SECTION B.1: FLORIDA PROCEDURES FOR TRIMBLE® R8/GNSS GPS SYSTEM

The use of the Trimble® R8/GNSS can greatly improve the efficiency of collecting and processing survey data. Survey data can be electronically recorded and stored for downloading to a computer for processing. The survey data must be collected in a manner that will be compatible with the software used for processing the data. The procedures described below shall be followed in collecting, recording, and downloading the survey data using the Trimble® R8/GNSS GPS & Virtual Station Reference (VRS) Network surveying instruments. Follow these procedures carefully and correctly. If not properly followed, damage to the survey equipment may occur.

Before using this procedure, the following programs should be installed, in their most current version, on your computer. Compatibility issues may arise if any program is not up to date.

- AutoDesk Civil 3D. – CADD program used to display field surveys and to design from.

- Microsoft Activesync. – Communication program used to link external devices such as TSC2 data collectors and various Total Stations to a computer to view files.

- Trimble Rinex Converter. – File converting program used to convert GPS base receiver files to a RINEX file in which the website "OPUS" utilizes for post processing.

- Trimble Data Transfer. - Communication program used to link the GPS Base Receiver to computer to view and retrieve files.

- Trimble Link Menu for AutoCAD (registration may be necessary). Program used to convert TSC2 files to an AutoCAD Fieldbook file and to download into AutoCAD Civil 3D. It's also used to install GPS Geoid models.

- Geoid Model installed using Trimble Link- (The local IT personal should help you with this.) A geoid model is a mathematical representation of the geoid for a specific area, or for the whole earth.

This procedure is written assuming that the reader has a basic understanding of the Survey Grade GPS instrument and software. If a more detailed explanation is needed, please refer to the Trimble® R8/GNSS user manual or the Trimble® TCS2 data collector user manual.

I. SETUP NEW SURVEY STYLE IN TSC2 DATA COLLECTOR FOR TRIMBLE® R8/GNSS SURVEY EQUIPMENT

NOTE: Once a survey style is established it *does not* need to be reestablished unless the Trimble TSC2 data collector memory is erased or the user is supplied with a new Trimble TSC2 data collector. The survey style may be setup in the office. If so, proceed to Section II.

A. Tap > **"CONFIGURATION"** icon *(This will set-up survey styles).*

  1. Select > **"Options"**

  2. Check all three boxes, *(Default may have them checked already).*

      a. *GPS Surveying*

      b. *TS Surveying*

      c. *Advanced Geodetic Survey*

  3. Tap > **"Enter"**

B. Tap >**"CONFIGURATION"**

C. Select > **"Survey Styles"**

  1. Highlight > **"RTK & Infill"** by using the scroll arrows in the center of the data collector.

      If you used the stylus and the touch screen, you will automatically be taken to the **"RTK & Infill"** options. Press Esc to get back out.

  2. Once RTK & Infill is highlighted Tap > **"Copy"** *on the bottom of the screen between" New" and "Delete" options.*

  3. Enter a Style name using the data collector keyboard: > **"RTK OPUS"**

  4. Tap > **"Enter"**

  5. Tap **> "Accept"**

D. Scroll to **"RTK OPUS"** using the scroll arrows in the center of the data collector

1. Tap > **"Base Options"**

2. Select a Survey Type > **"RTK & Infill"**

3. Select a Broadcast Format > **"CMR+"**

4. Leave the box uncheck to **"Output additional code RTCM:"**

5. Select a Station Index > **"29"**

6. Select a Logging Device > **"Receiver"**

7. Select a Logging Interval > **"15.0 s"**

8. Select Elevation Mask > **"10°"**

9. Select > $1^{/3}$ *"this will take you to page 2"*

10. On Page 2 , Select Antenna Type > **"R8 Model 2/ sps88x Internal"**

11. Select Measure type > **"Bottom of Antenna Mount"**

12. Enter Height > **"2.0m"** using data collector's keyboard *THIS WILL CONVERT TO 6.56 FT.*

13. Enter Height > **"2.25m"** (If using base height extension.) This will convert to 7.382 ft - This height will vary based on the height of the SECO Tripod receiver (see Figure 1).

14. Leave the Serial Number blank for now.

15. Select > $2^{/3}$ **"** this will take you to page 3"

16. Check boxes $\boxed{L2C}$, $\boxed{GLONASS}$

17. Tap > **"Accept"**

E. Tap > **"Base Radio"**

1. Select radio type > **"Trimble HPB450"**

2. Select a Controller Port > **"COM1"**

3. Select a Baud Rate > **"9600"**

4. Select Receiver Port > **"Port 1"**

   If you are using the 9 pin connection option 2 cable from the base receiver

to the radio, then the Receiver Port should be > *"Port 2"*

5. Parity should be set to > **"None"**

6. Tap > **"Connect"**

7. Tap > **"Accept"**

F. Tap > **"Rover Options"**

1. Select Survey Type > **"RTK"**

2. Select Broadcast Format > **"CMR+"**

3. Select Station > **"Any"**

4. Check the box to **"Prompt Station Index:"**

5. Tap for page 2 > $1^{/4}$

6. Select Satellite Diff: > **"OFF"**

7. Leave box to **"Ignore Health"** unchecked.

8. Select Elevation Mask > **"10°"**

9. Select PDOP Mask > **"6.0"**

10. Tap for page 3 > $2^{/4}$

11. Enter type > **"R8 Model 2/SPS88x Internal"**

12. Select Measure to > **"Bottom of Antenna Mount"**

13. Select Antenna Ht. > **"2.0m" (This will convert to feet automatically).**

14. Serial Number can be left blank.

15. Tap for page 4 > $3^{/4}$

16. Check boxes $\boxed{L2C}$, $\boxed{GLONASS}$

17. Tap **> "Accept"**

18. Tap > **"STORE"** (located on the bottom of the screen) – *VERY IMPORTANT TO TAP STORE, THIS WILL SAVE ALL YOUR CHANGES.*

G. Set up a new style for the Internal Radio – Set up once

1. Scroll to **"RTK OPUS"** using the scroll arrows in the center of the data collector.

2. Copy > **"RTK OPUS"**

3. Name the Survey Style **"RTK Internal"**

4. Tap > **"Enter"**

5. Tap > **"Accept"**

6. Select the style just copied **"RTK Internal"**

7. Scroll down to **"Base Radio"**

8. Under Type: dropdown select > **"Trimble Internal"**

9. Enter Method > **"Trimble 450"**

10. Tap > **"Accept"**

11. Tap > **"Store"** _VERY IMPORTANT_!

12. Tap > **"ESC"** to return to the main menu.

II. TSC2 DATA COLLECTOR JOB SET-UP

A. Turn on TSC2 Data Collector *(press green button on the lower left hand corner of the Data Collector).*

B. From the Windows Mobile Screen - Tap the **"Survey Controller"**

C. From the Survey Controller main menu – Tap the **"Files"** icon

   Tap > **"New Job"** or type "N" from data collector keyboard.

D. In the **"New job"** dialog box

   1. Enter in the Job name: (i.e. date-six characters of the Last name of Landowner- *10-01-09-Smith,* data collectors allow up to 16 characters for a job name).

   2. Under Job Name- in the Properties Box tap box next to **"Coord.sys.:"** wait for next screen to appear.

   3. At the Select coordinate system box-tap the **"Select from Library"** button.

   4. Select **"Next"**

   5. At the *"System:"* dropdown- Select: **"UTM"**

   6. At the *"Zone:"* dropdown- Select: **"17 North"** (for area west of Jefferson County, use **Zone 16 North**).

7. At the *"Datum:"* dropdown- Select: **"NAD 1983 (Conus)(Mol)"**

8. Check the *"Use geoid model:"* check box

9. At the *"Geoid Model:"* dropdown- Select: **"G03USDA"** (If not set to default).

10. Go to page 2 by selecting the $\boxed{1^{/2}}$ box in the lower right hand corner of the screen.

11. The *"Use datum grid:"* should be set to **"No"**

12. At the *Coordinates:"* dropdown- Select: **"Grid"**

13. At the *"Project Height:"* dropdown- Select: **"i.e. 100.00" sft"** (or use a relative elevation for your region).

14. Tap > **"Store"** (This is located in the lower right hand corner of the screen).

E. This will take you back to the "**New Job**" properties screen (page 1).

   1. Tap the > **"Units (Dist.):"** (the second option under "Properties").

   2. At the "*Distance and Grid Coords*:" dropdown- Select: **"US survey feet"**

   3. At the *"Height:"* dropdown- Select: **"US survey feet"**

   4. At the *"Distance Display:"* dropdown- Select: **"0.001"**

   5. At the *"Coordinate Display:"* dropdown- Select: **"0.001"**

   6. At the *"Angles:"* dropdown- Select: **"DDD.MMSS"**

   7. At the *"Angle display:"* dropdown- Select: **"1"**

   8. At the *Azimuth format:"* dropdown- Select: **"Azimuth"**

   9. At the *"Lat/Long:"* dropdown- Select: **"DDD.MMSS"**

   10. At the "*temperature:*" dropdown- Select: **"Fahrenheit"**

   11. Go to page 2 by selecting the $\boxed{1^{/2}}$ box in the lower right hand corner of the screen.

12. At the *"Pressure:"* dropdown- Select: **"Inch Mercury"**

13. At the *"Coordinate order:"* dropdown- Select: **"North-East-Elev"**

14. At the *"Stationing:"* dropdown- Select: **"10+00.0"**

15. At the *"Grade:"* dropdown- Select: **"Percent"**

16. At the *"Area:"* dropdown- Select: **"Acres"**

17. At the *"Coordinate view:"* dropdown- Select: **"WGS84"**

18. At the *"Laser VA Display:"* dropdown- Select: **"Vertical angle"**

19. At the *"Time Format:"* dropdown- Select: **"Local date/time"**

20. Tap > **"Accept"**

F. The *"Linked Files"* option shall be set to **"None"**. (Third option under "Properties").

G. The *"Active Map"* option shall be set to **"None"**. (Fourth option under "Properties").

H. The *"Feature library"* can be set to **"None" or may be selected from a list**. (Fifth option under "Properties").

I. You may create your own feature code library, which is the point codes library for the type of survey shot (ROAD, CROP, NG, etc). The State Office may provide you with a feature code library upon request.

J. From th*e "Cogo Settings:"* menu (Sixth option under "Properties").

1. At the *"Distances:"* dropdown **-** Select **"Grid"**

2. The *"South Azimuth(grid)"* The check box shall be unchecked.

3. At the *"Grid Coords:"* dropdown- Select: **"Increase North-East"**

4. At the *"Magnetic declination:"* dropdown- Select: **"0°00'00.00000E"**

5. The *"Neighborhood Adjustment:"* checkbox shall be unchecked.

6. At the *"Weight Exponent:"* dropdown- Select: **"0.5"**

7. Go to page 2 by selecting the $\boxed{1^{\prime 2}}$ box in the lower right hand corner of the screen.

8. On page 2 at the *"Road cross section interpolation by:"* dropdown- Select: **"Elevation"**

9. Tap > **"Accept"**

10. Tap > **"Accept"** again *(This will take you back to the Survey Controller Main Menu)*

K. The Job is set-up, the survey equipment can be set-up.

(Some of these setting will only need to be set one time, before becoming a settings default).

III. SURVEY EQUIPMENT SET-UP

A. The center leg of the large yellow SECO tripod shall be loosened and adjusted to the desired height-

1. The center leg has adjustable heights and pin holes for the heights of **1.5 M, 1.8 M, and 2.0 M**. The maximum height for this setting is **2.0 M**. See Figure 1.

2. Insert the push pin into the hole to lock the desired height. Once pin is inserted lock the center leg by tightening the black knob.

B. Place the center leg of the large yellow SECO tripod directly on the Control Point. Adjust the three legs of the tripod to get the tripod level using the level on the control rod. **The leg of the SECO tripod that has a brass screw must be tightened with the pinky finger and the thumb to avoid stripping of brass threads.**

C. It may be easier to attach cables to the base receiver (*base receiver is marked with a "tx" with permanent tape or permanent marker*) BEFORE placing the base receiver on top of the SECO tripod. As the tripod can get quite tall if set to the maximum height of 2.0m.

Figure 1: Rover Receiver Tripod
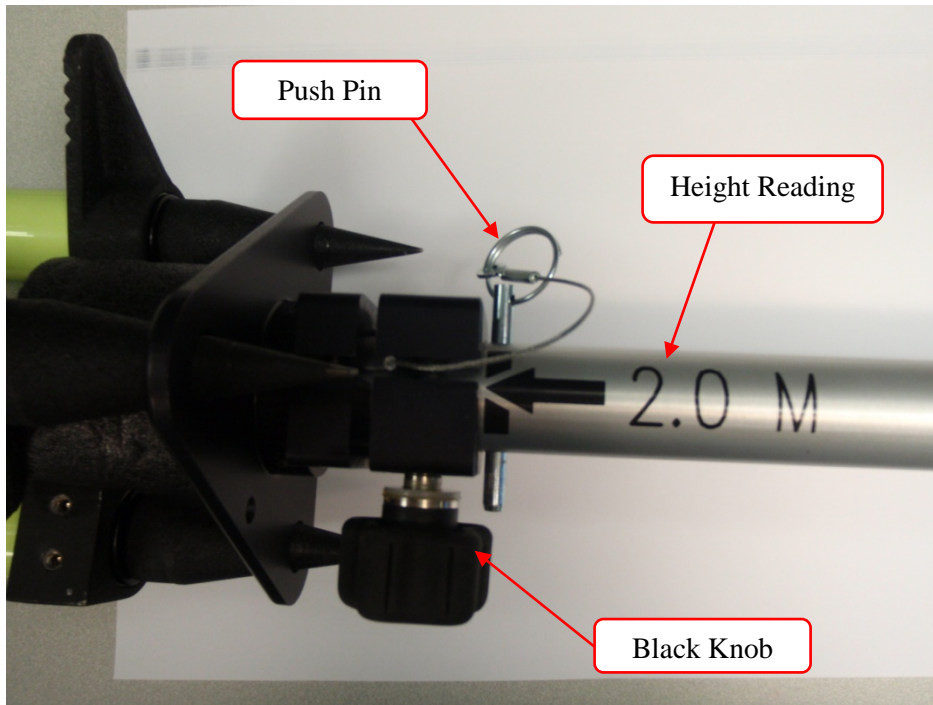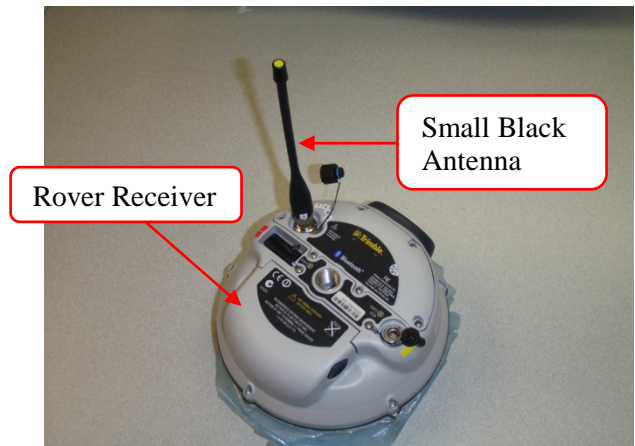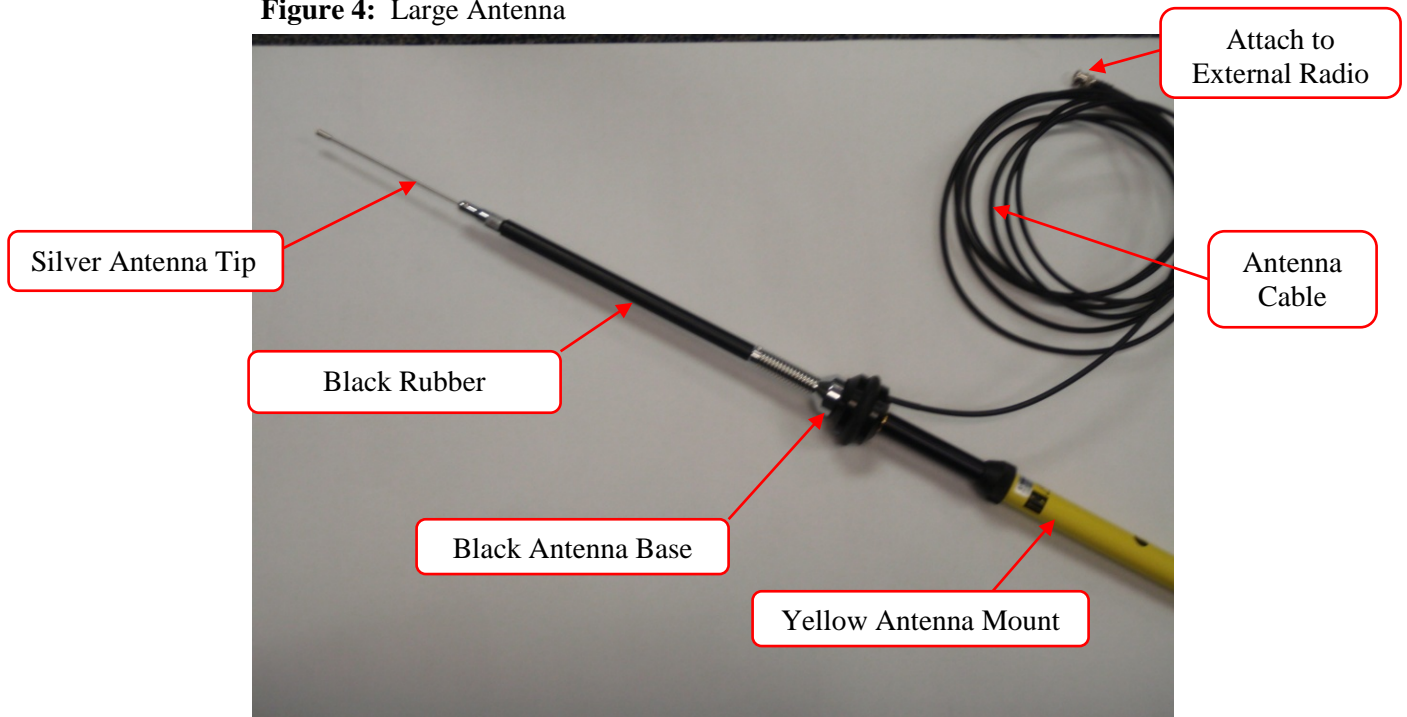

D. Attach the small black antenna to the base receiver.

E. Attach base receiver to brass attachment and place on top of the large yellow SECO tripod. Make sure you wiggle the brass piece on top of the tripod to secure it in place and tighten with brass screw underneath the base plate. (*Optional base extension may also be used. If using the port 2 cable it will need to be used. It's 0.25m in length and may be noted in the data collector for height of instrument*).

F. Level tripod- (tripod may have to be moved while base receiver was attached).

  1. There will be only two legs with loosening grips and one leg with a brass screw. Place one hand on the leg itself, and the other hand on the loosening grip.

  2. Squeeze the loosening grip so the leg can freely move.

  3. Use other hand to adjust the leg while looking at the leveling bubble.

  4. Repeat for the other leg.

  5. The third leg will have a brass screw and a black knob. Loosen both screw and black knob, level.

  6. Once tripod is level, tighten the last leg of SECO tripod by using the black knob. **Use the pinky finger and the thumb to tighten brass screw to avoid stripping the brass threads.**

G. Put the rover rod together- See Figure 2.

Figure 2: Rover Rod
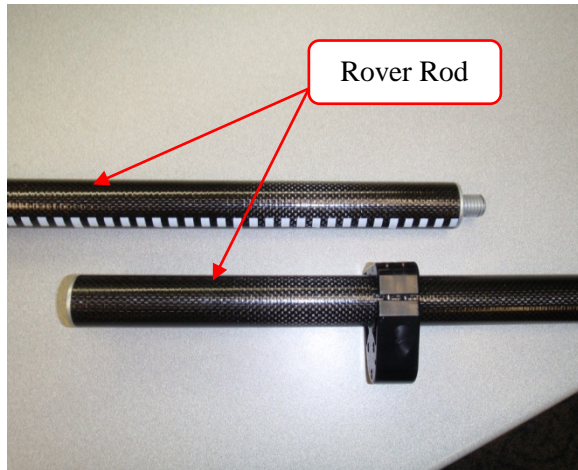
Rover Rod

H. Attach the small black antenna to the bottom of the rover receiver. *(Rover receiver will be the last receiver in the case, and will be labeled with a "t" or a permanent marker)* Attach rover receiver to black carbon fiber rod. See Figure 3.

I. Attach the Rover Receiver to black carbon fiber rod.

J. If using external radio, put the large antenna pieces together-

1. Attach the silver tip to the black rubber antenna. See Figure 4.

2. Attach black rubber antenna to the black antenna base, this will have a long antenna cable attached to it. See Figure 4.

Figure 3: Rover Receiver

Small Black Antenna

Rover Receiver

Figure 4: Large Antenna

Attach to External Radio

Silver Antenna Tip

Antenna Cable

Black Rubber

Black Antenna Base

Yellow Antenna Mount

3. Attach to the long yellow antenna mount. Fully extend the yellow antenna

mount until a black button snaps into the hole on the bottom of the yellow antenna mount.

4. Attach yellow antenna mount to a standard tripod using the black washer provided to prevent the antenna from falling through the tripod. See Figure 5.
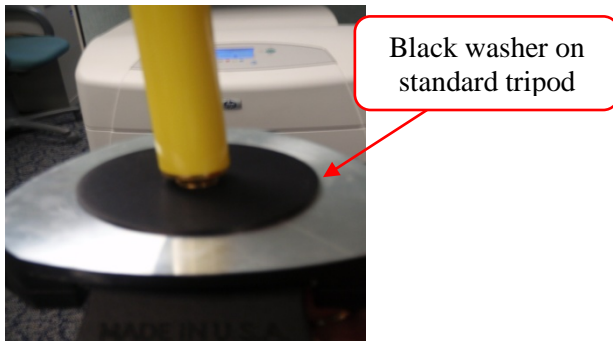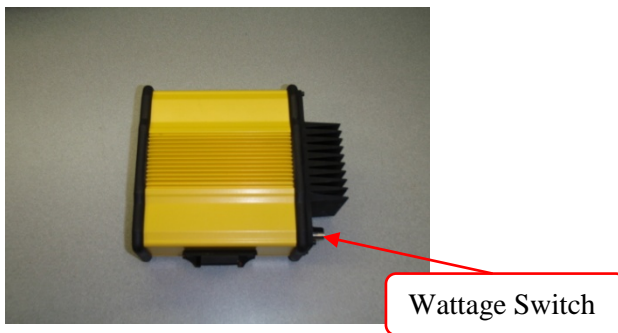
Figure 5: Washer on Standard Tripod

Black washer on standard tripod

Figure 6: External Radio

Wattage Switch

K. Attach the External radio (See Figure 6) to a standard tripod.

L. Attach antenna cable to the back of Radio.

M. *The Antenna Cable should be the First thing to connect to external radio, and the last Cable to be disconnected from the radio to avoid electrocution of the External Radio.*

N. Behind the external radio are two settings: Low *(2 watts)* and High *(35 watts)*.

O. The setting should be at Low *(2 watts)* for smaller surveys, High *(35 watts)* for

extended range for larger surveys. Place the setting at **low** for now.

P. Connect the black "lemo" cable to the base receiver with the single port.

One end will have a single port, the other end will have a dual ports. See Figure 8.

Figure 7: Black Lemo Cable

Single Port End - To Base Receiver

Q. Connect one of the ends of the black lemo cable to the lithium "cow bell" battery. See Figure 12 and Figure 13.

R. Remove the cables from the large battery pouch.

Because Trimble provided two different types of cables to gain a connection from the base receiver to the external radio, it's important to know both ways. The two ways to connect the base receiver to the external radio are labeled option 1 and option 2.

Directions for Option 1 (See Figure 12)

1. Connect external radio *option 1* cable to the back of the radio in the *"Data/PWR"* port. Note: This Radio Cable will have two connections on one end. One connection will go to the back of the radio (data/PWR); the other end will go to the large Motorcycle Battery. See Figure 8 and Figure 9.

