tape is held horizontally level as much as possible.
2. Using the clinometer at the distance you selected and reading the percent scale on the instrument, make your reading at a pre-determined diameter, which in forestry, is considered the merchantable height of the tree. For this exercise use 6" diameter. Record your reading.
3. Without moving, take a second reading at the base of the tree and record that reading.
4. At 50', all readings will be divided by two for the height. At 100', the reading is the same as the height. The following formula can be used at other distances when needed: $\text{Feet Run}/100 \times \% \text{ Slope reading} = \text{Height of tree}$.
5. Add the height of the first reading to the height of the second reading giving a total height of the merchantable timber.