2. Connect external radio *option 1* cable to the black lemo cable. See Figure 7 and Figure 8.

Figure 8: External Radio Cable

To Black Lemo Cable

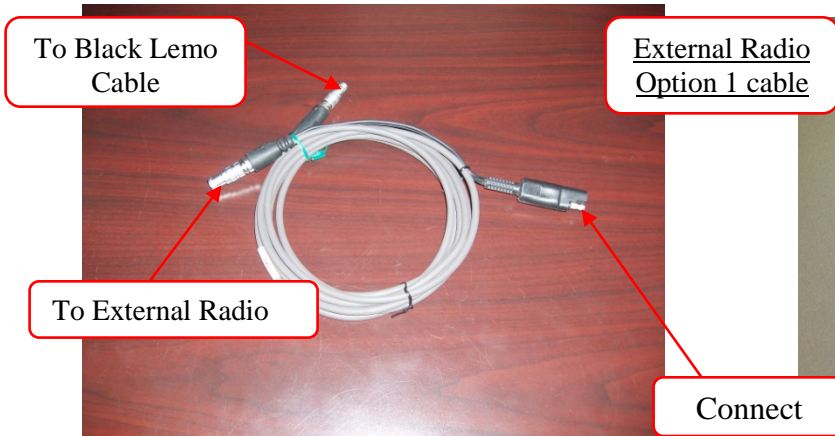To External Radio

External Radio Option 1 cable

Connect

Figure 9: Large Motorcycle Battery

Directions for using the Option 2 cable (See Figure 13)

3. Connect external radio *option 2* cable to the back of the radio in the "*Data/PWR*" port. Note: This Radio Cable will have two connections on one end. One connection will go to the back of the radio (data/PWR), the other end will go to the large Motorcycle Battery. When using the option 2 cable, note that you will need to change the **RECEIVER PORT** in the survey style from **PORT 1** to **PORT 2** (BASE RADIO OPTIONS). Refer to (Section 1 Subsection E - 4)

4. Connect the external radio *option 2* cable to the base receiver using nine pin connector end. See Figure 10.

Figure 10: External Radio Cable

Nine pin connector to connect to bottom of Base receiver

Connect to External Radio

External Radio Option 2 Cable

Connect
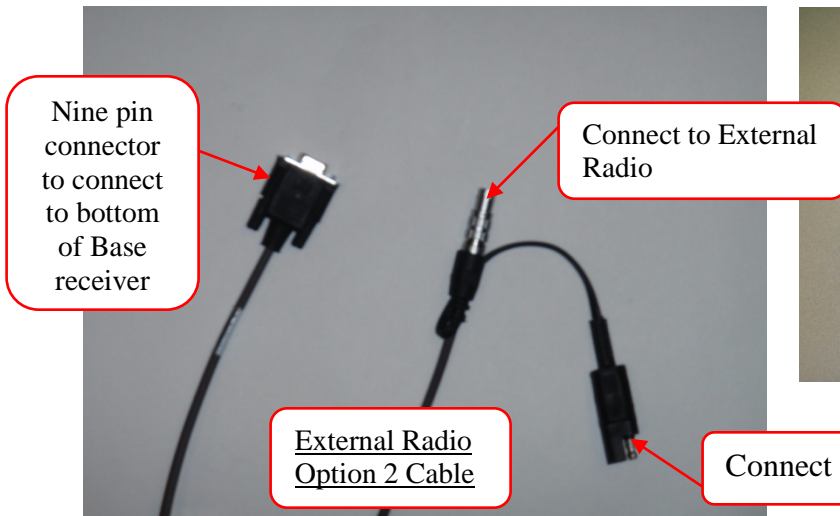
Figure 11: Large Motorcycle Battery

Connect

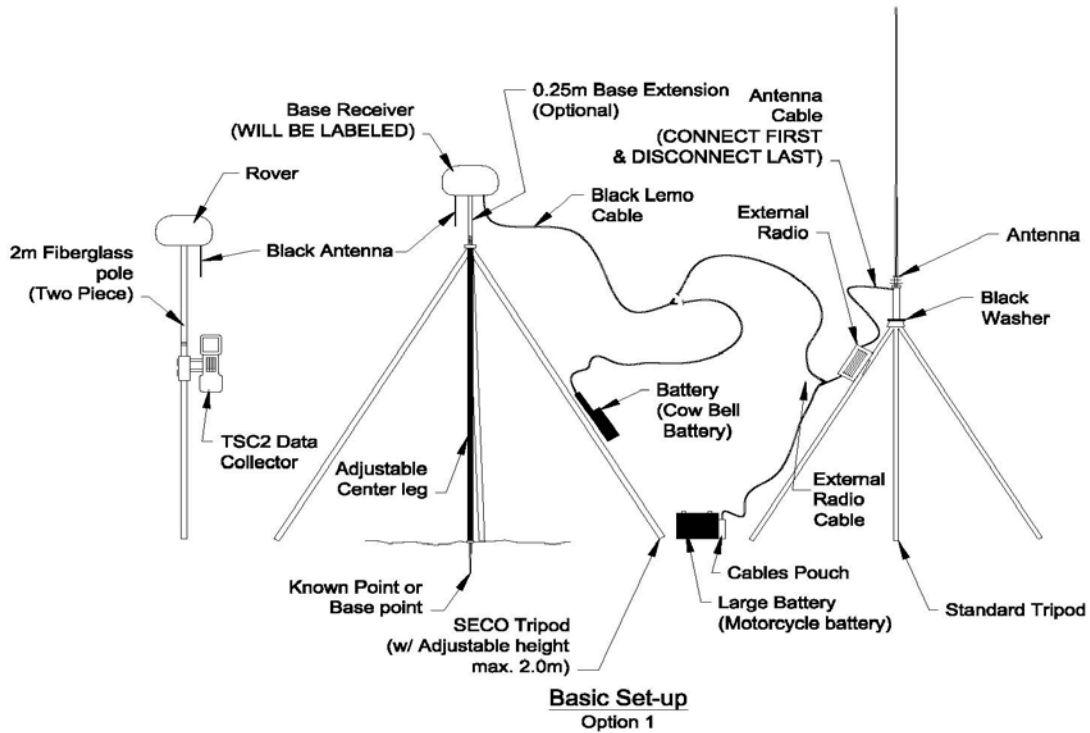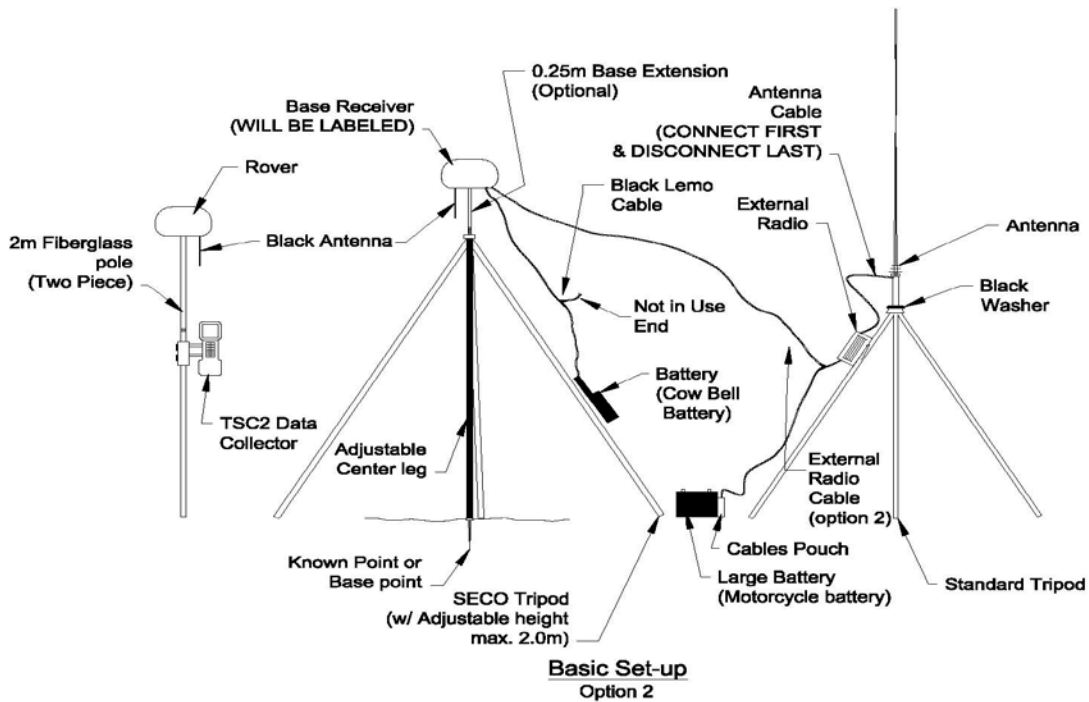**Figure 12:** Survey Grade GPS Hook-Up Option 1

Figure 13: Survey Grade GPS Hook-Up Option 2

IV. SETTING UP FOR COLLECTING FIELD SURVEY DATA

A. **Turn on** the **Base Receiver**, by pushing the green button on the receiver. Check to make sure the receivers have the small black antennas attached to them.

B. Turn on the Data Collector using the green power button on the lower left hand corner of the data collector.

C. Tap > **"Survey Controller"** icon.

If you set up the job in the office, it should default to that job, but if the data collector was turned off and then turned back on the default may have been lost.

D. Follow the steps listed below to open the job that was set-up in the office.

  1. If there is no current job loaded, tap > **"Files"**

  2. Tap > **"Open Job"**

  3. Find the job that you set-up in the office, double tap the job, and it shall be loaded.

E. At the Survey Controller main menu - to start the Base Receiver- Tap > **"Configuration"**

F. Tap > **"Controller…"**

G. Tap > **"Bluetooth"** or type "B" using the data collector keyboard

  1. At the *"Connect to GPS receiver / VX / S Series"* Dropdown, Select the Receiver by the Serial number (The last four digits of the serial number located on side of receiver).

  2. At the *"Connect to Laser"* Dropdown Select- **"None"**

  3. At the *"Send ASCII Data to:"* Dropdown Select- **"None"**

  4. Tap > **"Accept"**

   You may need to enable Bluetooth abilities if the data collector was powered down at some point, if so, a dialog box will come up asking you to enable the Bluetooth capabilities. Check box to **turn on** Bluetooth, and tap > **"ok"** on the top right hand corner of the screen.

  5. To make sure you have a Bluetooth connection with the base receiver, you will see two battery icons, a satellite icon, and two receiver icons on the right side of the screen pop into view when connection is made. This may take a few seconds to activate. If there is only one battery icon after a minute, the data collector, and you may have to repeat the steps.

H. At the Survey Controller main menu - Tap > **"Survey"** icon

  1. Tap > **"RTK OPUS"** for the survey style (External Radio use) or

   Tap > **"RTK OPUS INTERNAL"** for the Survey Style (Internal Radio use).

  2. Tap >**"Start base receiver"** This is activate the base receiver to receiver information from satellites.

  3. Enter the **PT Name** for the Base Station location. (PT=Point, and identifies the point for base station) tap Black Arrow (►).

  4. Tap > **"Key In"**

  5. Type in point name- Should be numeric, (1, 1000, 2000, etc.). W*hen importing a CSV point file into a civil package, an error will come up with line 1 (which is the base point) when importing points. You will have to change it in the CSV file if you don't do it here.*

  6. Tap > **"Here"**- *(once you tap this you'll notice the fields will be filled in. The satellites gave you a reading of where that base receiver is located).*

  7. Tap > **"Store"** to store the reading

  8. Tap > **"Antenna Ht."**

  9. Enter the **height** of the SECO tripod.

   a. To get your height, look at the bottom of the SECO tripod, it will be on either of three settings (**1.5 m**), (**1.8 m**), and (**2.0 m**). If you're using

the base extension, add 0.25 M to the height that was set.

    b. This height will vary from job to job depending on the height of the SECO tripod that was used.

    c. The maximum height is **2.25 m. At this height, the SECO tripod is extended to the maximum 2.0 m setting, and the 0.25 m base extension was used.** Once you enter the height, the data collector will automatically convert meters to feet.

10. Tap > **"Start"** at the bottom right corner of the screen. This will start the Base Receiver.

11. Once base is started, Tap **"Ok"**

12. Check the radio to make sure it is operating- *THE TX LIGHT WILL BE BLINKING ON AND OFF.*

I.   Turn on Rover Receiver.

J.   To Bluetooth and Link to the Rover Receiver-

K.   Tap > **"Configuration"**

L.   Tap > **"Controller"**

M.   Tap **> "Bluetooth"**

    1. At the *"Connect to GPS receiver / VX / S Series"* Dropdown select the Receiver by the Serial number (The last four digits of the serial number).

    2. At the *"Connect to Laser"* Dropdown Select- **"None"**

    3. At the *"Send ASCII Data to:"* Dropdown Select- **"None"**

    4. Tap > **"Accept"**

N.   Change the Radio Frequency.

    1. Tap > **"Configuration"** icon from Survey Controller main menu.

    2. Tap > **"Survey Styles"**

    3. Tap > **"RTK OPUS"** or **"RTK OPUS Internal"** depending on which survey style you used for the survey.

    4. Tap > **"Rover Radio"**

    5. Select **> "Trimble Internal"**

    6. Tap > **"Connect"**

    7. Choose the proper Radio frequency accept > **"411.3000 Mhz"**

    8. Tap **> "Accept"**

    9. Tap > **"Store"**

    10. Tap > **"ESC"**

O.   To Start the field survey:

    1. Tap > **"Survey"** icon

    2. Tap > **"RTK OPUS"**

    3. Tap > **"Start Survey"**

    4. Wait for data collector to get 100% reliability.

    5. Tap > **"Accept"**

    6. Once initialization is gained (data collector will beep) Tap > **"Ok"**

    7. Tap > **"Survey"** icon from Survey Controller Main menu.

    8. Tap > **"Measure Points"**

    9. Enter Point name, or point code and Point data.

    10. Enter **"2.0 m"** for Rover Rod height.

    11. Tap > **"Measure"** in bottom right corner of screen to store the point. *ONCE "MEASURE" TURNS TO "STORE"*

    12. Tap > **"Store"** *FOR EACH POINT.*

    13. Continue surveying to gather data.

    14. To view the points gathered, Tap > **"Map"** option on right side of screen.

    15. Tap > **"ESC"** to exit the map screen.

P.   To End your survey:

    1. Tap > "**ESC"**

    2. This will go back to the **"Survey Controller Main Menu"**

    3. Tap > **"Survey"** icon.

    4. Tap > **"End GPS Survey"**

5. Tap > **"Yes"** to power down Rover receiver.

Q. To power down Base Receiver you will need to Bluetooth link to the Base receiver.

　1. Tap > **"Survey"** icon from Survey Controller main menu.

　2. Tap > **"RTK OPUS"** or **"RTK OPUS Internal"** depending on which survey style you used for the survey.

　3. Tap > **"End GPS Survey"**

R. Turn off the radio and remove the power.

S. Begin to pack up the equipment.

V.　SITE ELEVATION CALIBRATION

This procedure will ensure elevation accuracy of benchmarks on project sites when using the survey grade GPS. These procedures assume the user possesses basic knowledge and understanding of surveying techniques to perform a Bench Level Circuit survey.

A. Set a minimum of three benchmarks using wooden stakes or #4 rebar. Set benchmarks at a minimum distance of 200 feet to limit the number of turns.

B. The elevation of the benchmark may be assumed or a known monument (i.e., NGS markers).

C. Draw a small sketch of the site in the fieldbook. Record necessary information about the survey in the fieldbook (i.e., rodman, date, weather, etc.).

D. Perform a Bench Level Circuit survey on all benchmarks (minimum of three (3) and record all measurements for turning points and benchmarks in fieldbook).

E. The survey must close within recommended tolerance as per equation –

—

M= distance in Miles

(i.e., 0.10√0.5 = 0.07ft allowable tolerance) in order for the information to be used for the survey.

If bench level circuit is not in tolerance, record in fieldbook, and rerun bench level circuit survey again until it closes within tolerance.

F. If the Bench Level Circuit Survey was conducted with assumed elevations, a translation will need to be performed. A translation on the site calibration elevations may be conducted using the "Translate Survey Database" tool in Civil 3D. Refer to the Engineers Field Handbook Part 650, Chapter 1, Florida Supplement, Section D for a more detailed explanation.

G. Once the bench level circuit survey is complete begin GPS surveying.

H. Elevation differences between BM should be the same with site calibration elevations and elevations shot with the GPS.

I. Bench Level survey may also need to be rerun if elevations from GPS and previous bench level survey elevations vary more than the allowable tolerance.

J. If survey job takes more than a day, the benchmarks will need to be recorded with the survey grade GPS at the beginning of each day to ensure accuracy of elevations.

VI.　DOWNLOADING THE BASE FILES USING TRIMBLE DATA TRANSFER SOFTWARE

This is done to get the base point adjusted by OPUS or post processed by OPUS to get the best results for the survey. Due to this being the newest survey equipment at the present time, OPUS requires that the T02 file or DAT file be converted to a RINEX file.

A. Connect the base to the computer using the 9 pin cable for port 1 and the other end connects to the base.

B. Open Trimble Data Transfer by going to the Start menu> All Programs> Trimble Data Transfer > Data Transfer.

C. Tap >**"Devices"** on the right hand side.

D. Tap >**"New"** on the lower left hand corner of the "Devices" dialog box.

E. Select "Survey Controller" from the list.

F. Select "COM1" for the port and tap "Next".

G. Give the device a Name- "R8 Base receiver" or something that represents the base receiver.

H. Tap Finish.

I. To connect to R8 Base receiver select the new device and the base receiver in the list. Tap the "Connect" button which is the green plug in button.

J. Will see a new list.

The files are stored in the "**Trimble Data"** folder. Now you should be able to download these files using Active Sync or place the file on a thumb drive.

VII. USING THE TRIMBLE RINEX CONVERTER

A. Create a folder in which you can place your "T02" R8/GNSS base file or files. (Usually associated with the project file folder).

Figure 14: File Name

B. Open the Trimble RINEX Converter by clicking on the desktop icon or going to "All Programs/Trimble/Convert to RINEX/Convert to RINEX. See Figure 15 or Figure 16.

C. You will first see a small DOS dialog box. See Figure 17.

Figure 15: RINEX Icon

Desktop Icon

Figure 16: RINEX File Menu

Figure 17: DOS dialog box
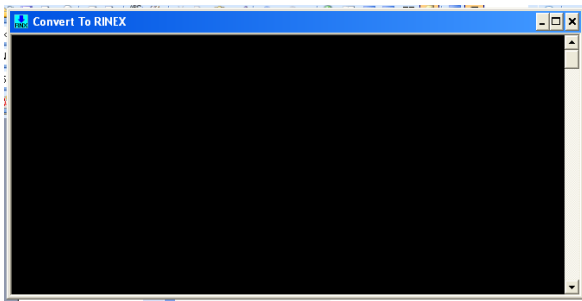
D. Then the program dialog box will appear. See Figure 18.
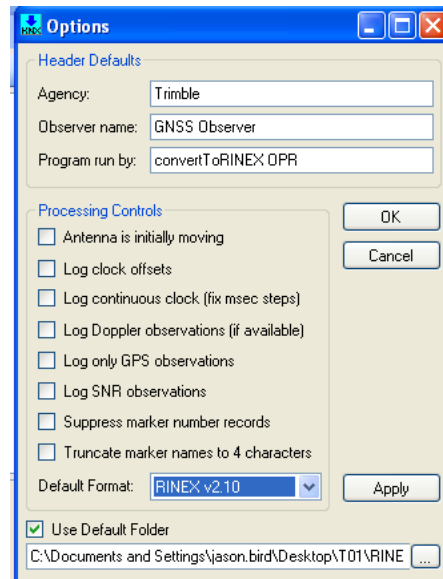
Figure 18: Program Dialog Box
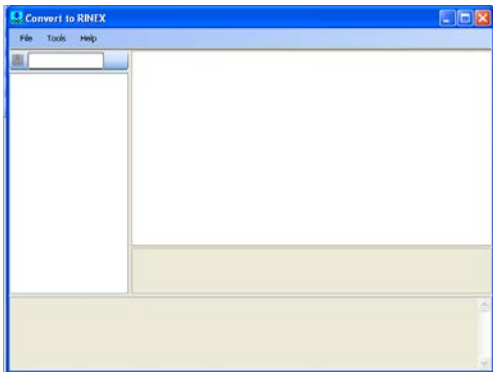
E. Set the format version of RINEX to **"2.10"** by going to the menu *"Tools" > "Options"*. See Figure 19.
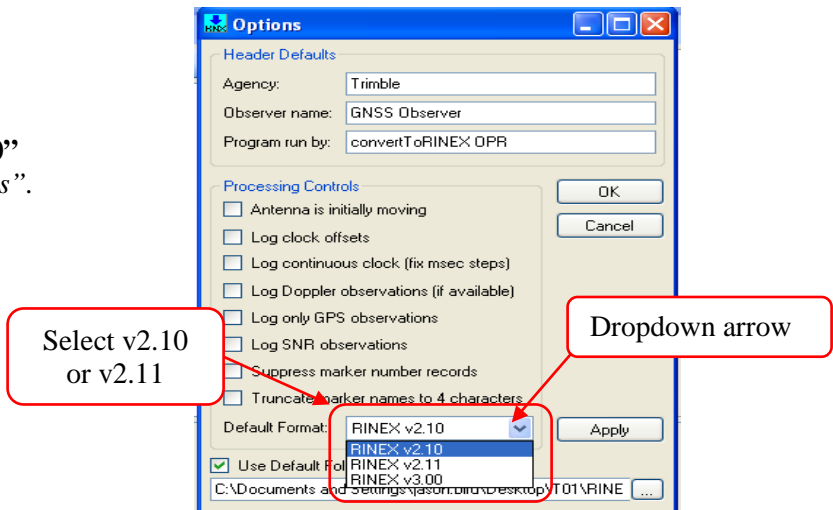
Figure 19: RINEX Menu

F. The options Dialog box will appear. See Figure 20.

Figure 20: Option Dialog Box

G. Go to *"Default Format"* and click on the blue dropdown arrow- Select *"RINEX v2.10" or v2.11"* OPUS will give you an error when the version is set to v3.00. See Figure 21.

Figure 21: Option Dialog Box

H. Set the default folder in which you wish to place the RINEX files clicking the "Use Default Folder" checkbox and by clicking on the **Browse button**. Browse to the file you set-up earlier. See Figure 22.

Figure 22: Setting File Path

I.   Browse out to the folder in which you wish
     to place the RINEX files. See Figure 23.

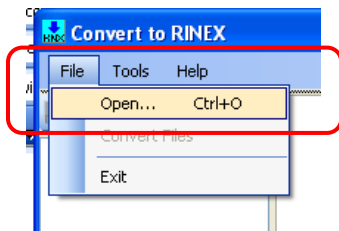**Figure 23:** Setting File Path for RINEX folder

J.   Once the RINEX version is set, and the
     folder to place the RINEX are set, **click
     "Apply" and click "OK"**. See Figure 24.

Figure 24: Options Dialog Box
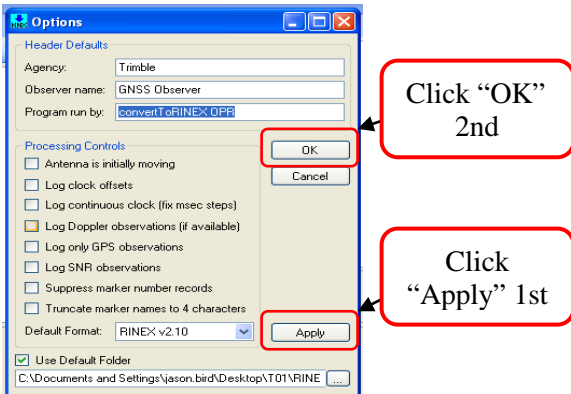
K.   This will prompt you back to the main
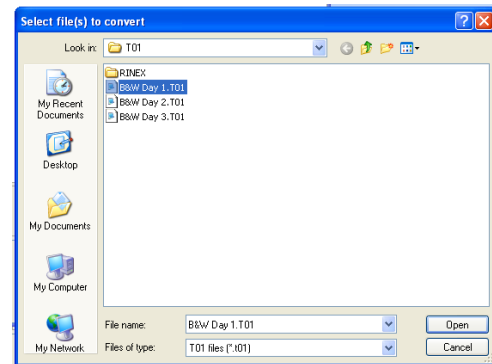   screen, Go to **"File" > "Open"**. See Figure
     25.

Figure 25: Dialog Box to Open File

L.   Browse to the file folder which has the T02
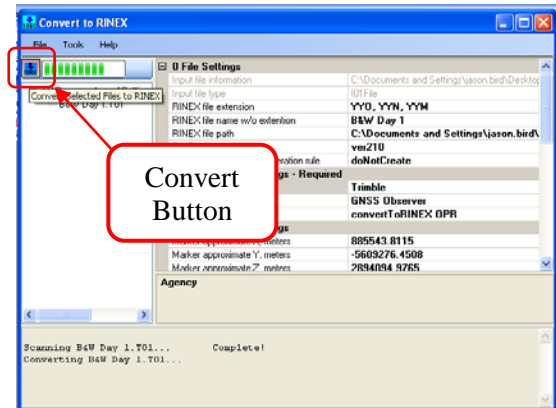   files. Select all of the T02 files you wish to

convert, Click "OPEN". See Figure 26.
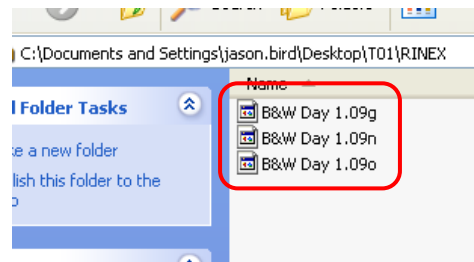
Figure 26: Convert File Dialog Box

M.   The RINEX converter will scan the files.
     Once complete, Click the "blue convert
     button" to convert the selected files. See
     Figure 27.

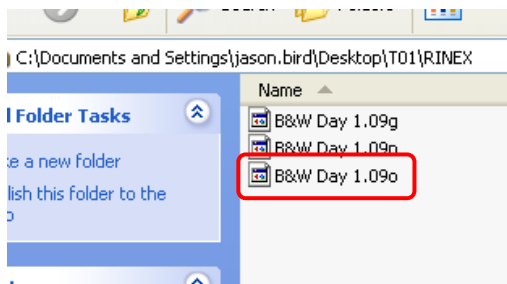**Figure 27:** RINEX Converter Dialog Box

N.   Once the conversion is done browse out to
     your default folder and you will see the three
     converted files. See Figure 28.

Figure 28: RINEX Converted Files

O.   Use the file that ends with "o" as the file to
     send to "OPUS". See Figure 29.

Figure 29: File Extension to be sent to OPUS.

P. Open Internet Explorer, go to website http://www.ngs.noaa.gov/OPUS/

Q. For using OPUS homepage to post process your RINEX file follow the steps on the webpage or click the "Using OPUS" button for more details. See Figure 30.

Figure 30: OPUS button on Opus website.

VIII. **SET UP BLUETOOTH COMMUNICATIONS FOR NEW RECEIVERS OR OTHER RECEIVERS**

A. Turn on the receiver you wish to set up communications with.

B. Turn on data collector

C. Select **"Survey Controller"** from

D. Tap > **"Configuration"**

E. Select > **"Controller"**

F. Select > **"Bluetooth"**

G. Select > **"Config"** on the bottom of the screen.

H. Once the Bluetooth settings screen comes up there will be three tabs on the bottom of the screen- <Mode>, <Devices>, and <COM Ports>.

I. Select the> **"Devices"** tab on the bottom of the screen.

J. Select the option of > **"New Partnership "**

K. **The data collector will scan for a new bluetooth device to connect to.**

L. The data collector will list all bluetooth devices.

M. Highlight the appropriate receiver listed that contains the last 4 digits of the receiver serial number.

N. Tap > **"Next"**

O. Tap > **"Finish"**

P. Once the bluetooth communication has been established, this will not have to be done again.

Q. To survey from the base receiver. Bluetooth to your Rover Receiver.

R. Go to > "Survey" from the main menu screen of the survey Controller.

S. Go to the survey style you're using > **"RTK OPUS"** or **"RTK OPUS Internal"**

T. Go to > **"Measure Points"** or > **"Continuous Topo"** this will automatically start the connection to the base receiver. Once connected you're ready to measure points.

IX. **TRIMBLE VIRTUAL REFERENCE STATION (VRS) NETWORK MODEM CONNECTION SETUP**

A. Power on the TSC2 data collector.

B. Tap the green **Start icon** located on the desktop of the TSC2 data collector.

C. Select **Settings**.

D. Notice three tabs on the bottom of the screen, Select the **Connections** tab.

E. Select the **Connections** icon.

F. Select the **"Manage existing connections"** link.

G. Notice the "*My ISP*" in blue print at the top. And two tabs on the bottom "**General**" and "**Modem**". Select the "**Modem**" tab.

H. Tap the **"New…"** button on the right.

I. Type the new connection name "**Verizon**".

J. Select **Hayes Compatible on COM1:** as the modem type.

K. Tap "**Next**" on the lower right hand corner of screen.

L. Type **#777** for the number to dial.

M. Tap **Next**.

N. Leave the *"User Name"*, *"Password"*, and *"Domain"* blank for now.

O. Tap the **Advanced** button.

P. Notice the four tabs on the bottom of the screen "**General**", "**Port Settings**", "**TCP/IP**", and "**Servers**".

Q. From the *"General"* tab select baud rate: **115200** using the dropdown arrow. This setting will be the last listed.

R. Check the box labeled "**Wait for dial tone before dialing**".

S. Leave the rest of the settings as they were and go to the **"Port Settings"** tab.

T. The port settings are as follows:

   1. Data Bits: **8**

   2. Parity: **none**

   3. Stop Bits: **1**

   4. Flow Control: **Hardware**.

U. Go to the **"Servers"** tab.

V. Using the radial button- Select **"Use specific server address"**.

W. Enter the following(Click in the value box with stylus):

   1. DNS: **66.174.95.44**

   2. Alt DNS: **69.78.96.14**

   3. WINS: **Leave Blank**

   4. Alt WINS: **Leave Blank**

X. Once the DNS values have been entered tap **OK**.

Y. Tap **Finish**.

Z. Select the new *Connection*.

AA. Now tap **OK**. (upper right hand corner of screen).

BB. Tap **OK** again to close the connections screen.

CC. Tap **X** to return to *Start* menu.

X. **TRIMBLE VIRTUAL REFERENCE STATION (VRS) NETWORK DIAL PROFILE SETUP**

   A. Open "**Survey Controller**" on the TSC2 data collector.

   B. Go to the **Configuration** icon.

   C. Select "**Dial Profiles**".

   D. Tap "**New**" *(Located on the bottom of the screen)*.

   E. Name the new dial profile "**VRS Now**".

   F. For Profile type: **"Internet Rover"**.

   G. Use Connection: select **"Verizon"**.

   H. Leave the Modem PIN value blank.

   I. APN (using side arrow ►) select = **None**

   J. IP Address: **155.63.211.99**

   K. IP Port: **2101**

   L. Go to Page 2.

   M. Check the box **"Use NTRIP"**.

   N. NTRIP Username: *User provided Username*

   O. NTRIP Password: *User provided Password*

   P. Connection Type select: **Dial-up**

   Q. Leave "Send user identity info" unchecked.

   T. Tap **Store**, and then tap **ESC.**

XI. **TRIMBLE VIRTUAL REFERENCE STATION (VRS) NETWORK SURVEY STYLE SETUP**

   A. Tap **"Configurations" > "Survey Styles"**

   B. Select **"New"** *(located at the bottom of the screen)*.

   C. Give Style a name: "**VRS Network**"

   D. Style type: GPS

   E. Tap "**Accept**"

   F. Select **"Rover Options"**

G. Survey Type: RTK

H. Broadcast format (dropdown list) :
VRS(RTCM)

I. Store Points: **Vectors**

J. Elevation Mask: **10°**

K. PDOP Mask: **6.0**

L. Go to Page 2 **"Antenna"**

M. Type: **"R8 Model2/SPS88x Internal"**

N. Measure to: **"Bottom of antenna mount"**

O. Antenna Height: **"2.0M"**

P. Leave **"Serial Number"** blank.

Q. Go to page 3.

R. Select checkboxes **"L2C and GLONASS".**

S. Tap "**Accept**"

T. Select **"Rover Radio"**

U. Type: **"Internet Connection"**

V. Dial Profile: **"VRS Now"**

W. Check **"Prompt for Dial Profile"**

X. Tap **"Accept"**

Y. Tap **"Store"**

XII. IN THE FIELD WITH THE VRS NETWORK

A. Connect the Modem to the battery that was
supplied, (Self explanatory). See Figure 31.

Figure 31: Modem to Battery Connection
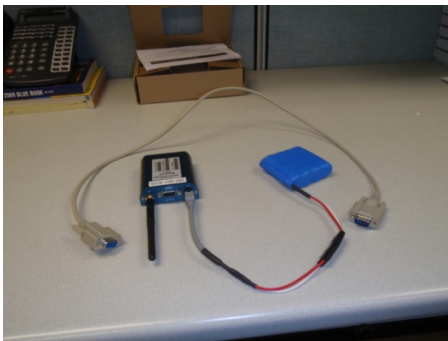
B. Connect the small antenna to the modem that
was supplied.

C. Put together Rover rod with Rover receiver.

D. Connect the modem to the TSC2 Data
Collector using the cream colored
communications cable (one end FEMALE,
the other end is MALE).

E. Attach the VRS modem and TSC2 data
collector to the Rover Rod for a complete
set-up. See figure 32.

Figure 32: Complete set-up of VRS
Network

F. Turn on TSC2 data collector.

G. Set-up new job or open existing job.

H. Turn on Rover receiver.

I. Using TSC2, blue tooth to Rover Receiver.

J. Once connected go to the **Survey** icon.

K. Select the **VRS Network** survey style.

L. Select **Start Survey**.

M. Select the Dial Profile from the list; it will be
the only one available **"VRS Now"**.

N. Tap **"Accept"**.

O. The screen will say **"Switching Modem into
Command Mode"**.

P. **Network Log on screen will appear:**

1. User name: **NRCS Supplied Username**

2. Password: **NRCS Supplied Password**

3. Domain: **Leave Blank**

Q. The modem will establish internet connection and a list of base stations will appear.

R. Select a "*Base Station*" from the list. There are multiple base stations, choose any station to create a connection.

S. An open connection scroll bar will appear. The instrument will attempt to communicate with satellites. The survey will begin once a connection has been established.

T. Initialization will be ***gained***.

U. Select the **"Survey"** icon

V. Select **"Measure Points"**

W. Select proper field code and begin field survey.

X. To end Survey Tap > **"ESC"**

Y. Tap > **"Survey"**

Z. Tap > **"End GPS Survey"**

AA. Turn off rover receiver.

BB. Shut down TSC2 data collector and Pack up Equipment.

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SECTION B.2: FLORIDA TRIMBLE® S6 SERIES TOTAL STATION WITH TRIMBLE® TSC2 DATA COLLECTOR

The use of the S6 Series total station and the Trimble® TSC2 data collector can improve the efficiency of collecting and processing survey data. Survey data can be electronically recorded and stored for downloading to a computer for processing. The survey data must be collected in a manner that will be compatible with the software used for processing the data. A surveyor's field book should be handy to record any conditions, measurements, sketches, and information regarding the site. The procedures described below shall be followed in collecting and recording the survey data using the Trimble® S6 Series Total Station and the Trimble® TSC2 data collector. Follow these procedures carefully and correctly.

In order to become familiar with the total station, read the *Trimble S Series Total Station User Guide*. The procedure will detail the setup of the data collector, equipment, Bluetooth, and field survey. Also, the procedure explains the use of the equipment to record survey shots and making turns. Please see Figures 1 and 2 for pictures of the total station and data collector.

Figure 1: Trimble S6 Total Station	**Figure 2:** Trimble TSC2 Data Collector

Figure 1: Trimble S6 Total Station

Figure 2: Trimble TSC2 Data Collector

I. SETUP OF SURVEY STYLE IN TSC2 DATA COLLECTOR FOR THE TRIMBLE® S6 SERIES SURVEY EQUIPMENT

NOTE*:* Once a survey style is established it *will not* need to be reestablished unless the

Trimble® TSC2 data collector memory is erased or the user is supplied with a new Trimble® TSC2 data collector. The survey style may be setup in the office.

A. Turn on TSC2 data collector by pushing the green button on the lower left hand corner of the keypad.

B. From the Windows Mobile Desktop main menu (blue background), select the **"Survey Controller"** icon. See Figure 3.

   Figure 3: "Survey Controller" icon

   Survey Controller

C. From the six icons, select **"Configuration"** > **"Survey styles"**.

D. *VX & S Series* is the pre-defined survey style for the Trimble S6 Series. If this survey style is already in the drop-down menu, select **"Esc"** and proceed to Section II., otherwise continue to the next step.

E. On the bottom of the screen there is three small buttons, select **"New"**.

F. Name the new survey style (e.g. **VX & S Series**).

G. Select "**Conventional"** from the dropdown menu for the style type.

H. Tap **"Accept"**.

I. Select **"Instrument"**.

J. Set the following parameters on the instrument screen:

   1. Manufacturer: **"Trimble"**

   2. Model: **"VX/S Series"**

   3. Measurement mode: **"STD"**

   4. Averaged observations: **"10"**

   5. Auto F1/F2: **box left blank**

   6. Measure dist on face 2: **box checked**

   7. Autolock off for offsets: **box checked**

   8. Set backsight: **"Azimuth"**

   9. Servo auto turn: **"HA & VA"**

10. Select icon **1/2**

11. For page 2 leave the default settings.

12. Select **"Enter"** > **"Accept"**.

K. From the list menu, select **"Topo point"**.

L. Set the following parameters on the instrument screen:

  1. Measure display: **"HA VA SD"**

  2. Auto point step size: **"1"**

  3. View before storage: **box checked**

M. Select **"Accept"** > **"Store"**.

N. The survey style is now established. (Select **"Esc"** > **"Exit"** to return to the main menu.)

II. TSC2 DATA COLLECTOR JOB SETUP (may be performed in the office)

A. Select **"Survey Controller"** from the main menu.

B. Open **"Files" > "New Job"**.

C. Fill out the resulting screen as follows:

  1. Give name: Enter the name of the job (property and date)

  2. Under the "Properties" table, set the following options:

    a. Coordinate system: **"Scale Factor Only"** > **"Next"**

    b. Set the scale factor to **0.999600000** > **"Store"**

    c. Units: **"US survey feet"**

        i. Distance and grid coords: **US survey feet**

       ii. Height: **US survey feet**

      iii. Distance display: **0.001**

       iv. Coordinate display: **0.001**

        v. Angles: **DDD.MMSS**

       vi. Angle display: **1"**

      vii. Azimuth format: **Azimuth**

     viii. Lat/Long: **DDD.MMSS**

       ix. Temperature: **Fahrenheit**

        x. Press the "1/2" symbol at the bottom right corner to continue to page 2.

       xi. Pressure: **Inch mercury**

      xii. Coordinate order: **North-East-Elev**

     xiii. Stationing: **10+00.0**

      xiv. Grade: **Ratio – Run : Rise**

       xv. Area: **Acres**

      xvi. Laser VA display: **Vertical angle**

     xvii. Time format: **Local date/time**

    xviii. Select accept.

    d. Linked Files: **None**

    e. Active Map: **None**

    f. Feature Library: **Local Library** "Created by user"

      NOTE: The feature table can be loaded onto the data collector in the office. Statewide feature table can be obtained from the Area Engineer or from the SO Engineering Section.

    g. Cogo Settings: **Ground**

    h. Use all the default settings for page 2.

 3. Tap **"Enter"** > **"Accept"**.

  NOTE: Use a surveyor's field book to make necessary notes to the field conditions

such as time, project, crew members, temperature, and weather, etc.

III. SURVEY EQUIPMENT SETUP

A. Find the existing control point or create a new control point.

B. Place tripod base level directly over control point. Make sure the tripod has a wide, stable stance and the legs are securely in the ground.

C. Place Trimble S6 Total Station on top and center on the tripod and securely screw the total station to tripod.

D. Using the 3 adjustable screws at the base of total station, level the total station using the leveling bubble located at the base of the total station as a reference.

E. Once level, slightly loosen the screw that connects the total station with the tripod.

F. Look through the optical plummet on the Trimble S6 Total Station and only focus the sight on the ground. See Figure 4

Figure 4: Anatomy of total station.
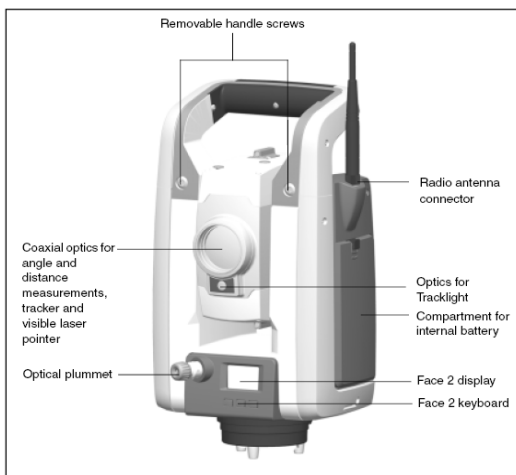
1. To focus the crosshairs, rotate the plummet's eyepiece.

2. To focus the optical plummet to the ground, push the eye piece in or out.

G. Shift the total station horizontally until the cross hairs of optical plummet are exactly

on the control point. Re-tighten the screw to secure the total station to the tripod.

H. Measure the height of the instrument (Ih) by following the instructions below.

1. Using Figure 6, measure Hm to the hundredths (X.XXX) using a survey rod. Hm is defined as the distance from the control point to the bottom mark as seen on Figure 5. The distance from the top mark to the bottom mark is 0.158 meters or 0.518 feet.

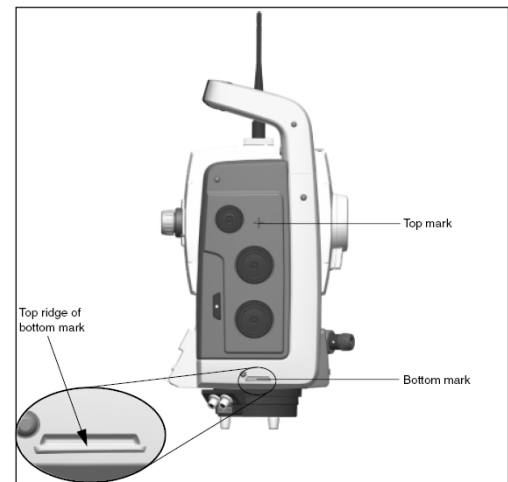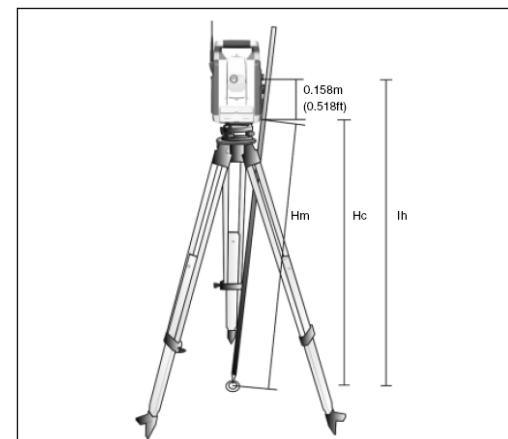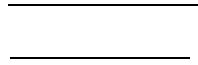**Figure 5:** Top and bottom marks on Total Station.

Figure 6: Measuring the height of the instrument.

2. Calculate Ih **(in Survey Feet)** by using the formula found in Figure 7 below.

Figure 7: Formula for calculation of Ih.

Figure 7: Additional features on the back of the total station.
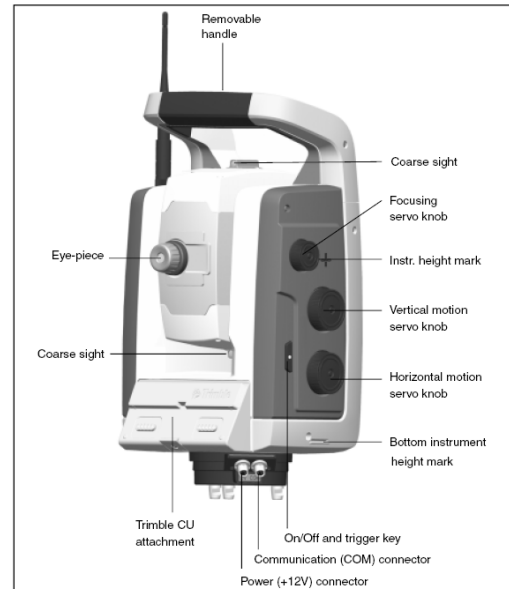

> **NOTE:** Record the height of the instrument in your surveyor's field book. You will need to input this height into the data collector later in the setup process.

I. Attach the bipod to the survey rod. Place the survey rod on top of the desired bench mark. Ensure that the prism on the backsight is pointed towards the total station. Level the prism using the bubble level on the survey rod.

J. Measure the distance from the center of the prism to the base of the survey rod. Rod height is adjustable.

> **NOTE:** Record the height of backsight in your surveyor's field book. You will need to input this height into the data collector later in the setup process.

IV. BLUETOOTH SETUP

A. (Skip this step if data collector is on) Turn Trimble TSC2 data collector on by pushing the green button on the lower left hand corner of the keypad.

B. Turn on the total station. Please see Figure 7 to locate the On/Off and Trigger Key.

C. If blue tooth is not automatically turned on, from the "Survey Controller" main menu on the TSC2 data collector tap **"Configuration" > "Controller…"** > **"Bluetooth"**.

D. If a Bluetooth connection was never previously set-up between the total station and the data collector, follow the instructions below. Otherwise skip to the next section.

1. Tap **"Config"** at the bottom of screen.

2. Verify that the **"Turn on Bluetooth"** box is checked.

3. Tap the **"Devices"** tab at the bottom of the screen.

4. Tap **"New Partnership…"**. Wait for data collector to find total station.

5. Select the device which has the serial number of the total station listed. Tap **"Next"**.

> **NOTE:** The serial number of the device is located on the of the yellow Trimble S6 case.

NOTE: If the total station does not appear listed, restart the total station and tap **"Refresh"** on the data collector.

6. Enter the passkey for the total station which is by default the last four digits of the Trimble S6 serial number. Tap **"Next"**.

7. Change the display name of device from the serial number to "Trimble S6". Tap **"Save"**.

8. Tap **"Ok"** which is located at the top right corner of the screen.

9. Select **"Trimble S6"**, under the "Connect to GNSS Receiver/ VX/S Series" drop-down box. All other default values can be left alone. Tap **"Accept"** and wait till the equipment establishes the connection.

10. Once connected begin setup for collecting field data.

V. SETTING UP FOR COLLECTING FIELD SURVEY DATA

A. Confirm that the eye-piece is in the correct orientation by verifying that text next to the eye-piece is in the upright direction.

B. Once connected, the data collector should go to the *"Electronic Level"* screen. Verify that the text "Compensator in range" appears at the bottom of the screen. Tap **"Accept"**.

C. The data collector will now go to the "Corrections" screen. Enter the correct temperature. Tap **"Accept"**.

D. Use a magnetic compass to rotate the total station to as close to magnetic north as possible. In the *"Survey Basic"* screen, tap **"Zero"** on the bottom of the TSC2 screen. Tap **"Esc"**.

E. Point the lens of the total station in the direction of back sight. The prism and survey rod should be setup level on the bench mark. See below for details on how

to accurately focus the cross hairs on the prism of back sight.

NOTE: See Figure 7 to locate the knobs that operate the sight.

1. Turn the focusing Servo knob until the benchmark can be seen clearly.

2. Adjust the vertical and horizontal motion servo knobs to align the cross hairs with the prism on the back sight.

F. From the survey controller main menu select **"Survey"** > **"VX & S Series…"** > **"Station setup"** > **"Accept"**.

G. In the "Station setup" screen, enter the following information.

1. Instrument point name: **"1"**

2. Code: **"CP"**

3. Tap **"Enter".**

4. Instrument height: Enter the height of the total station as measured in "Step H of Section III-SURVEY EQUIPMENT SETUP".

H. Once the instrument height is entered, the *"Key in instrument point"* box appears below. Enter the following information:

1. Northing: **"10000" or exact value if known**

2. Easting: **"5000" or exact value if known**

3. Elevation: **"100" or exact value if known**

4. Control point: **box checked**

I. Tap **"Accept"** and/or **"Enter"**.

J. Now the information for the backsight's benchmark must be entered.

1. Backsight point name: **"100"**

2. Code: **"BM"** (Benchmark)

3. Tap **"Enter"**.

4. Backsight height: Enter the backsight height as measured in "Step I and J of

Section III. SURVEY EQUIPMENT SETUP".

5. Azimuth (Keyed in): Enter the value for HA (horizontal azimuth) as seen on the bottom of the screen. To enter the degrees, minutes, seconds symbols, press the arrow next to the Azimuth text box then select **"Units…"**. Select each symbol individually to insert it.

6. Method: **"Average observations"**

K. Tap **"Enter"** > **"Measure"**. Wait until the data collector switches pages.

L. Verify that all information is correct. Tap **"Store"**.

M. Data Collector will announce "Station setup completed".

VI. COLLECTING FIELD SURVEY DATA

The following procedures explain the user how to use the equipment to survey.

A. Move the prism to the desired survey point location.

B. Tap **"Survey"** > **"Measure topo"**.

C. In the "Measure Topo" screen, enter the following information.

1. Point name: **"1000"**

2. Code: Use the appropriate alpha or numeric code. Tap **"Enter"**. See Appendix C-A for Florida NRCS numeric and alpha survey codes.

3. Method: **"Angles and distance"**

4. Target height: The height of the backsight should be correctly inputted every time the height of the backsight is adjusted.

D. Tap **"Measure" > "Store"**. The equipment will announce "observation stored".

E. Repeat steps C and D until all the shots have been taken for the given control point. Note that the point name automatically increases in value after each shot.

F. If a Turn becomes necessary, continue to "Section VII" *before* powering down the data collector.

VII. MAKING A TURN

A. Once a Turn becomes necessary set a new control point. Make sure the new control point has adequate vision to get the most out of the turn.

B. Setup a prism over the control point.

C. In the "Measure Topo" screen, enter the following information.

1. Point name: **"xxxx"**

2. Code: Use the appropriate alpha or numeric code such as "CP2" for the next control point. CP1 will be the current instrument point. Tap **"Enter"**.

3. Method: **"Angles and distance"**

4. Target height: The height of the backsight should be correctly inputted every time the height of the backsight is adjusted.

D. Tap **"Measure" > "Store"**. The equipment will announce "observation stored".

Record the number of the shot in the field book.

E. Tap **"Escape"**.

F. Before performing the turn, end the survey by selecting **"Survey"** and the **"End conventional Survey"**.

G. Turn off the Trimble S6, and then move to and setup a new control point (CP2). Follow "Section III. SURVEY EQUIPMENT SETUP" For control point set-up

H. Measure and record the height of instrument. See "Section III. SURVEY EQUIPMENT SETUP" Step H." Record in field book.

I. Set rod with bi-pod over the previous control point (CP1). Measure the height of rod and record in field book. "See Section

III. SURVEY EQUIPMENT SETUP, Step I and J".

J. Turn on the instrument and aim towards last control point or the previous instrument point.

K. Plug in or turn on Bluetooth the TSC2 data collector to the instrument.

L. Go to **"Survey Controller"** if not there already.

M. Wait until the TSC2 connects to the total station.

N. Once connected, the data collector should go to the "Electronic Level" screen. Verify that the text "Compensator in range" appears at the bottom of the screen. Tap **"Accept"**.

O. Enter local corrections and tap **"Accept"**.

P. Use tangent screws to precisely aim to prism.

Q. Tap **"Zero" > " Measure" > "Escape"**

R. Make sure the correct job is opened.

S. Tap **"Survey"** icon.

T. Select the survey style for the Trimble S6 total station, if not selected.

U. Select **"Station Setup"** from menu.

V. Enter local corrections and tap **"Accept"**.

W. Under Station Setup screen, Select the arrow next to the **"Instrument point name"** field. Select **"List"** from the menu.

X. Select the point name/code (CP2) given to the control point.

Y. Northing, easting, and elevation will populate.

Z. Enter the new height of instrument from field book.

AA. Tap **"Enter"** > **"Accept"**.

BB. Enter the backsight information by selecting the arrow next to field **"Backsight point name"** and select **"List"** from menu.

CC. Select the point name/code (CP1) given to the previous control point or instrument setup point.

DD. Enter new height of rod from fieldbook

EE. Tap **"Enter"**.

FF. Method: **"Averaged observations"**

GG. Tap **"Measure"**. This will automatically populate the field according to the chosen point.

HH. Tap **"Store"**.

II. Data Collector will announce "Station setup completed".

JJ. Tap **"Survey"**.

KK. Tap **"Measure Topo"**.

LL. Continue with survey. See Section "VII. COLLECTING FIELD SURVEY DATA- Steps C and D".

VIII. **TO END A SURVEY**

A. To end the survey, tap **"Esc"**.

B. From the "Survey Controller" main menu tap **"Survey"** > **"End conventional survey"**.

C. To power down data collector push the green button for three seconds then select **"Shutdown"** > **"Yes"**.

D. Power down Total Station by pushing the power button down for 3 seconds.

E. Disassemble the equipment to and setup for transport/storage.

F. For a procedure to import the TSC2 job file into Civil 3D, refer to EFH Chapter 1, "SECTION C: Sub-Section IV IMPORTING A TSC2 JOB FILE INTO AUTOCAD CIVIL 3D".

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SECTION B.3: FLORIDA TRIMBLE® 5600 SERIES TOTAL STATION WITH TRIMBLE® TSC2 DATA COLLECTOR

The use of the Trimble® 5600 total station and the Trimble® TSC2 data collector can greatly improve the efficiency of collecting and processing survey data. Survey data can be electronically recorded and stored for downloading to a computer for processing. The survey data must be collected in a manner that is compatible with the software used for processing the data.

The following set of procedures describes how to survey with the Trimble ®5600 Total Station and the Trimble® TSC2 Data Collector. The following document only explains features that a NRCS field office will typically use when surveying. This procedure details the user on how to setup the data collector, Trimble® 5600 Total Station, and conduct a field survey. Please see Figures 1 and 2 for illustrations of the total station and the data collector.

Figure 1: Trimble 5600 Series Total Station

Figure 2: Trimble TSC2 Data Collector

I.   SETUP OF SURVEY STYLE IN TCS 2 DATA COLLECTOR FOR THE TRIMBLE® 5600 SURVEY EQUPMENT

NOTE: Once survey style is established it *will not* need to be reestablished unless the Trimble® TSC2 data collector memory is erased or the user is supplied with a new Trimble® TSC2 data collector. The survey style may be setup in the office.

A. Turn on TSC2 data collector by pushing the green button ( ) on the lower left hand corner of the keypad.

B. From Windows Mobile Desktop main menu, select the **"Survey Controller"** icon. See Figure 3.

Figure 3: "Survey Controller" icon.
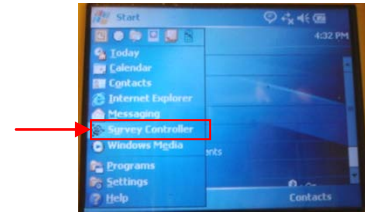
C. From the six icons select **"Configuration"** > **"Survey styles"**.

D. *5600&3600* is the pre-defined survey style for the Trimble 5600 Series.

a. If the survey style exists, ensure it is highlighted and select **"Esc."** Proceed to Section II.

b. If this survey style is not already in the drop list, follow Steps E – N to create the survey style.

E. At the bottom of the screen there will be three small buttons, select **"New"**.

F. Name the new survey style (e.g. **Trimble 5600**)

G. Select "**Conventional"** from the **style type** dropdown menu.

H. Select **"Accept"** > **"Instrument"**.

I. Fill out the resulting "Instrument" screen with the following parameters (see Figure 5):

1. Manufacturer: "**Trimble"**

2. Model: "**5600/3600"**

3. Baud rate: "**9600"**

4. Parity: "**None"**

5. Measurement mode: "**STD"**

6. Averaged observations: **"10"**

7. Auto F1/F2: **box left blank**

8. Measure dist on face 2: **box checked**

9. Autolock off for offsets: **box checked**

10. Select $1^{/2}$ icon

11. Set backsight: "**Azimuth**"

12. Servo auto turn: "**HA & VA**"

13. Edit instrument precisions: **box left blank**

14. Centering error: **0.0000sft**

15. Offset & Stakeout directions: "**Automatic**"

16. Select "**Enter**" > "**Accept**"

Figure 5: Instrument Configuration Settings
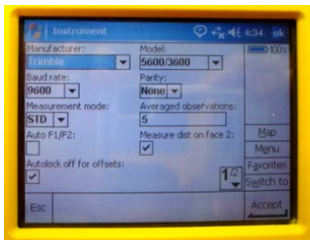
J. From the *new survey style* menu, select "**Topo point**".

K. Set the following parameters on the instrument screen (see Figure 6):

1. Measure display: **HA VA SD**

2. Auto point step size: **1**

3. View before storage: **box checked**

4. Select "**Accept**".

Figure 6: Topo point settings
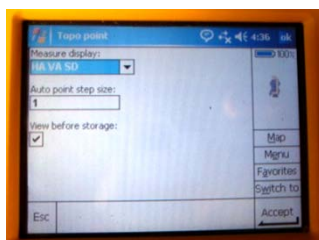
L. Select "**Store**" on the bottom of the screen. The survey style is now established.

M. When returned to the list of Survey Styles, ensure the newly created survey style is selected.

N. Select "**Esc**" > "**Exit**" to return to the main menu.

II. **TSC2 DATA COLLECTOR JOB SETUP** (Perform for **each** job. May be **performed in the office**)

A. Select " Survey Controller" from the main menu.

B. Open "**Files**" > "**New Job**".

C. Fill out the resulting screen as follows:

1. Give name: Enter the name of the job (property and date)

2. Under the "Properties" table, set the following options:

   • Coordinate system: Click the box next to "Coordinate System to bring up a pop-up window. Select "**Scale Factor Only**" > "**Next**"

   • Set the scale factor to "**0.999600000**" then click "**Store**"

   • Units: "**US Survey Feet**"

   • Linked Files: "**None**"

   • Active Map: "**None**"

   • Feature Library: *local office feature library*

   NOTE: The feature table can be loaded onto the data collector in the office. Statewide feature table can be obtained from the Area Engineer or from the SO Engineering Section.

   • Cogo Settings: "**Ground**"

   • Use all the default settings for page 2.

3. Tap **"Enter"** > **"Accept"**.

NOTE: Use a surveyor's field book to make necessary notes to the field conditions such as time, project, crew members, temperature, and weather, etc.

III. SURVEY EQUIPMENT SETUP

A. Set control point (#1) and set a second control point (#2) due north if possible. Distance between the two control points can vary.

Figure 7: Side view of total station showing asterick.
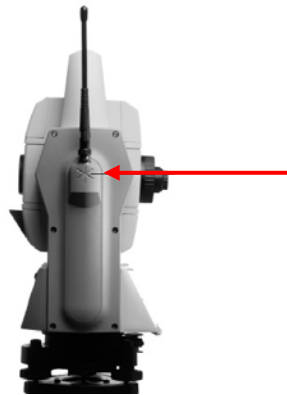
B. Set instrument over control point #1 and level it. Measure instrument height and record it in field book.

Instrument height is measured from the control point to the asterisk mark (*) on the side of the instrument. See Figure 7.

C. Set rod with a prism on control point #2 by using a bi-pole holding the rod. Record the rod/prism height in field book**.**

IV. SETTING UP FOR COLLECTING FIELD SURVEY DATA

A. Remove gray Geodimeter CU unit and attach yellow face plate. See Figure 8

Figure 8: Remove Geodimeter CU unit.

B. Slide 5600 battery onto battery adapter. See Figure 9.

Figure 9: 5600 battery and adapter

Adapter

C. **Connect** the appropriate wire from the battery adapter to the total station hook up. The total station should automatically power-up. See figure 10.

Figure 10: Battery connection to Total Station.

D. **Connect** a second wire from the adapter to the bottom of the TrimbleTSC2 Data Collector. See figure 11.

Figure 11: Battery connection to TSC2 Data Collector

E. A leveling window will appear on the TSC2. Once the instrument is level, select **"Accept"**.

F. Instrument will automatically compensate.

G. A screen asking to confirm corrections will be displayed. Select **"Accept".**

H. Make sure the desired job opened. If correct job is selected proceed to Step I, if not:

    1. Select **"Files"**

    2. Select **"Open job"**, or **"New job"** if you do not have a previously created job (see Section B of this procedure).

    3. Select the desired job, the names will be listed at the top of the screen.

I. Select **"Survey"** > **"5600 & 3600"** > **"Station setup"**.

    1. **"Accept"** corrections

    2. Give point name (ex. 1 or a)

    3. Code: CP for control point.

    4. Enter the instrument height.

    5. Northing: **5000**

    6. Easting: **5000**

    7. Enter the elevation.

       Note the elevation difference between bench mark and control point 1.

    8. Control point: **box checked**

    9. Select **"Accept"**.

    10. Name the backsight (ex. 2 or b)

    11. Code CP for control point.

    12. Enter the rod height (measured in section C, step 3)

    13. Method: **"Angles and Distance"**

    14. Azimuth – **"0"** for due north.

       If not due north, put in the degrees to due north.

    15. Select **"Enter"**

J. Select **"Measure"** > **"Store"**.

K. TSC2 will announce "station setup completed" upon completion.

L. Select **"Survey"** > **"Measure Topo"**

M. Enter point starting station number.

N. Continue taking shots until a turn is necessary.

V. COLLECTING FIELD SURVEY DATA

The following procedures explain how to use the equipment to survey.

A. Move the prism to the desired survey point location.

B. Tap **"Survey"** > **"Measure topo"**.

C. In the "Measure Topo" screen, enter the following information.

    1. Point name: **"1000"**

    2. Code: Use the appropriate alpha or numeric code. Tap **"Enter"**. See Appendix C-A for Florida NRCS numeric and alpha survey codes.

    3. Method: **"Angles and distance"**

    4. Target height: The height of the backsight should be correctly inputted every time the height of the backsight is adjusted.

D. Tap **"Measure"** > **"Store"**. The equipment will announce "observation stored".

E. Repeat steps C and D until all the shots have been taken for the given control point. Note that the point name automatically increases in value after each shot.

F. If a Turn becomes necessary, continue to Section "VI" before powering down the data collector.

VI. MAKING A TURN

A. Once a turn becomes necessary set a new control point. Make sure control point has adequate vision to get the most out of the turn.

B. Setup a Prism over the new control point.

C. Take a shot. Code it (CP2) for the next control point. Record the number of the shot in field book.

D. Before performing the turn, end the survey by selecting **"Survey"** and then **"End conventional survey"**.

E. Shut down the Trimble 5600 total station and TSC2 data collector. Disconnect the TSC2 and 5600 from the battery adapter.

F. Move to and setup Trimble 5600 over control point #2.

G. Measure and record the height of instrument. Record in field book.

H. Set rod with bi-pod over the previous control point or instrument point. Measure the height of rod and record in field book.

I. Connect the battery to the 5600, allowing it to turn on.

J. Turn and aim towards last CP or the previous instrument point.

K. Reconnect the TSC2 data collector.

L. Go to **"Survey Controller"** > **"Survey"**.

M. Select the Survey Style for the Trimble 5600 total station.

N. Select **"Station Setup"**, the TSC2 will connect to the total station.

O. Enter local corrections and tap **"Accept"**.

P. Enter the instrument information by selecting the arrow next to the **"Instrument point name"** field and selecting the desired point name/code (CP#2).

Q. Northing, easting, and elevation will populate. The HA at this time should be set to Zero (0°00'00")

R. Enter the height of instrument (recorded in field book).

S. Select **"Enter"** > **"Accept"**.

T. Enter the Control Point information by selecting the arrow next to the **"Back sight point name"** field and selecting the desired point name/code (CP#1).

U. This will automatically populate the field according to the chosen point.

V. Select **"Enter"**.

W. Select **"Measure"** > **"Store"**.

X. Select the **"Survey"** icon.

Y. Select **"Measure Topo"** and change the point name to 2000 side shots.

Z. Refer to the backsight if visible.

AA. Continue with survey. See Section "V. COLLECTING SURVEY DATA" Steps C-D.

VII. TO END A SURVEY

A. Select **"Esc"** button.

B. Select **"Survey"** > **"End conventional survey"** > **"Exit"**.

C. Shut down TSC2 data collector and Trimble 5600 total station. Disassemble each to the condition needed for transport/storage.

D. For a procedure on how to import the TSC2 job file to your computer for use with AutoCAD, refer to EFH Chapter 1, Section C: Sub-section IV "IMPORTING A TSC2 JOB FILE INTO AUTOCAD CIVIL 3D

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SECTION B.4: FLORIDA NIKON DTM-302 SERIES TOTAL STATION WITH TRIMBLE® TSC2 DATA COLLECTOR

The use of the Trimble® 5600 total station and the Trimble® TSC2 data collector can greatly improve the efficiency of collecting and processing survey data. Survey data can be electronically recorded and stored for downloading to a computer for processing. The survey data must be collected in a manner that will be compatible with the software used for processing the data.

The following set of procedures describes how to survey with the Nikon DTM 332 total station and the Trimble® TSC2 data collector. The following document only explains features that a NRCS field office will typically use when surveying. In order to become familiar with the total station, read the *Nikon DTM 302 Series Total Station Instruction Manual* located in the appendix. This procedure will detail the user on how to setup the Trimble® TSC2 data collector, Nikon DTM 332 series total station, and conduct a field survey. See Figures 1 and 2 for illustrations of the Nikon Total Station and the Trimble® Data Collector.

Figure 1: Nikon DTM-302 Total Station	**Figure 2:** Trimble TSC2 Data Collector

I. INITIAL SETUP OF SURVEY STYLE IN TSC2 DATA COLLECTOR FOR THE NIKON DTM-302 SERIES SURVEY EQUIPMENT

NOTE: Once survey style is established it *will not* need to be reestablished unless the Trimble® TSC2 data collector memory is erased or the user is supplied with a new Trimble® TSC2 data collector. The survey style may be setup in the office.

A. Turn on TSC2 data collector by pushing the green button on the lower left hand corner of the keypad.

B. From Windows Mobile Desktop main menu, select the **"Survey Controller"** icon. See Figure 3.

   Figure 3: "Survey Controller" icon.

    Survey Controller

C. From the six icons, select **"Configuration"** > **"Survey styles"**

D. *NikonDTM* is a pre-defined survey style for the Nikon DTM-302 Series. Select **"Esc"** and proceed to Section II if the survey style is already in the drop down menu. If this survey style is not in the dropdown list, follow Steps E-M.

E. On the bottom of the screen there will be three small buttons, select **"New"**.

F. Name the new survey style (e.g. **NikonDTM**).

G. Select **"Conventional"** from the dropdown menu for the style type.

H. Select **"Accept"** > **"Instrument"**.

I. Fill out the resulting screen with the following parameters:

   1. Manufacturer: **"Nikon"**

   2. Baud rate: **"4800" or "9600" depending on the total station settings.**

   3. Parity: **"None"**

   4. HA VA status rate: **"2s"**

   5. Measurement mode: **"Fine"**

   6. Measure dist on face 2: **box checked**

   7. Set backsight: **"Azimuth"**

   8. Edit instrument precisions: **"Yes"**

   9. Select $1^{/2}$ icon

10. **For page 2 –** Enter using Data collector keyboard**.**

11. Horizontal angle: **5"**

12. Vertical angle: **5"**

13. EDM*: **0.05 sft**

14. EDM (ppm)**: **30**

15. Centering error: **0.02**

16. Offset and Stakeout directions: **"Automatic"**

17. Select **"Enter" > "Accept"**

*EDM= Electronic Distance Measurement

**ppm = Parts Per Million

J. Select **"Topo point"**.

K. Fill out the resulting screen with the following parameters:

1. Measure display: **HA VA SD**

2. Auto point step size: **1**

3. View before storage: check the box

4. Select **"Accept"**.

L. Select **"Store"** on the bottom of the screen.

M. The survey style is now established. (Select **"Esc"** > **"Exit"** to return to the main menu.)

II. **INITIAL TSC2 DATA COLLECTOR JOB SETUP (May be performed in the office)**

A. Turn on the TSC2 data collector

B. Select the **"Survey Controller"** icon from the main menu.

C. Open **"Files"** > **"New Job"**.

D. Fill out the resulting screen with the following parameters:

1. Give name: Enter the name of job (name or date)

2. Select **"Coord. Sys."** > **"Scale Factor Only"** > **"Next"**.

3. Scale factor box leave: **"0.9996000000"**

4. Select: **"Store"**.

5. Units: **"US. Survey Feet"**

6. Linked files: **"None"**

7. Active map: **"None"**

8. Feature library: Select the local office field library

NOTE: The feature table can be loaded onto the data collector in the office. Statewide feature table can be obtained from the Area Engineer or from the SO Engineering Section.

9. Cogo setting:

- Distances: **"Ground"**

- Leave remainder default settings, Tap **"Accept"**.

10. Leave the default settings for page 2.

11. Select **"Accept"**.

III. **INITIAL SURVEY EQUIPMENT SETUP**

A. Place the total station directly over control point (#1) using the optical plummet.

1. (Rodman may) Place the backsight on benchmark at this time as well.

2. Measure the rod height (back sight height) and record in the field book

B. Level the Nikon total station.

Figure 2: Nikon DTM-302 Series – Face 1 and Face 2
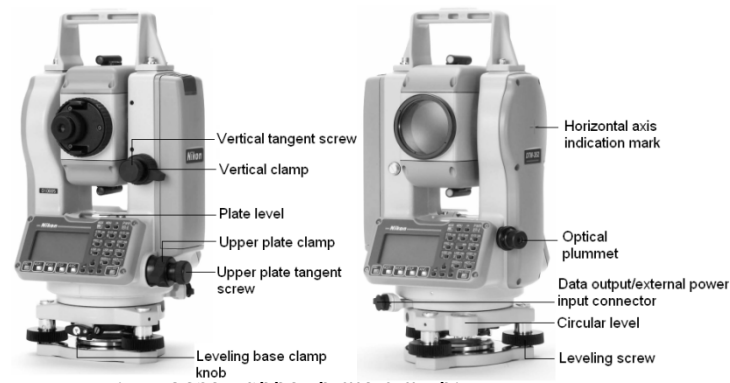
- This allows the instrument to move freely.

2. Level the plate level.

3. Use two of the three leveling screws to level the instrument referencing the bubble level.

4. Rotate the total station $90°$.

5. Level the instrument using the circular (bubble) level and the third screw.

6. Rotate the instrument $180°$ and make any necessary adjustments.

C. Once Instrument is level - Measure the instrument height and record in the field book.

1. Instrument height is measured from the control point to the horizontal axis indication mark on side of the instrument. See Figure 2.

IV. SETTING UP FOR COLLECTING FIELD SURVEY DATA

A. Turn the total station's power on using the red button located at the top right of the instrument key pad.

B. Tilt the optical lens until the display appears on the keyboard.

C. Set the instrument to true north using a compass or as close as possible. Survey may be rotated back in the office.

Note: To move the optical lens vertically, unlock the vertical clamp. Find the target, Lock the vertical clamp. Then use the vertical tangent screw to fine tune the vertical movement. To rotate the instrument, unlock the upper plate clamp. Turn the instrument to find the target. Lock the upper plate clamp. Then use the upper plate tangent screw to fine tune the rotation.

D. Press the **[ANG]** button.

E. Press **[1]** to zero the horizontal azimuth.

F. Turn the instrument to face the back sight.

G. Position the optical lens on the backsight prism. The horizontal azimuth (angle) will display on instrument keyboard.

H. Record the horizontal azimuth in your field book.

I. Connect the TSC2 to the Nikon total station using proper cable.

J. Turn on the TSC2 data collector and select **"Survey Controller"** from the main menu.

K. Open the job file you wish to use.

If you created the desired job file using the previous section it should already be selected.

L. From the Survey Controller main menu, select the **"Survey"** icon.

M. Select the survey style created for use with the Nikon total station.

N. Select **"Station Setup"**, the TSC2 will connect to the total station.

O. Enter local corrections and tap **"Accept"**.

P. Enter instrument point information:

1. Instrument point name (e.g. 1)

2. Code (e.g. CP)

3. Instrument height (in sft)

4. Northing: **5000.000** (assumed)

5. Easting: **5000.000**

6. Elevation: **100.000**

   - *Following coordinates are assumed- may enter coordinates from a known point here.*

7. Control point: **box checked**

8. Select **"Accept"**.

Q. Enter back sight information:

1. Back sight point name (e.g. 10)

2. Code (e.g. BM)

3. Backsight height (rod height)

4. Azimuth (Keyed in) from: Use the small black arrow to the right of the field to select **"Units"** for degrees, minutes, and seconds.

5. Method: **"Angles and distance"**

6. Select **"Enter"**.

R. Tap **"Measure"** > **"Store"**.

S. TSC2 will announce "Station set-up completed".

T. Select **"Survey"** > **"Measure topo"**.

U. Continue surveying until a Turn is necessary.

    1. Adjust rod height if visibility between the total station and the prism becomes obstructed.

    2. Make corrections in the TSC2 data collector if Rod height changes.

V.   COLLECTING FIELD SURVEY DATA

The following procedures explain to the user how to use the equipment to survey.

A. Move the prism to the desired survey point location.

B. Tap **"Survey"** > **"Measure topo"**.

C. In the "Measure Topo" screen, enter the following information.

    1. Point name: **"1000"**

    2. Code: Use the appropriate alpha or numeric code. Tap **"Enter"**. See Appendix C-A for Florida NRCS numeric and alpha survey codes.

    3. Method: **"Angles and distance"**

    4. Target height: The height of the backsight should be correctly inputted every time the height of the backsight is adjusted.

D. Tap **"Measure"** > **"Store"**. The equipment will announce "observation stored".

E. Repeat steps C and D until all the shots have been taken for the given control point. Note that the point name automatically increases in value after each shot.

F. If a Turn becomes necessary, continue to Section "G" before powering down the data collector.

VI.   MAKING A TURN

A. Once a turn becomes necessary set a new control point. Make sure control point has adequate vision to get the most out of the turn.

B. Setup a Prism over the new control point.

C. Take a shot. Code it (CP2) for the next control point. Record the number of the shot in field book.

D. Before performing the turn, end the survey by selecting **"Survey"** and then **"End conventional survey"**.

E. Shut down the Nikon DTM 332 total station and TSC2 data collector. Disconnect the TSC2 from the total station.

F. Move to and setup Nikon DTM 332 over control point #2.

G. Measure and record the height of instrument. Record in field book.

H. Set rod with bi-pod over the previous control point or instrument point. Measure the height of rod and record in field book.

I. Turn on instrument, tilt optical lens until display comes up on keyboard.

J. Turn and aim towards last CP or the previous instrument point.

K. Lock down vertical and horizontal clamps use tangent screws to precisely aim to Prism.

    1. (Optional) Once locked on to the prism press the **[ANG]** button on Nikon keyboard.

    2. (Optional)Press **[1]** to zero the horizontal azimuth.

L. Reconnect the TSC2 data collector.

M. Go to **"Survey Controller"** > **"Survey"**.

N. Select the Survey Style for the Nikon DTM total station.

O. Select **"Station Setup"**, the TSC2 will connect to the total station.

P. Enter local corrections and tap **"Accept"**.

Q. Enter the instrument information by selecting the arrow next to the **"Instrument point name"** field and selecting the desired point name/code (CP#2).

R. Northing, easting, and elevation will populate. The HA at this time should be set to Zero (0°00'00")

S. Enter the height of instrument (recorded in field book).

T. Select **"Enter"** > **"Accept"**.

U. Enter the Control Point information by selecting the arrow next to the **"Back sight point name"** field and selecting the desired point name/code (CP#1).

V. This will automatically populate the field according to the chosen point.

W. Select **"Enter"**.

X. Select **"Measure"** > **"Store"**.

Y. Select the **"Survey"** icon.

Z. Select **"Measure Topo"** and change the point name to 2000 side shots.

AA.   Refer to the backsight if visible.

BB. Continue with survey. See Section "V. COLLECTING SURVEY DATA" Steps C-D.

VII.   **TO END A SURVEY**

A. Select **"Esc"** button.

B. Select **"Survey" > "End conventional survey" > "Exit"**.

C. Shut down TSC2 data collector and Nikon DTM 332 total station. Disassemble each to the condition needed for transport/storage.

D. For a procedure on how to import the TSC2 job file into Civil 3D, refer to EFH Chapter 1, Section C: Sub-section IV *"IMPORTING A TSC2 JOB FILE INTO AUTOCAD CIVIL 3D"*.

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SECTION B.5: FLORIDA TRIMBLE DiNi DIGITAL LEVEL

The use of the Trimble® DiNi Digital Level can greatly improve the efficiency of collecting and processing survey data. Survey data can be electronically recorded and stored for downloading to a computer for processing.

The following set of procedure describes surveying with the Trimble DiNi Digital Level. However, this procedure only explains features that a NRCS field office will typically use when surveying. For additional information about the instrument, read the *Trimble DiNi Digital Level User Guide* located in the appendix. This procedure will detail the user on how to setup the Trimble® DiNi Digital Level conduct a field survey. See Figures 1 for an illustration of the Trimble® DiNi Digital Level.

Figure 1: Trimble® DiNi Digital Level

I. SETUP OF TRIMBLE DiNi INSTRUMENT

A. Take care in setting up the tripod legs in a matter which ensures stability of the device. See Figure 2.

   1. Note: Setting the legs wide enough can compensate stability for heterogeneous surfaces, e.g. one leg on asphalt with the other two on soil. If something prevents the legs of the tripod from being spaced sufficiently apart then the tripod can be lowered to increase stability.

Figure 2: Tripod Setup

B. Tighten all of the screws on the tripod and tribrach. Ensure that they have no play.

C. Take into account the ambient temperature. The digital level must adjust to the new temperature for high precision measurements. Temperature difference in degree Celsius (C) x 2 = approximate duration in minutes required for the instrument to adjust to the new temperature.

Figure 3: Tripod Setup
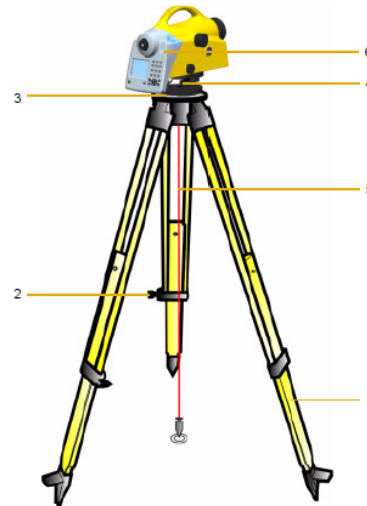
D. Adjust the tripod legs (1) such that the digital level is at a comfortable level for observation. Once this is done fix the legs using the tripod locking screws (2). See Figure 3.

E. Screw the central tripod/head plate screw (3). The tribrach screws (4) should be in mid-position. See Figure 3.

F. Need plumb line and coarse leveling?

G. Roughly level the circular bubble (6) by adjusting the length of the tripod legs. See Figure 3.

H. Fine-tune the circular bubble level using the tribrach screws. See Figure 4.

   1. To test if the level is set properly turn the instrument so that it faces you; ensure the circular bubble is still within the level tolerance (inner circle on the bubble level).

Figure 4: Leveling the Instrument
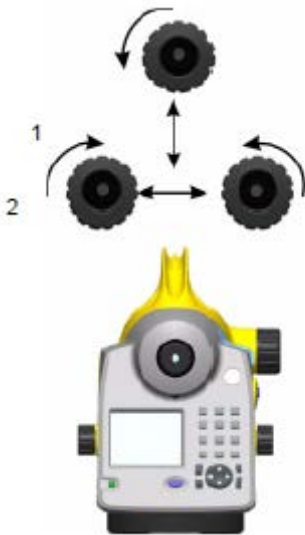
I. Adjust the tribrach on the tripod head plate until the plumb line is hanging directly over the ground mark. Repeat leveling as necessary.

J. Aim the sights at a bright, evenly colored surface and turn the telescope eyepiece until the line patter is sharply defined.

   1. WARNING: Do not point the sights at the sun or strong light source. Irreparable eye damage could be caused if this isn't followed.

K. Turn the focusing unit for the telescope until the target point is sharply defined.

L. Press the power button on the left side of the control panel to turn the instrument on. See Figure 5.

   1. *Note: There are two (blue) trigger keys that may be used to start taking a measurement. For high precision measurements, it is recommended that the trigger key on the right side of the*

instrument (the one that is located away from the control panel) is used. The placement of this trigger key is intended to minimize the influence of any vibrations caused by touching the instrument when pressing the trigger key.

Figure 5: Triggers and Power Button

II.   CONFIGURING THE DINI

A. Choose **"Configuration"** from the main menu. See Figure 6.

Figure 6: Main Menu
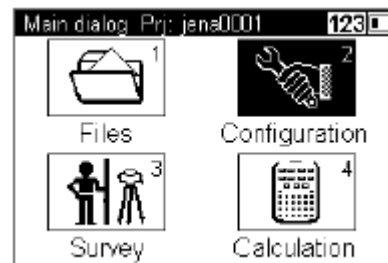
B. Select **"Input"** from the **"Configuration Menu"**. See Figure 7.

Figure 7: Configuration Menu
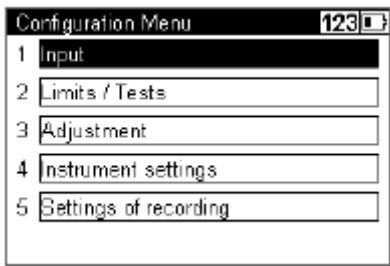
1. Fill in the resulting screen as appropriately and accurately as possible. See Figure 8.

    a. Enter the **"Refraction coeff." – 0.130**

    b. Enter the **"Addition const.(R)" – 0.000ft**

Figure 8: Input

2. Press the enter key to store the information.

C. Select **"Limits / Tests"** from the **"Configuration Menu"**. See Figure 9.

Figure 9: Configuration Menu
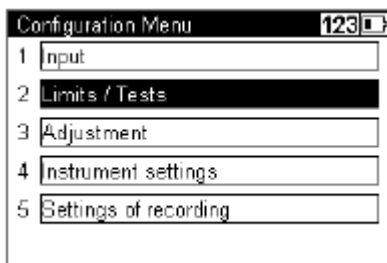
D. Enter **"Max. sighting dist." –** 300.00ft

E. Enter **"Min. sighting height" –** 1.640ft

F. Enter **"Max. sighting height"**.- 9.500ft

G. Press the enter key to access page 2.

H. Use the drop-down list to select the "Difference"- Select "Measurement"

I. Enter the "Max. Difference" – 0.0033ft See Figure 10 for screen caption

J. The "Check 30cm" should be checked

Figure 10: Limits/Tests Settings
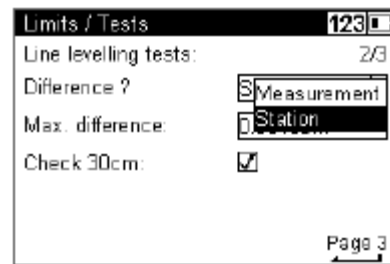
K. Press the enter key to access page 3.

L. Enter the **"back to fore"** (max. distance of choice for a station: 0ft-16.0ft) – 16.0ft

M. Enter the **"total back to fore"** (max. distance for the whole line: 0ft-328ft). – 328ft See Figure 11 for screen caption.

Figure 11: Limits/Tests Settings

N. Press the enter key to save the information.

O. Select **"Adjustment"** from the **"Configuration Menu"**. See Figure 12.

Figure 12: Configuration Menu
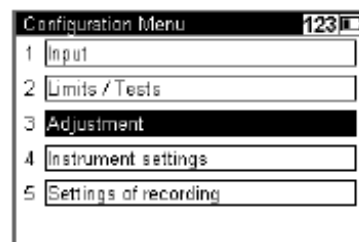
P. The old adjustment values and info will be shown. Select the **"Curvature corr."** and/or

"**Refraction corr.**" box(es) to turn the selection(s) on or off. See Figure 15.

Figure 15: Adjustment Settings
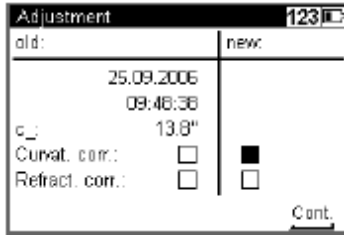
Q. Press the enter key to continue.

R. Select **"OK"** to continue or **"Cancel"** to abort the adjustment. See Figure 16.
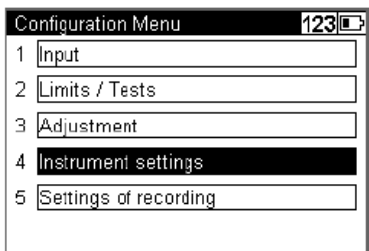
Figure 16: Adjustment Settings
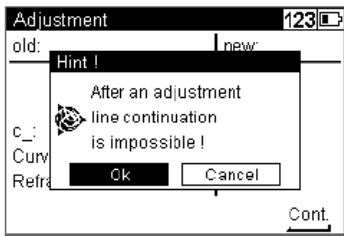
S. Select the "Forstner Method" as the desired adjustment method. See Figure 17.
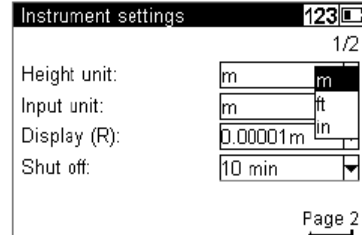
Figure 17: Adjustment Settings
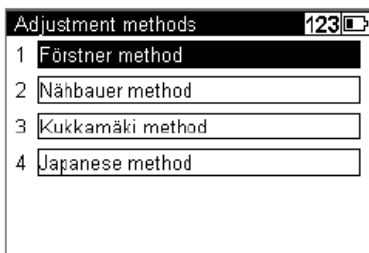
T. Select **"Instrument Settings"** from the **"Configuration Menu"**. See Figure 18.

Figure 18: Configuration Menu

U. Select the preferred unit for the height (US Survey foot(*?*)). See Figure 19.

Figure 19: Instrument Settings

V. Select the preferred unit for value input into the device. See Figure 20.

Figure 20: Instrument Settings
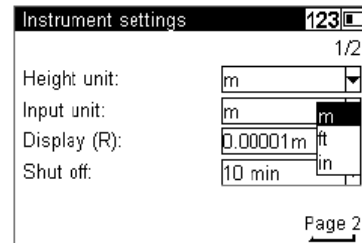
W. Select the number of decimal places you wish to be displayed. See Figure 21.

Figure 21: Instrument Settings
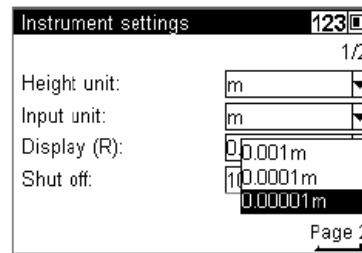
X. Select 10 min for **"Shut off"** to have the instrument automatically shut off after 10 minutes of sitting idle. See Figure 22.

Figure 22: Instrument Settings
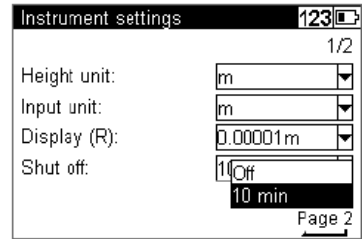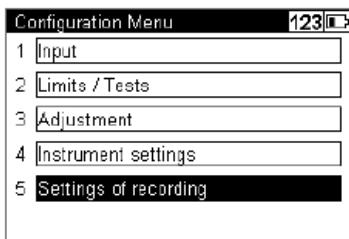

Y. Press enter to access page 2.

Z. Use the "Sound" check box to turn instrument sound on or off. See Figure 23.
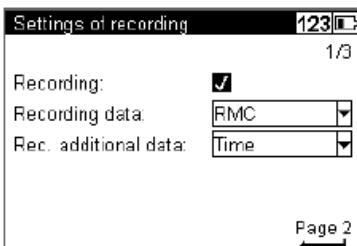
Figure 23: Instrument Settings

AA. Make sure the "Language" is set to English.

BB. Set the date format desired.

CC. Set the time format desired.

DD. Select **"Settings of Recording"** from the **"Configuration Menu"**. See Figure 24.

Figure 24: Configuration Menu

EE. Use the "Recording" check box to turn recording on or off. See Figure 25.

Figure 25: Recording Settings

FF. Set the method in which the data will be recorded. "RM" saves the measured values only, "RMC" includes calculations as well as the measured values.

GG. Select addition data (time or temp.) to include in the data using the "Rec. additional data" dropdown menu.

HH. Press the enter key to access page 2.

II. Enter the rate at which you wish to increase the point numbers in the "PNo. Increment" field. See Figure 26.

Figure 26: Recording Settings
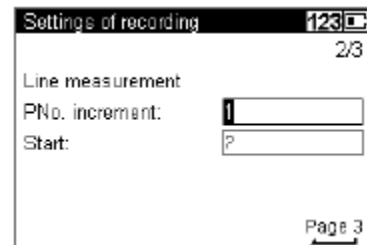
JJ. Enter the initial point number in the "Start" field.

KK. Press enter to access page 3.

LL. Repeat steps GG-HH, however this time the information is regarding numbering for single point measurements and intermediate sights.

MM. Press the enter key to store the info.

III. FUNCTIONS OF THE TRIMBLE DINI

At any time the Trimble Functions menu can be reached by pressing the Trimble icon key *(picture?)*. Note: The functions available at any given time are related to the selected program. *Any of these functions can be chosen using the designated number pad selection number (See Figure 28) in lieu of using the enter key.*
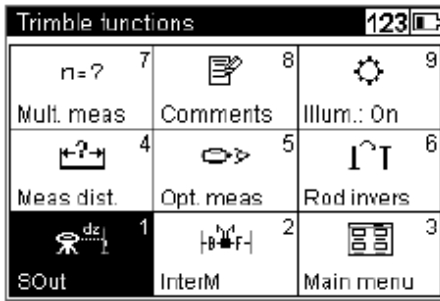
A. Press the Trimble icon key. See Figure 27.

Figure 27: Control Panel

B. The Trimble functions menu will open. See Figure 28.

Figure 28: Trimble Functions

1. Choose **"SOut"** to stake out a point. See Figure 28.

2. Choose **"InterM"** to measure a single point during line leveling. See Figure 28.

3. Choose **"Main Menu"** to access the main menu. See Figure 28.

4. Choose **"Meas dist."** to measure the distance to the staff before doing a final measurement. This is necessary for functions such as line leveling. This function is only able to measure the distance to a point. See Figure 28.

5. Choose **"Opt. meas."** to take a measurement using a metrical staff. This function is used for cases where the digital measurement cannot be taken and allows the optical measurement reading to be keyed in for a point. See Figure 28.

   a. Choose **"distance"** for manual input using the horizontal distance, "HD", reading and the rod reading, "R". See Figure 29.

Figure 29: Visual Measurement
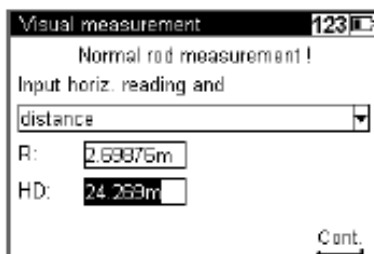
   b. Choose **"stadia reading"** for manual input using stadia readings (the readings from the upper and lower Reichenbach stadia lines) and the rod reading. See Figure 30.

Figure 30: Visual Measurement
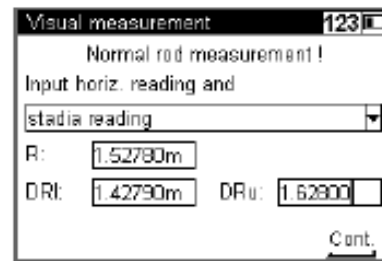
6. Choose **"Rod invers"** and select yes to confirm inverted staff setting and to take inverted measurements. This type of shot may be needed for work underground and inside buildings. Note: This setting will remain active until changed and an arrow pointing downwards will be shown in the lower right hand corner of the display when it is active. See Figure 31.

**Figure 31:** Rod Inversion Symbol
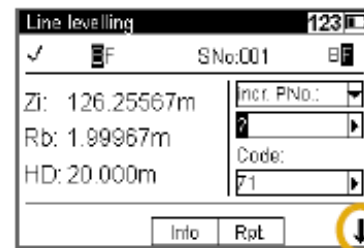
7. Choose **"Mult. Meas."** to take repeated measurements. With this function you can set the desired standard deviation (mR) and the number of measurements (nM) for the instrument to take. The process can be stopped once the desired deviation has been met; however, this may incur some vibrations by touching the instrument. The mean staff reading and distance and the standard deviation are displayed after each measurement.

8. Choose **"Comments"** to input additional information for a measurement. See Figure 32.

Figure 32: Comments input
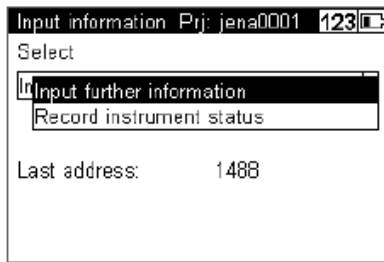
a. Select **"Input further information"** from the dropdown menu and press the enter key to input information manually *or skip to step "b."*. See Figure 33.

   i. Input alphanumeric text.

   ii. Select "Append current date" and/or "Append current time" from the dropdown menu to add current date or time.

   iii. Press the enter key to store in information.

b. Select **"Record instrument status"** from the dropdown menu to document the basic status of the instrument (measuring unit, amount of the line of sight correction, date of last adjustment, earth curvature/refraction setting and coefficient, staff offset/addition constant to quit the instrument info). See Figure 32.

9. Choose **"Illum.*: On*"** to turn the display and bubble illumination on or off using the enter key. A symbol is show if the illumination is enabled. *Note: Power safe mode will turn off the illumination after 30 seconds of the instrument sitting idle and the icon will change to that of a moon and will remain off until the next time a key is pressed*. See Figure 33.

Figure 33: Illumination Symbol
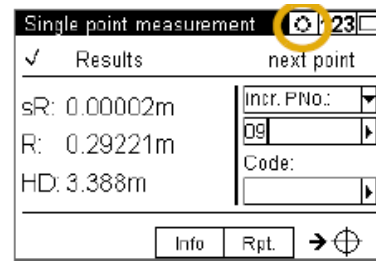
10. Press the *dot/comma key* to display the program version and serial number

IV.   **SURVEYING**

Note: Some of the functions that are accessible using the function button are also found when "Survey" is selected from the main menu. These functions will be mentioned in this section; however, you should refer to the previous section for more in-depth explanation of those functions previously described.
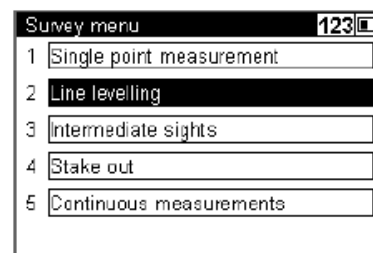
A. Choose **"Survey"** from the main menu. See Figure 34.

Figure 34: Main Menu
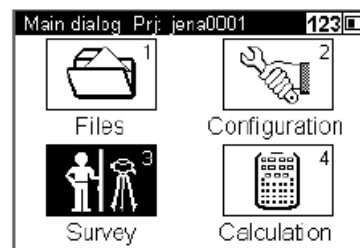
B. Choose **"Single point measurement"**, or press 1 on the key pad, to measure a single point. See Figure 35.

Figure 35: Survey Menu

C. Choose **"Line leveling"** from the Survey menu, or press 2 on the keypad, to begin line leveling.

D. Choose **"New"** if you want to start a new line; **"Continue"** to continue an uncompleted line; or **"From project"** to select a (previously completed) line from a project. See Figure 36.

Figure 36: Line Leveling

E. If you begin a new line you must now set the **"Line Number"**, **"Measuring method"**. Also, choose whether you'd like alternate enabled or disabled by using the check box next to it. See Figure 38.

Figure 38: Line Leveling

F. Press the enter key.

G. Select a **"Point number"** for the line leveling benchmark using the drop-down menu: **"Find"** will find the next free point number; **"From project"** will allow the selection of a point number in the current project; **"Other project"** allows the selection of a point number from a different project than the current. See Figure 39.

Figure 39: Line Leveling Benchmark

H. Choose a **"Code"** from the drop-down list or enter it using the key pad. See Figure 40.

Figure 40: Line Leveling Benchmark

I. Enter in the benchmark height. If the point number was chosen from a list the height will be given automatically. See Figure 41.
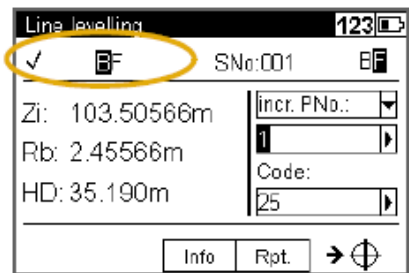
Figure 41: Line Leveling Benchmark

J. Press the enter key.

K. Aim and focus the instrument at the staff, and start a backsight measurement with either of the trigger keys. See Figure 42. *Note: A symbol will be displayed at the bottom right corner of the screen when the instrument is ready to take a measurement.*
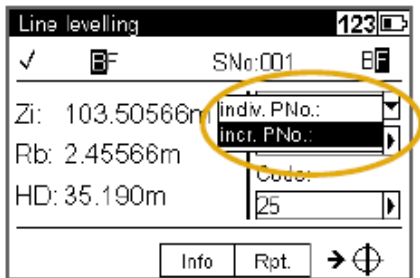
Figure 42: Line Leveling
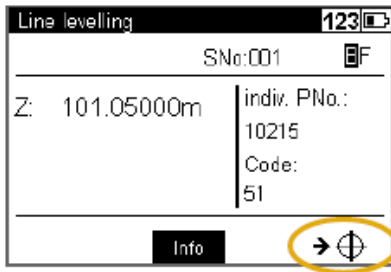
L. The result will be displayed once the measurement is ready. See Figure 43.

Figure 43: Line Leveling

M. Select incremented or individual point number. See Figure 44.

Figure 44: Line Leveling

N. Select a **"Point number"** for the line leveling benchmark using the drop-down menu: **"Find"** will find the next free point number; **"From project"** will allow the selection of a point number in the current project; "Other project" allows the selection of a point number from a different project than the current. See Figure 45.

Figure 45: Line Leveling

O. Select a **"Code"** list from the drop-down menu or enter a point number using the key pad. See Figure 46.

Figure 46: Line Leveling
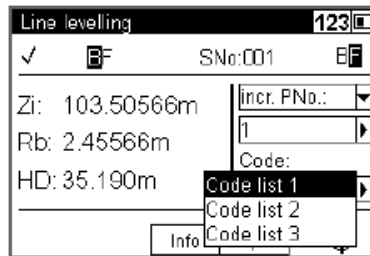
P. Select **"Info."**. The total sighting distances are know, and the next stations, Db and Df, are required to be such that they are almost identical at the end of the line.

Q.   Select "Rpt." if you wish to repeat the last measurement or the last station. *Note: This option can be used for single point measurements as well as line leveling.* See Figure 47.

Figure 47: Repeat Measurement
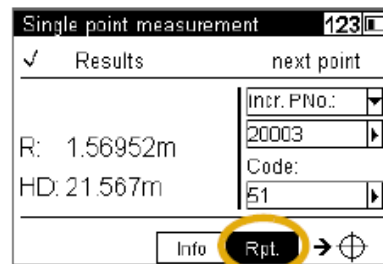
R. Select the appropriate function. See Figure 48. Repeat until the measurement is satisfactory. *Note: Repeated Data lines will be marked with "#####" and ignored for calculations.*

Figure 48: Repeat Measurement
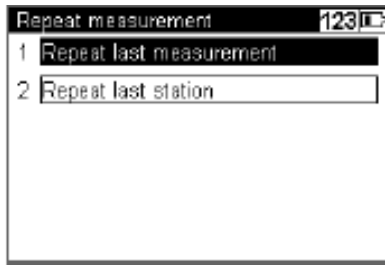
S.   After the backsight measurement (using BF and BBFF) or complete station measurement (all other methods including alternated versions) are done, thereby providing a reference height, some of the functions mentioned in section III become available.

1.   Intermediate Sights: Taking the measurement works the same as taking the backsight shots for the line leveling. See section III.B.2 for more information. *Note: The program "Line Adjustment" will only calculate and improve the intermediate points in respect to the respective instrument station.*

2.   Stake out: Select a point number using the dropdown menu from the current project or another project, or key in the desired point number, code, and nominal

elevation. Press the escape key to return to line leveling. *Note: The program "Line Adjustment" will not adjust and change the stakeout heights.*

T.   Select **"Lend"** to end the leveling line. For the following screen select yes for a point with a known height, no at a point with unknown height. See Figure 49.

Figure 49: Line Leveling

1.   With a known height select the point number, code, and benchmark choice or select the point from memory with the information already stored. Highlight **"Accept"** and press the enter key.

2.   With an unknown height highlight **"Accept"** and press the enter key.

SECTION B.6: FLORIDA SURVEYING CODES

Table FL1C – 1 Florida Special Codes

SPECIAL (CONTROL) CODE	DESCRIPTION OF SPECIAL (CONTROL) CODE	EXAMPLE OF USE
B	BEGIN A LINE OR A FIGURE	"B 800" - "B FEN"
E	ENDS A LINE OR A FIGURE	"E 800" - "E FEN" Beginning a New figure ends the previous
C3	A THREE SHOT CURVE	"C3 300" THIS WILL START A CURVE USING THREE POINTS TAKEN WITH THE FIELD CODE (C3 300, 300, 300) SECOND SHOT SHALL BE THE CENTER OF THE CURVE, THE THIRD SHOT WILL END THE CURVE
MCS	MULTIPLE POINT CURVE SEQUENCE START	STARTS A CURVE WITH MCS- CONTINUE TO CREATE A CURVE UNTIL "MCE" IS USED "MCS ROAD1, ROAD1, ROAD1, MCE ROAD1"
MCE	MULTIPLE POINT CURVE SEQUENCE END	ENDS A MULTIPLE POINT CURVE SEQUENCE.
CLOSE	CLOSES A SURVEY LINE OR FIGURE	"B BLDG2, BLDG2, BLDG2, CLOSE BLDG2" THIS WILL CLOSE A BUILDING ONCE ALL FOUR SIDES ARE SHOT AND RECORDED.

Table FL1C – 2 Florida Survey Field Codes

NUMERIC CODE	ALPHA CODE	DESCRIPTION OF CODE	FEATURE CLASS
1	BM	BENCH MARK	CONTROL
11	TBM	TEMP. BENCH MARK	CONTROL
20	HCP	HORIZONTAL CONTROL PT.	CONTROL
21	VCP	VERTICAL CONTROL PT.	CONTROL
22	RP	REFERENCE PT.	CONTROL
23	CP	CONTROL PT.	CONTROL
24	PROP	PROPERTY CORNER	CONTROL
25	EASE	EASEMENT MARKER	CONTROL
50	NG	NATURAL GROUND	NATURAL
51	WET	EDGE OF WETLAND	NATURAL
52	CROP	EDGE OF CROPLAND	NATURAL
53	WOOD	EDGE OF WOODED AREA	NATURAL
54	DIT	CENTERLINE DITCH	NATURAL
55	STR	STREAM	NATURAL
56	GUL	GULLY	NATURAL
57	BPIT	BORROW PIT	NATURAL
58	POND	EDGE OF POND	NATURAL
59	HWM	HIGH WATER MARK	NATURAL
60	WL	WATER LEVEL	NATURAL
61	TOB	TOP OF DITCH BANK	NATURAL

Table FL1C – 2 Florida Survey Field Codes

NUMERIC CODE	ALPHA CODE	DESCRIPTION OF CODE	FEATURE CLASS
62	TOE	GRADE BREAK	NATURAL
75	TREE	TREE	NATURAL
80	ROCK	ROCK OUTCROPPING	GEOLOGICAL
82	TPIT	TEST PIT	GEOLOGICAL
83	SINK	SINKHOLE	GEOLOGICAL
84	SLB	SOIL LIMITATION	GEOLOGICAL
100	EMB	EMBANKMENT	EARTHEN STRUCTURES
101	DIKE	EDGE OF DIKE	EARTHEN STRUCTURES
102	LEV	EDGE OF LEVEE	EARTHEN STRUCTURES
103	TER	EDGE OF TERRACE	EARTHEN STRUCTURES
300	ROAD	EDGE OF ROAD	ROADS / STREETS
350	SW	EDGE OF SIDEWALK	ROADS / STREETS
351	CURB	EDGE OF CURB	ROADS / STREETS
352	PAV	EDGE OF PAVEMENT	ROADS / STREETS
355	WALL	EDGE OF WALL	ROADS / STREETS
356	HW	HEADWALL	ROADS / STREETS
360	GRAIL	GUARDRAIL	ROADS / STREETS
370	CBOX	CONCRETE BOX	ROADS / STREETS
380	CB	CATCH BASIN	ROADS / STREETS
381	SI	SURFACE INLET	ROADS / STREETS
390	RR	RAILROAD TRACKS	ROADS / STREETS
400	BR	BRIDGE	ROADS / STREETS
405	PIER	PIER	ROADS / STREETS
500	PIPE	PIPE	W.C. STRUCTURES
501	BOX	BOX CULVERT	W.C. STRUCTURES
502	EPIPE	ELLIPTICAL CULVERT	W.C. STRUCTURES
503	APIPE	ARCH CULVERT	W.C. STRUCTURES
504	RISE	RISER	W.C. STRUCTURES
550	BLDG	BUILDING	BUILDINGS
551	DOOR	DOOR	BUILDINGS
552	FLR	FLOOR	BUILDINGS
553	HVAC	HEAT/COOL BOX	BUILDINGS
554	RAMP	RAMP	BUILDINGS
555	SLAB	CONCRETE SLAB	BUILDINGS
600	UTIL	UTILITY LINE	UTILITIES
601	GUY	GUY WIRE	UTILITIES
602	PA	POLE ANCHOR	UTILITIES
605	UPOLE	UTILITY POLE	UTILITIES
610	ELEC	POWER LINE	UTILITIES
615	PP	POWER POLE	UTILITIES
620	TELE	TELEPHONE LINE	UTILITIES
625	TPED	TELEPHONE PEDESTAL	UTILITIES

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Table FL1C – 2 Florida Survey Field Codes

NUMERIC CODE	ALPHA CODE	DESCRIPTION OF CODE	FEATURE CLASS
626	FIBOP	FIBER OPTIC CABLE	UTILITIES
630	TV	TV CABLE	UTILITIES
640	WTR	WATERLINE	UTILITIES
645	WM	WATER METER	UTILITIES
650	SEW	SEWER LINE	UTILITIES
655	MH	MANHOLE	UTILITIES
660	GAS	GASLINE	UTILITIES
661	GV	GAS VALVE	UTILITIES
662	PTANK	PROPANE TANK	UTILITIES
665	GM	GAS METER	UTILITIES
670	SL	SIGNAL LINE	UTILITIES
675	TS	TRAFFIC SIGNAL	UTILITIES
700	STEP	STEPS	MISCELLANEOUS
701	SIGN	SIGN POST	MISCELLANEOUS
702	BB	BILLBOARD	MISCELLANEOUS
703	MB	MAILBOX	MISCELLANEOUS
704	GPUMP	GAS PUMP	MISCELLANEOUS
705	ANT	ANTENNA	MISCELLANEOUS
706	TWR	TOWER	MISCELLANEOUS
707	HYD	FIRE HYDRANT	MISCELLANEOUS
708	FPOLE	FLAG POLE	MISCELLANEOUS
709	GYAD	CEMETERY	MISCELLANEOUS
800	FEN	FENCE	AGRICULTURAL
801	GATE	GATE	AGRICULTURAL
810	IRR	IRRIGATION PIPE	AGRICULTURAL
820	WELL	WELL	AGRICULTURAL
821	PUMP	PUMP	AGRICULTURAL
822	ENG	ENGINE	AGRICULTURAL
823	TANK	TANK	AGRICULTURAL
825	VAL	VALVE	AGRICULTURAL
826	TB	THRUST BLOCK	AGRICULTURAL
827	IR	IRRIGATION RISER	AGRICULTURAL
828	SPR	SPRINKLER HEAD	AGRICULTURAL
830	SILO	SILO	AGRICULTURAL
831	TRO	TROUGH	AGRICULTURAL
832	COOP	SOLID SEPARATOR	AGRICULTURAL

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SECTION C: FLORIDA AUTOCAD CIVIL 3D DESIGN PROCEDURES

The use of AutoCAD Civil 3D can provide the user greater efficiency when downloading, processing, designing and plotting data. The survey data must be collected in a manner that will be5 compatible with AutoCAD Civil 3D. Several features in AutoCAD Civil 3D will need to be set and correlated with each other. The procedures described below shall be followed when setting the NRCS template, Survey and Figure databases, importing survey points, importing .SID files, and creating surfaces for contour lines using the downloaded survey data.

Before using this procedure, the following programs and files should be installed, in their most current version, on your computer. Compatibility issues may arise if any program is not up to date:

- NRCS Civil 3D template –several features have been localized from the National Headquarters Civil 3D template including all of the Florida Survey codes, Layers, Coordinate systems, and Styles

- Microsoft Activesync - used to link external devices such as TSC2 data collectors and various Total Stations.

- Trimble Data Transfer - used to download the base files from R8/GNSS GPS grade survey equipment.

- Trimble RINEX converter- useful to convert the DAT or T01 base receiver file into a RINEX file, which is the file required by OPUS for post processing.

- Trimble Link menu on AutoCAD – (Register with Trimble to obtain an authorization key to use.)

- Geoid Model installed using AutoCAD and Trimble Link menu. (An IT specialist may have to do this.)

  This procedure is written assuming that the user has a basic understanding of AutoCAD Civil 3D. If a more detailed explanation is required refer to the online vbooks located at www.nrcsknowledge.com

I.   DOWNLOADING THE FLORIDA TEMPLATE.

A. The Florida Template may be downloaded from the Florida Sharepoint located here:

   https://nrcs.sc.egov.usda.gov/east/fl/cadd/default.aspx

B. Create a folder to place any templates. This will be needed later.

   1. Save the Florida Template *(Or any template)* into the newly created folder.

**II. SETTING THE FLORIDA TEMPLATE IN CIVIL 3D.**

A. Open Civil 3D if not open already.

B. Go to "Options" –

   1. To get to options, type in "OP" or right-click in the drawing area, and select options" from the menu.

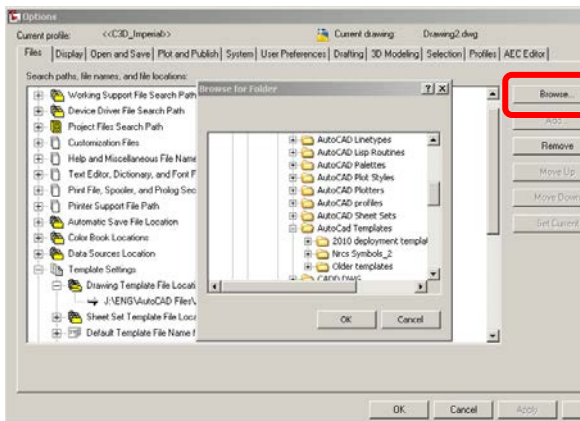C. Once the Options dialog box appears, select the **"Files"** tab.
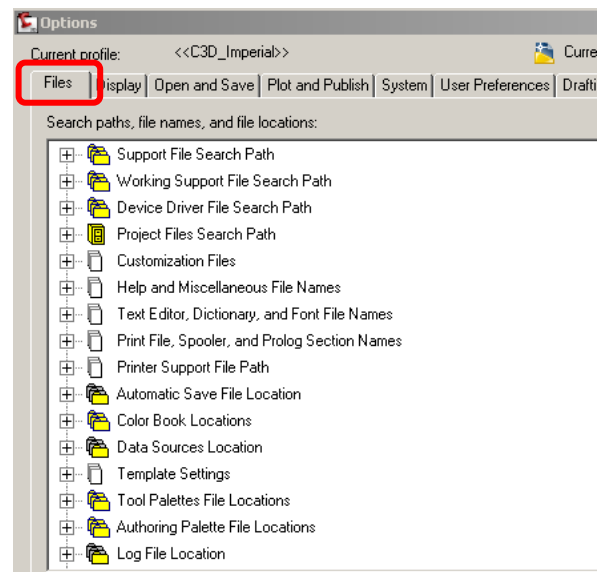
D. Scroll to the option **"Template Settings"** and click on the Plus sign on the left-hand side to expand the menu.
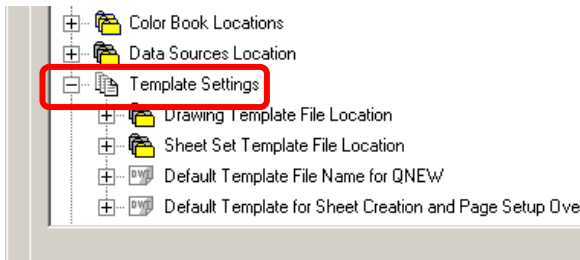
E. Scroll to **"Drawing Template File Location"** expand the menu with plus sign.
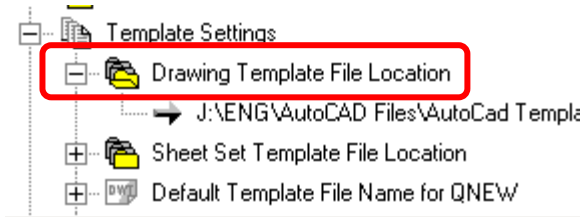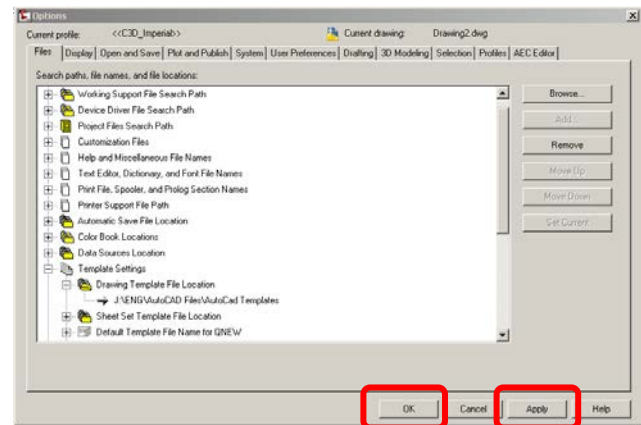

F. Click on the File path and hit the **"Browse"** button in the upper right hand corner.

G. Once the Browse dialog box opens find the newly created Template Folder (see Section I- Subsection B) .

H. Select the Folder and click "Ok". The Browse dialog box will close.

I. On the Options dialog box, click **"Apply"** and **"OK"**

**III. SETTING THE USER SURVEY DATABASE AND FIGURE PREFIX DATABASES.**

A. Open a new drawing in AutoCAD Civil 3D.

B. Open the **"Toolspace"** palette if not already open by clicking **"General"**>**"Toolspace"**, or type "showts" into the command line.

C. In Toolspace select the **"Survey"** tab.

D. Click the icon at the upper left corner of the survey tab. See Figure A-1.

Figure A-1: Survey User Settings
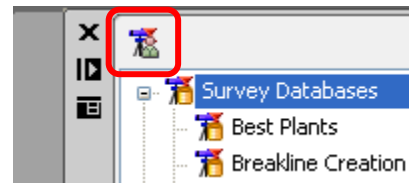
E. In the **"Survey User Settings"** dialog box click the file path icon for **"Survey database settings path"**. See Figure A-2.

Figure A-2: Survey User Settings Dialog Box
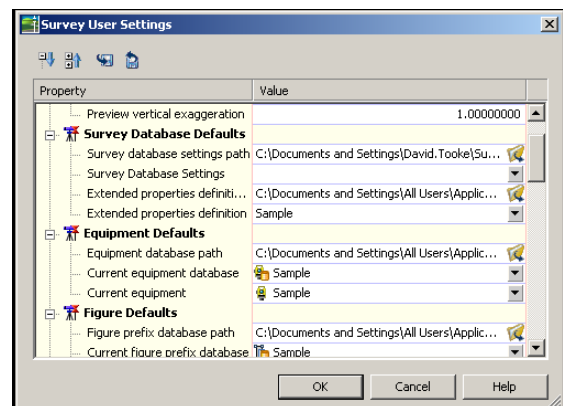
F. In the **"Browse for Folder"** window navigate to the desired location for saving survey databases and click **"OK"**.

A. This file path is saved until changed.

B. The desired location should be set to allow access for everyone that needs to use the survey databases (Server or external hard drive that can be mapped by everyone).

G. In the **"Survey User Settings"** dialog box click the file path icon for **"Figure prefix database path"**.

H. In the **"Browse for Folder"** window navigate to the desired location for saving figure prefix databases and click **"OK"**.

　　1. This file path is saved until changed.

　　2. The desired location should be set to allow access for everyone that needs to use the Figure Prefix databases. (Server or external hard drive that can be mapped by everyone)

I. Click **"OK"** to close the **"Survey User Settings"** dialog box.

IV. IMPORTING A TSC2 JOB FILE INTO AUTOCAD CIVIL 3D

A. Open and save a new drawing in AutoCAD Civil 3D. Place in the proper project folder and give it a file name.

B. Plug the TSC2 Data collector into the computer.

C. MS Active Sync will sync Data collector with the computer and will bring up a dialog box notifying the connection between the computer and the Data collector.

D. In Civil 3D select **"Import Job"** from the **"Trimble"** menu. See Figure B-1.
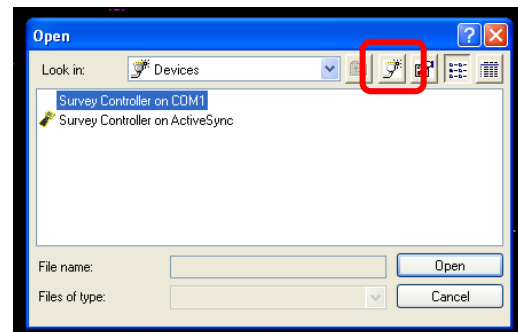
Figure B-1: Trimble Menu
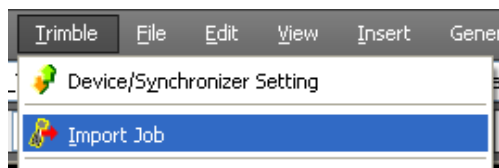
E. From the list of Devices, select **"Survey Controller on Activesync"**.

There will be two devices, one mentioned above and a connection device that allows the data collector to use a different Trimble Communications cable to the computers COM1 port called **"Survey Controller on COM1"**. See Figure B-2.
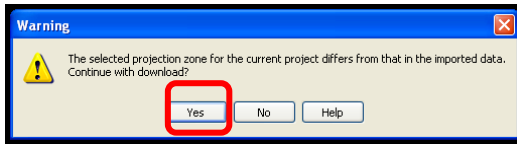
Figure B-2: Trimble Link Window

F. Once the device is selected, a list of jobs within that device will be displayed. See Figure B-3:

Figure B-3: Trimble Job files list
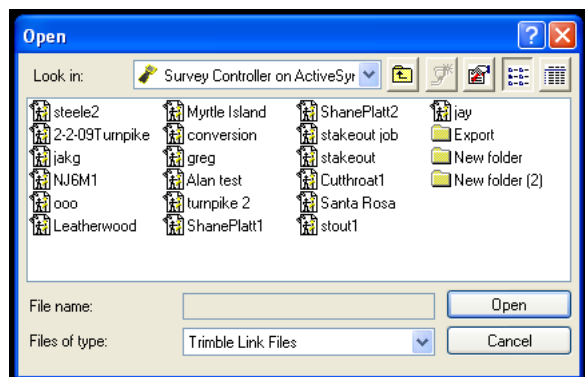
G. Select the job to be imported and click **"Open"**

H. The Job file will then be RECEIVED, and then CONVERTED. *Note: if a warning message opens select "Yes" to continue.* See Figure B-4.

Figure B-4: Warning Message

I.   This will open a **"Check In"** dialog box, to
     view the point number Feature Code, Rod
     Height, and sometimes Antenna Type and
   Antenna method. Click **"OK"** to accept**.** See
     Figure B-5.

*Note: if you have two survey job files into
one survey database, this is a great place to
renumber the survey points before you
import them into the drawing. Using the
"Renumber.." button to perform this. This
eliminates the duplicate point issue.*

Figure B-5: Check In Dialog Box
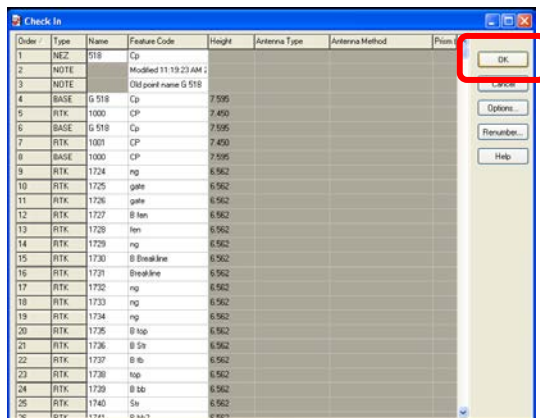
J.   In the Import survey dialog box select
     "Create New Survey Database" and name
   the survey database. The name of the project
     will do. See Figure B-6.

Figure B-6: Creating a Database
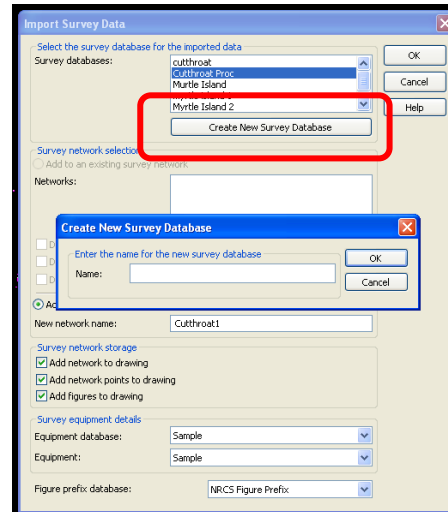
K.   Select **"Add a New Survey Network"** for
     new surveys. See Figure B-7.

     Adding points to an existing survey select
     "Add to an Existing Survey Network"
     select the network or survey job to add the
     points to. (Two different .job files same
     project). You may have to renumber the
     points with the use of the Check-in to avoid
   duplicate points numbers.

Figure B-7: Adding Survey Networks
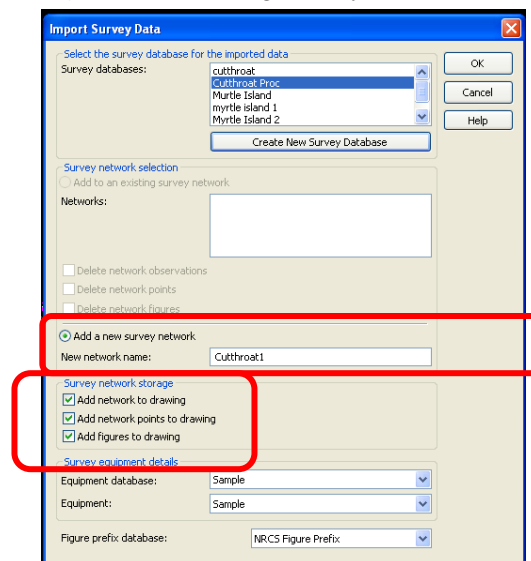
L.   Check all three boxes under **"Survey
     network storage".** See Figure B-7.

M. Leave **"Survey Equipment Details"** as is. See Figure B-7.

N. Select the figure prefix database **"NRCS Figure prefix"** or a figure prefix database that was lined out by the State Office.

O. Click **"OK"** the points will import.

P. Two things will happen, the JOB file will convert to a AutoCAD Fieldbook (FBK file, and the fieldbook file will be imported.

Q. Trimble Link will inform the user of survey data imported. Select **"OK"** to close the window. See Figure B-8.

**Figure B-8**: Trimble Link Notice Window
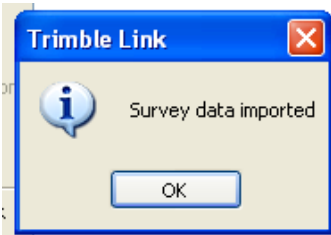
R. Perform zoom extents.

V.   TRANSLATING SURVEY DATABASE USING AN OPUS SOLUTION

If a more detailed explanation about obtaining the OPUS Solution is needed, please refer to "SECTION B.1: FLORIDA PROCEDURES FOR TRIMBLE R8/GNSS GPS SYSTEM"

A. If the survey was just imported the database will be open. Highlight the survey database header and right click to open a menu of options.

If a database isn't open, double click on a database to open.

B. Select **"Translate Survey Database"**. See Figure C-1.

Figure C-1: Translate Database Selection
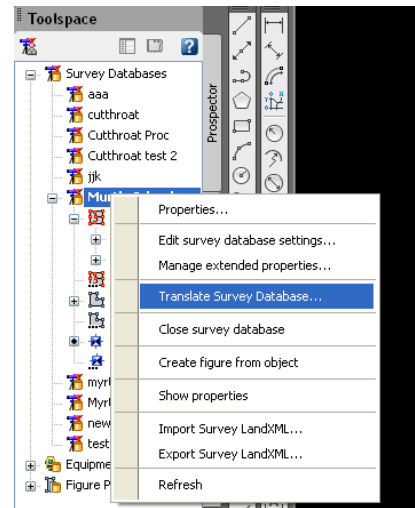
C. Select the point where the GPS base was located as the control point by typing the number one (1) or selecting the point from the drawing. See Figure C-2. Control point is usually point number 1.

Figure C-2: Setting Control Point
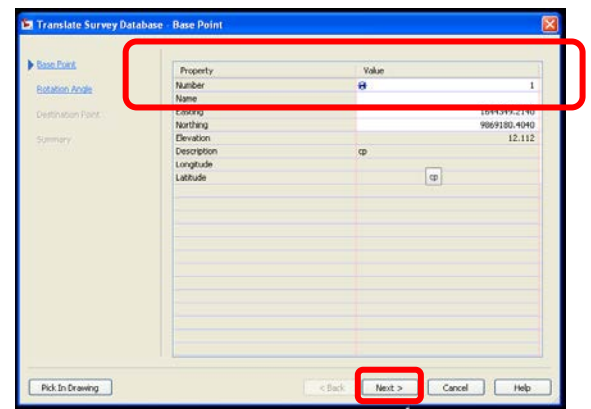
D. Fields (Northing, Easting, and Elevation) will automatically populate. Note starting elevation to assist with calculating destination elevation.

E. Select "Next".

F. Enter rotation angle. See Figure C-3. Set as 0 unless doing conventional surveying.

Figure C-3: Setting Rotation Angle
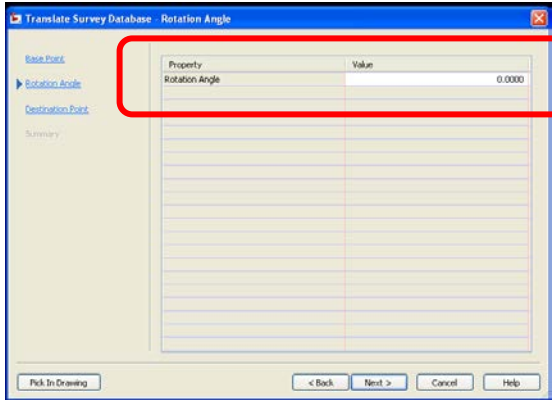
G. Select "Next".

H. Enter destination point coordinates. See Figure C-4.

   1. Note – Elevation change means the difference between old point and new point (12.112 to 17.792, enter 5.68)

   2. Using Opus Solution convert coordinated to feet.

Figure C-4: Setting Destination
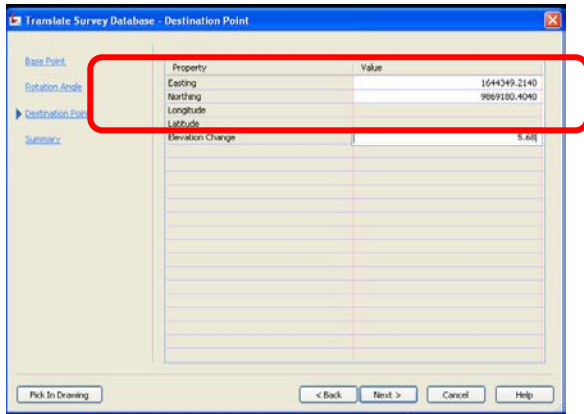
I. Select "Next".

Figure C-5: Translation Summary
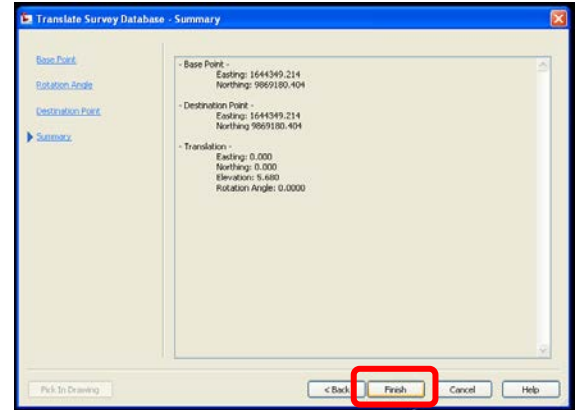
J. Select Finish. See Figure C-5. Survey database will update.

VI. **POPULATING POINT GROUPS**

   A. Select the **"Prospector"** tab in the Toolspace. See Figure D-1.

   B. Highlight the header **"Point Groups".**

   C. Right-click and select **"Update"**. See Figure D-2.

Figure D-1: Toolspace
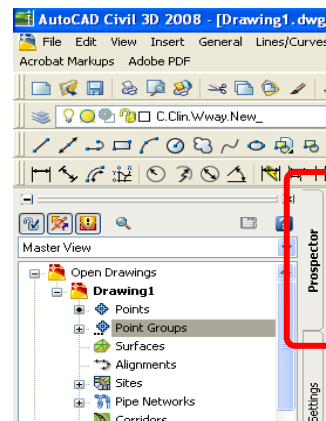
Figure D-2: Updating Point Groups
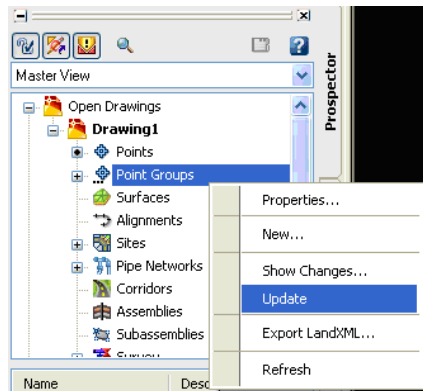
D. Point Groups are now populated. Creating a surface requires the addition of point groups.

A point group is a filtering process AutoCAD uses to filter survey codes such as NG, and or BM. The NRCS template is set-up to filter the Survey Codes ONLY.

VII. CREATING A SURFACE USING POINT GROUPS

A. With the survey imported and point groups updated. Go to the **"Prospector"** tab.

If the **"Toolspace"** on the interface is not shown, open by selecting it from the menu (**"General"**> **"Toolspace"**) or by typing in **"SHOWTS"**

B. Right click **"Surfaces"** and select **"Create Surface…"** from the list. See Figure E-1. A USDA/NRCS template may have a surface ready for use.

Figure E-1: Create Surface

C. Give the surface a name by clicking inside the values box where it says **"Ognd"**.

Rename it and then click **"OK"**. See Figure E-2.

Figure E-2: Create Surface Dialog Box
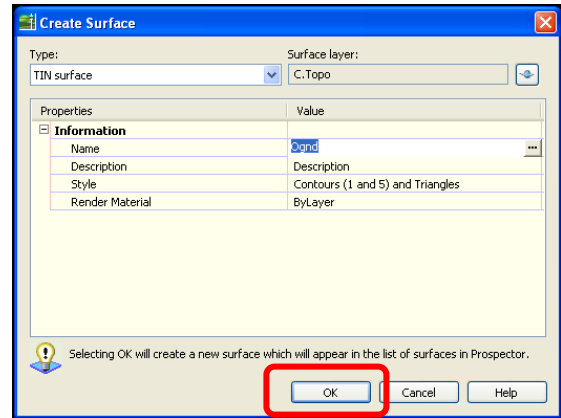
D. Next open the surface header. Select the expansion icon (small plus sign) next to **"Surfaces"**. The new created surface will appear under the **"Surfaces"** header as the name that it was given. See Figure E-3.

E. Open the named surface by clicking the corresponding expansion icon. See Figures E-3 & E-4.

Figure E-3: Surfaces List
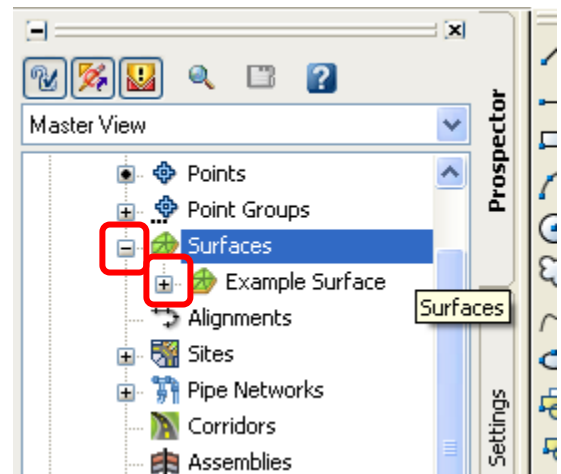
F. Open the **"Definition"** by clicking the corresponding expansion icon. See Figure E-4.

G. Right-click **"Point Groups"** and select **"Add"**. See Figure E-4.

Figure E-4: Adding Point Groups
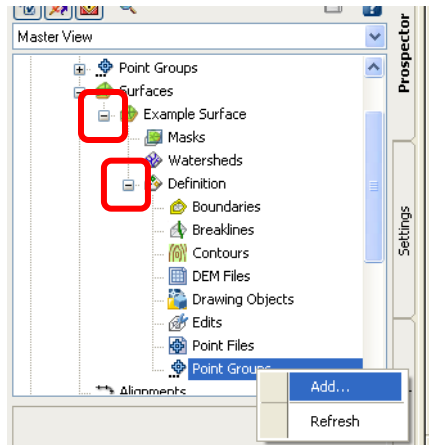
H. In the **"Point Group"** list select the point
    groups that will be contoured. Hit **"Apply"**
    and **"OK"**. See Figure E-5.

    Some point groups such as EX Tree, or EX
    Bldg. will not be contoured so do not add
    them to the surface. Add the point groups
    that are necessary based on the survey. See
    Figure E-5.

Figure E-5: Point Groups Dialog Box
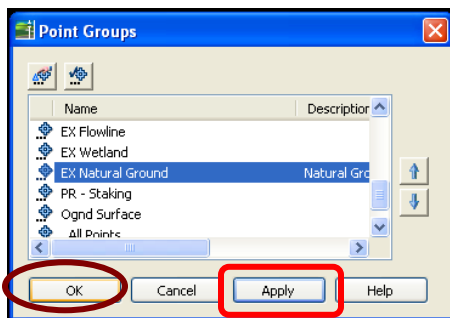
I. Once a point group is added, the surface will
    begin to take shape as contours and triangles
    are added. See Figure E-6.

Figure E-6: Surface
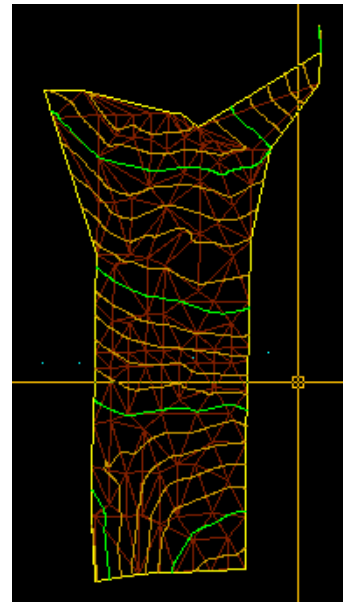
J. Add the point groups to be included into the
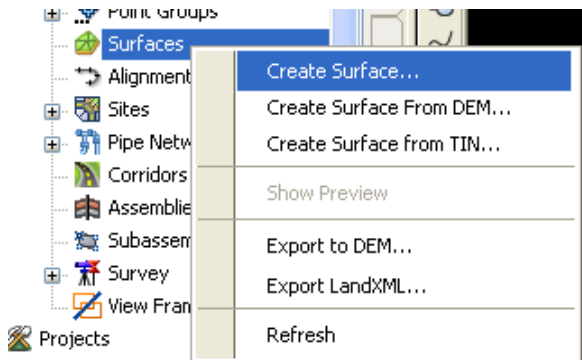   surface until surface is complete.

K. If no surface is visible after adding all
    desired point groups:

    1. Right click on the name of your surface
        and select **"Surface Properties…"**. See
        Figure E-7.

    2. In the surface properties dialog box
        expand the **"Build"** field with the
        corresponding expansion icon. See
        Figure E-8.

Figure E-7: Surface Properties
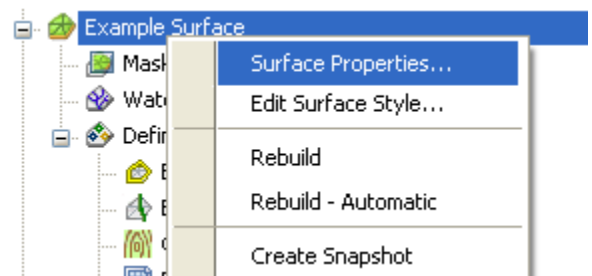
    3. If **"Use maximum triangle length"** is
        set to **"Yes"**, either change it to
        "No" or adjust the **"Maximum triangle
        length"** to the desired length. Once
        adjustments are completed hit
        "Apply">"OK". This option is useful

for excluding points from the surface.
See Figure E-8.

Figure E-8: Surface Properties Dialog Box
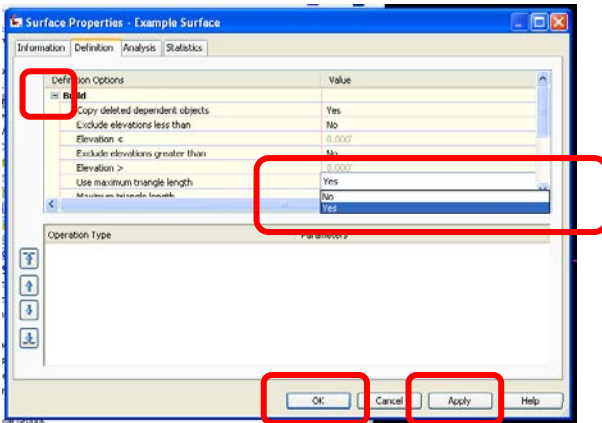
VIII. MANUALLY ADDING BREAK LINES TO A SURFACE

A. Using the polyline command and the **"OSNAP"** node, draw a polyline from point to point, using the codes as the guide **"EMB to EMB"**.

B. Once all of the lines that represent a surface feature, such as an embankment line or a centerline of a ditch, have been drawn break lines can be created.

C. Go to the **"Prospector"** tab. See Figure F-1.

   a. Go to **"Surfaces"**.

   b. Open the desired surface's tree by selecting the expansion icon next to the surface name.

   c. Open the **"Definition"** by selecting the corresponding expansion icon.

   d. Right-click on **"Breaklines"**. Select **"Add"** from the list.

Figure F-1: Adding Breaklines
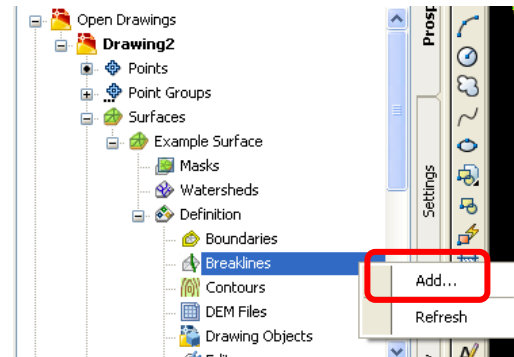
D. The **"Add Breaklines"** dialog box will open. See Figure F-2.

   a. Give the breakline a name (ex. Ditch A)

   b. Set **"Type"** to **"Proximity"**.

   c. Click **"OK"**.

Figure F-2: Add Break Lines Dialog Box
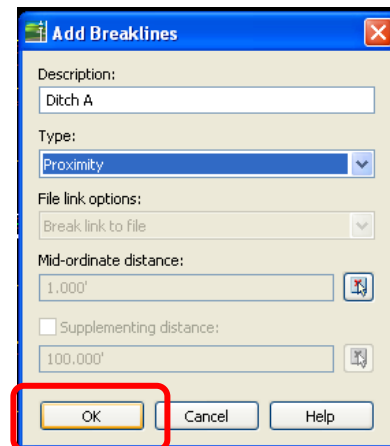
E. Once the breakline is named select the polyline that was created in the preceding steps. See Figure F-3.

Figure F-3: Selecting Polylines for Breaklines

F. Once the breakline is added, the surface will automatically update. Continue adding breaklines until surface is defined.

G. Save the file once the surfaces have been defined.

IX. CREATING AN ALIGNMENT IN AUTOCAD CIVIL 3D

With a completed surface an alignment can be created. There are two ways to create an alignment: by layout or by converting a polyline.

Creating an alignment from a polyline

This procedure explains how to create an alignment by a polyline, the easiest way to create an alignment.

A. To create an alignment with a polyline, select **"Polyline"** and draw a polyline on a surface. See Figure G-1.

Figure G-1: Drawing a Polyline
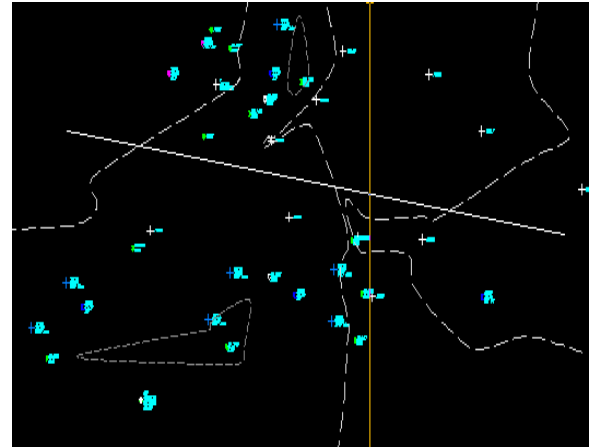
B. Once drawn, a polyline can be used for an alignment.

C. Go to the **"Alignments"** menu, left click **"Create Alignment by Polyline"**. See Figure G-2.

Figure G-2: Alignment Menu
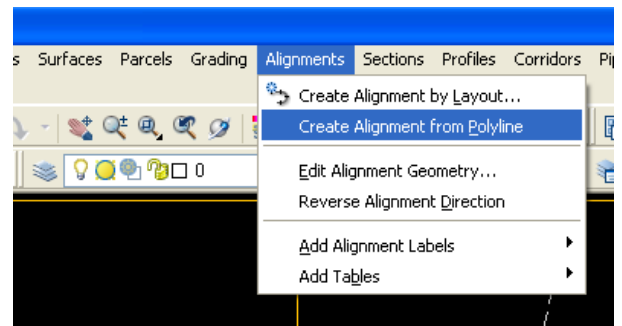
D. Select the polyline to be converted to an alignment. See Figure G-3.

Figure G-3: Select Polyline
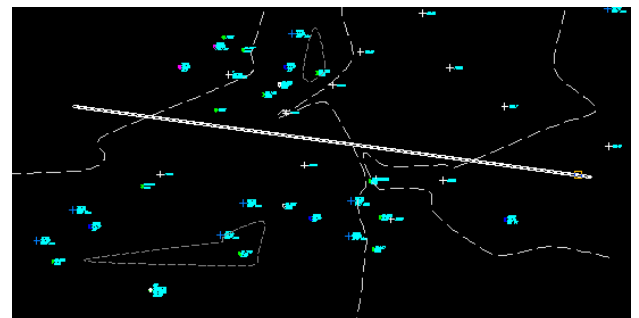
E. Once the polyline is selected, a dialog box to create the alignment will open. See Figure G-4.

Figure G-4: Create Alignment Dialog Box
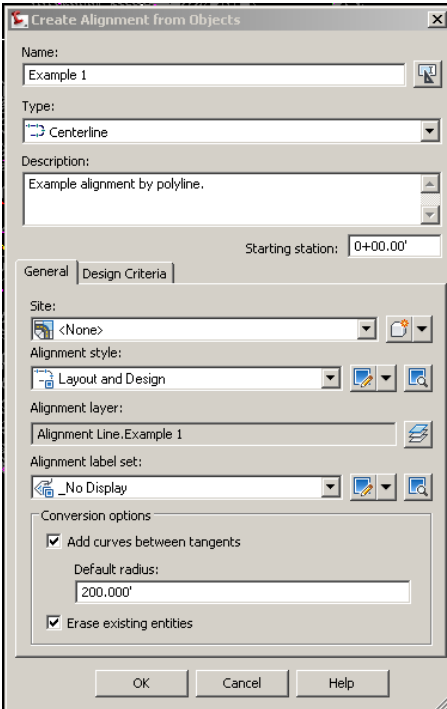
1. For **"Site"** select **"None"**

2. Give the alignment a name (ex. Ditch 1)

3. Give a small description if desired.

4. Specify the starting station of your alignment (0+00.00 or 10+00.00).

5. Specify the alignment style, these styles are in the template and one may be chosen as a style (Final for plotting, Layout and Design, No label display, Standard, and None).

6. AutoCAD will automatically create a layer based on the name of the alignment. Or one can be chosen by the icon beside the **"Alignment layer"**.

7. Toggle off **"Add curves between tangents"** (If this is toggled on, the alignment style will specify the radius distance per tangent and apply a curve at every intersection of the tangents).

8. Toggle on **"Erase existing entities"** to erase the existing polyline from the drawing.

F. Click **"OK"**, the polyline will convert to an alignment. See Figure G-5.

Figure G-5: Polyline Converted to an Alignment
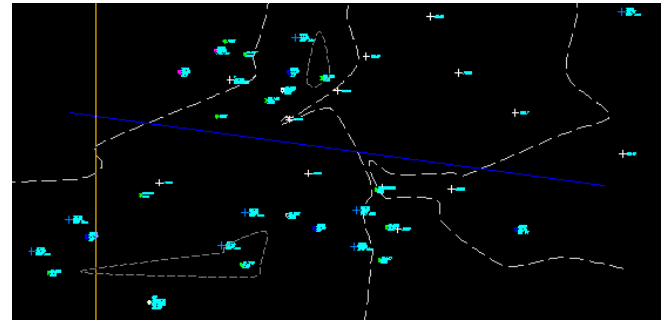
X. CREATE AN ALIGNMENT FROM LAYOUT

A. Go to the **"Alignment"** menu, scroll to **"Create Alignment by Layout"**, and left click to select.

B. The **"Create Alignment – Layout"** dialog box will appear. See Figure G-6.

Figure G-6: Create Alignment Dialog Box
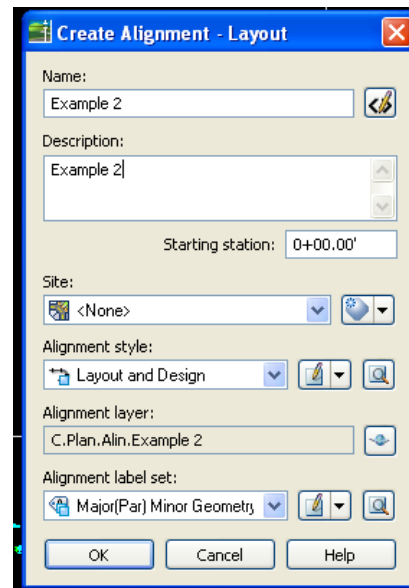
1. Give the alignment a name.

2. Give the alignment a small description if desired.

3. Specify the starting point of your alignment 0+00.00 or 10+00.00. This example doesn't have any.

4. For **"Site"** select **"None"**.

5. Specify an **"Alignment Style"**. These styles are in the template and one may be chosen as a style (Final for plotting, Layout and Design, No label display, Standard, and None).

6. Specify an **"Alignment Label Style"**. These styles are within the AutoCAD Template (Major(Parallel) Minor Geometry 100 and 50, Major(perpendicular) Minor Geometry 100 and 50, standard, and None)

C. Click **"OK"**.

D. The **"Alignment Layout Tools"** tool bar will appear. Here you can draw the alignment based on the structure of the alignment. Each tool has a purpose based on the type of alignment that needs to be drawn. See Figure G-7.

Figure G-7: Alignment Layout Tools
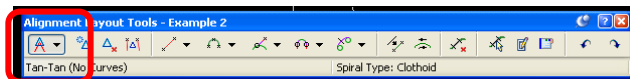
E. Use the first icon if you wish to draw line to line for the alignment. Press "Enter" to end the command.

For a more detailed explanation of the alignment tools please refer to the NRCSknowledge website or the reference manual.

XI.   CREATING A PROFILE OR PROFILES FROM ALIGNMENTS

Profiles from an alignment can be created in several ways. The most basic is using a surface and an alignment.

A. Go to **"Profiles"**, scroll to **"Create Profile from Surface"**. See Figure H-1.

Figure H-1: Profiles Menu
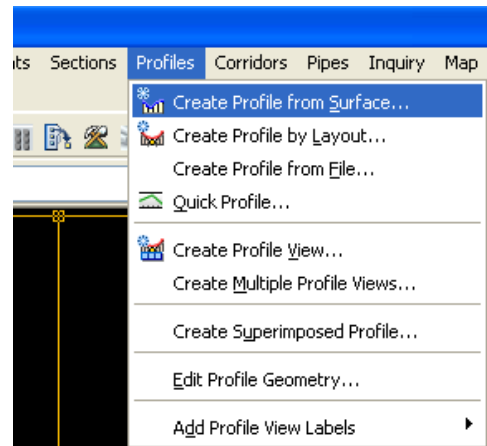
B. The **"Create Profile from Surface"** dialog box will appear. See Figure H-2.

Figure H-2: Creating Profile from Surface
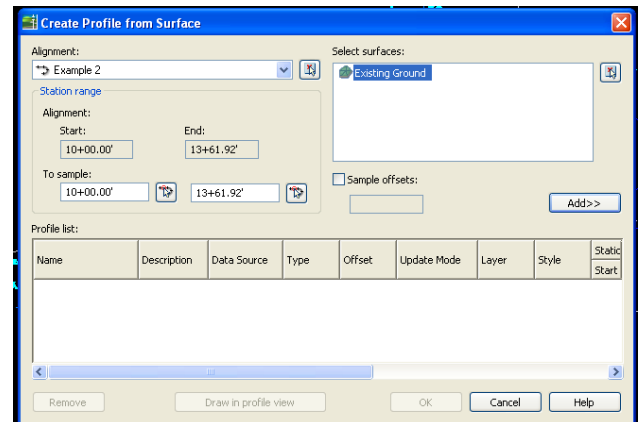
C. If there are multiple alignments, use the dropdown menu for a selection of the alignments. Choose an alignment the station range and the data will come up.

D. If you have more than one surface (TIN, or DTM) select it on the right hand window.

E. Select the **"Add"** button on the right hand side of the screen. See Figure H-3.

Figure H-3: Creating Profile from Surface
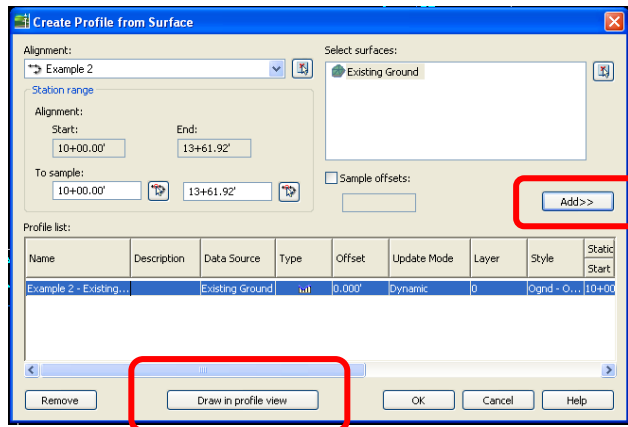
F. Click **"Draw in Profile View".** See Figure H-3.

G. The **"Create Profile View"** dialog box will appear. See Figure H-4.

Figure H-4: Create Profile View Dialog Box
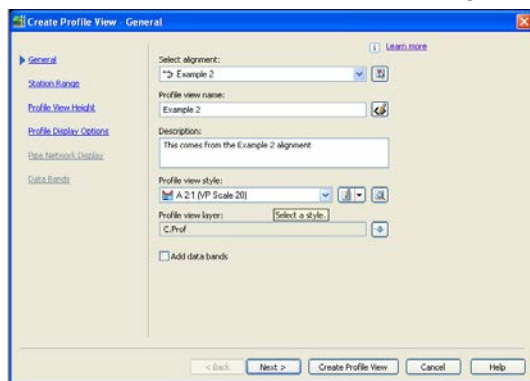
H. Select the desired alignment. See Figure H-4.

I. Give the profile a name. See Figure H-4.

J. Give the profile a description if desired.

K. Set the **"Profile view style"** to **"A 2:1 (VP Scale 20)"** (this represents the vertical exaggeration. 2:1 for every 1 foot horizontal, there's 2 feet vertical).

L. Toggle off data bands. (Data bands may have their own dialog box following those explained below in newer versions of AutoCAD)

M. Click **"Next"**.

N. The next dialog box allows a specific station range in which can be set instead of the whole alignment. AutoCAD defaults to the beginning and to the end of the alignment. Click **"Next"** to accept the whole alignment.

Figure H-5: Station Range Dialog Box
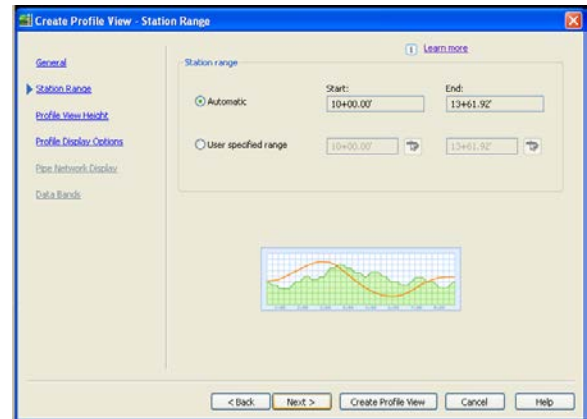
O. The next dialog box allows specify the elevation range. AutoCAD defaults to the maximum and minimum elevation that the surface allows. See Figure H-5. Click **"Next"**.

P. The next dialog box is for more display options if there's a need to edit the profile display options. Select **"Create Profile View"**.

Q. Move away from the surface to place the profile. Once the profile is placed, a viewport (VP) can be created and set to a distance of 1" = 20' as per the style that was used. See Figure H-6.

Figure H-6: Select Area to Place Profile
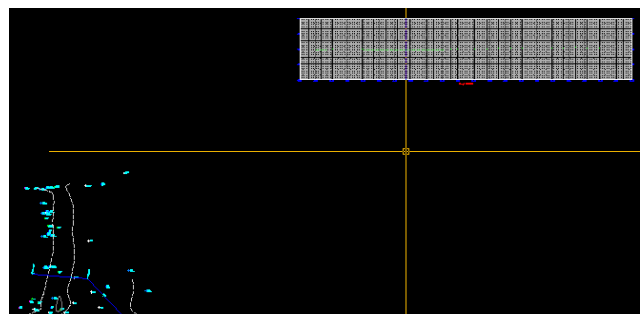
XII.   CREATE SAMPLE LINES IN AUTOCAD CIVIL 3D TO LAYOUT CROSS SECTIONS

Once an alignment and profile(s) are created, cross sections can be created along the alignment. The first step is producing sample lines by

AutoCAD. A sample line is a preview of where the cross sections will appear along the alignment. Sample lines display the right and left swath (cross section width) and lines will appear along the alignment at intervals set by the user. Any adjustments to the width of the cross sections or the intervals can be completed before cutting the cross sections.

A. Go to the **"Sections"** menu, select **"Create Sample Lines"**. This will produce the graphic preview of where the cross sections will be cut and produced. See Figure I-1.

Figure I-1: Sections Dialog Box
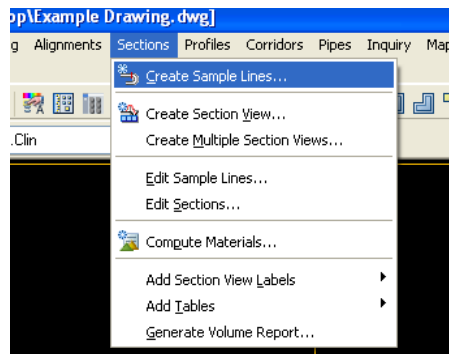
B. Next, select an alignment using the selection box, this alignment should be the alignment to cut cross sections from. See Figure 44.

Figure I-2: Select Alignment
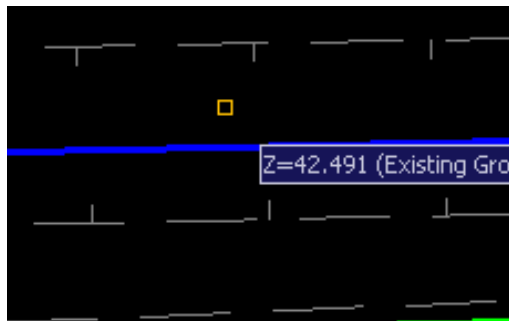
C. The **"Create Sample Line Group"** dialog box will appear. See Figure I-3.

Figure I-3: Create Sample Line Group
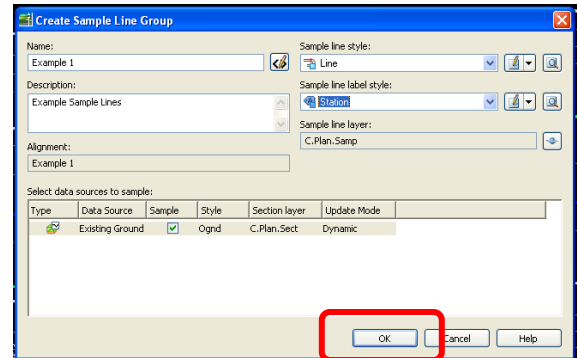
D. Enter a name for the sample lines.

E. Give a short description if desired.

F. For the **"Sample line style"** select **"Line"**.

G. For the **"Sample line label style"** select **"Station"**. This will produce a station location next to the sample line.

H. Verify the alignment name in **"Alignment"**.

I. Click **"OK"**.

Figure I-4: Sample Line Tools Toolbar
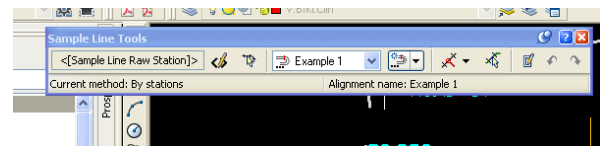
J. Use the **"Sample Line Tools"** toolbar to set up the sample lines. See Figure I-4.

Figure I-5: Cross-Section Area Selection

K. If only one cross section is needed, move the cursor along the alignment and select a desired area. See Figure I-5.

1. "Enter the Left swath width <30.000'>" look for this at the command line. See Figure I-6.

2. "Enter the Right swath width <30.000'>". See Figure I-6.

Figure I-6: Specifying Swath Width
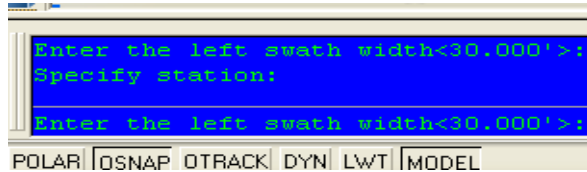
L. Once this is entered, a sample line will be displayed along the alignment. See Figure I-7. To create a cross section from this, proceed with *Create Cross Sections in AutoCAD Civil 3D*.

Figure I-7: Sample Line Along the Alignment
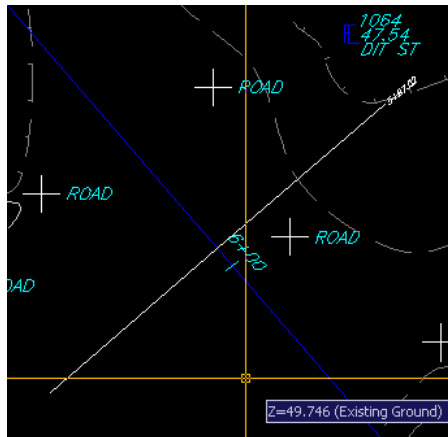
M. Select **"Sample Line Creation Method"** tool icon to pick the type of sample lines to produce, such as one sample line versus multiple sample lines along the alignment. See Figure I-8.

Figure I-8: Sample Line Tools Toolbar
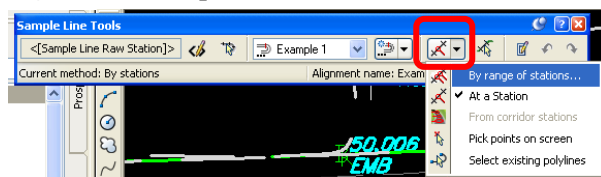
N. To create multiple cross sections along the alignment select **"By range of stations"**. See Figure I-8.

O. The **"Create Sample Lines - By Station Range"** dialog box will appear. See Figure I-9.

Figure I-9: Creating a Sample Line
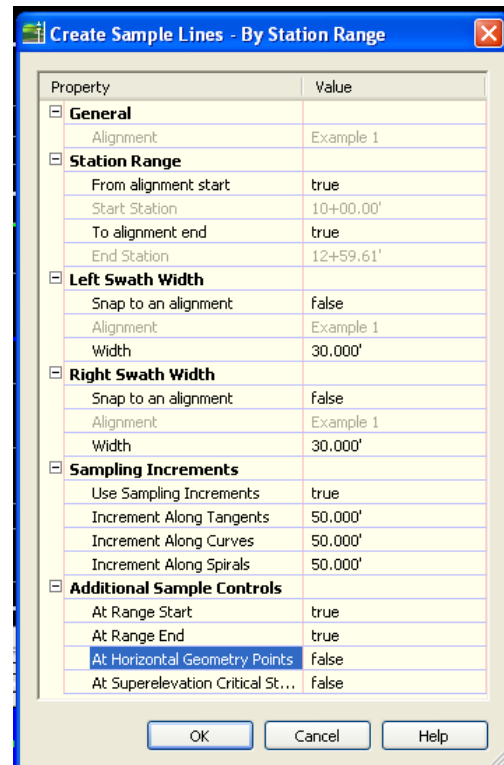
P. The first header **"General"** lists the alignment where the sample lines will be produced.

Q. The header **"Station Range"** can be set for the whole alignment or can be set to a section of the alignment by selecting **"False"** on either ends of the alignment or both ends of the alignment. In this case the whole alignment will be used.

1. **"From alignment Start"** select **"True"**

2. **"To alignment End"** select **"True"**

R. In the headers **"Left Swath Width"** and **"Right Swath Width"**. Keep the **"Snap to Alignment"** to **"False"** to have more options to select a width. Each width is set to 30' from the alignment. But can be set to a desired width per side of the alignment.

S. In the header **"Sampling Increments"** select **"True"** in **"Use Sampling Increments"**. Set **"Increments Along Tangents, Curves, and Spirals"** to desired increments. This will place a sample line

along the alignment. Since the alignment has no curves or spirals, this will have no effect.

T. In the header **"Additional Sample Controls"**

　1. **"At Range Start"** select **"True"**

　2. **"At Range End"** select **"True"**

　3. **"At Horizontal Geometry Points"** select **"False"**. This will omit placing a cross section at every turn in the alignment.

　4. **"At Super elevation Critical Stations"** select **"False"**

U. Click **"OK"**.

V. The sample lines will be produced along the alignment selected. See Figure I-10.

Figure I-10: Sample Lines Along the Alignment
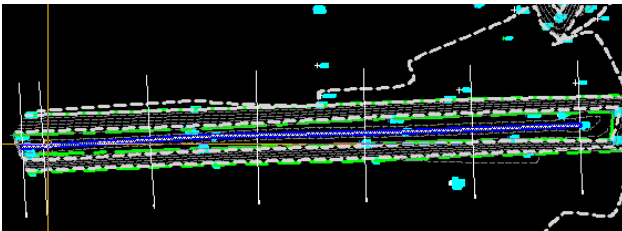
W. If zoomed in on the ends of the sample line the station label will be displayed. See Figure I-11.

Figure I-11: Station Label
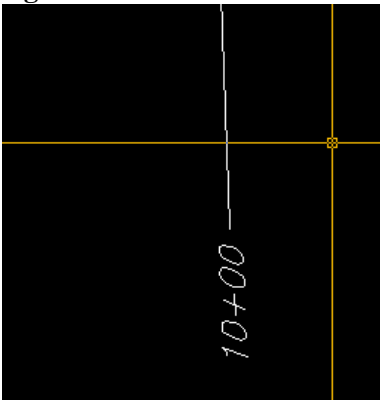
XIII. CREATE CROSS SECTIONS IN AUTOCAD CIVIL 3D USING SAMPLE LINES

A. With sample lines created, cross sections can be produced (if there was no editing during

the placement of the sample lines). Go to the **"Sections"** menu, select **"Create Multiple Sections Views"**.

B. The **"Create Multiple Section Views"** dialog box will appear. See Figure J-1.

Figure J-1: Creating Multiple Section Views
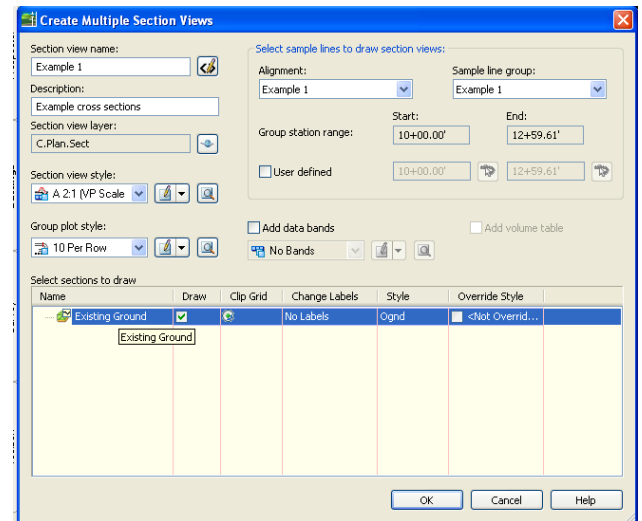
1. Enter a name in the **"Section View Name"** field (ex. Section 1).

2. Enter a small description if desired.

3. Select a **"Section View Style"** – Within the template there are several styles to choose from (ex. **"A 2:1 (VP Scale 20)"**).

4. Select a **"Group Plot Style"** this orients the placement of the cross sections. (10 Per Row = 10 cross sections per row).

5. Select **"Alignment"** (if there are multiple alignments). It will default to the current alignment if only one is present.

6. Select the **"Sample line group name"** (There may be more than one sample line group within the alignment.)

7. Toggle off **"Add Data Bands"**. (Data bands may have their own dialog box following those explained below in newer versions of AutoCAD)

8. Click **"OK"** or **"Create Section Views"** and place the cross sections away from the surface and profile. See Figure J-2.

Figure J-2: Placement of Cross Sections
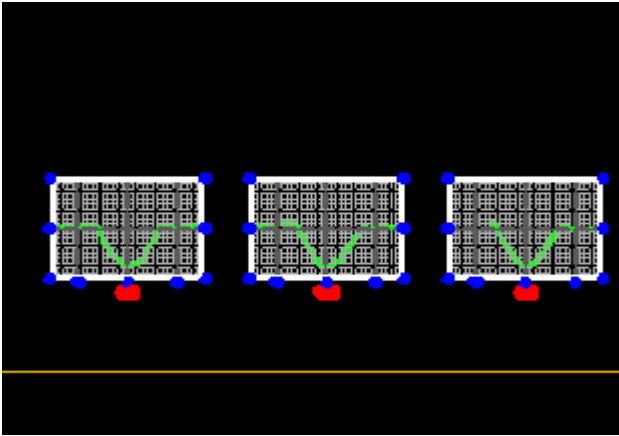
9. The section view of **"A 2:1 (VP Scale 20)"** means a vertical exaggeration of 2:1 and a viewport scale of 1" = 20'.

10. Save the file.

XIV. CREATING A FEATURE LINE FROM SCRATCH

A feature line is necessary to design an earthwork object. For our example, we will be drawing a small embankment. There are multiple methods for creating a feature line. This procedure will detail instructions to create feature line from scratch. It's important that the surface was properly created for use with the Florida AutoCAD Civil Design Procedures.

A. To create a feature line select **"Menu Browser"** > **"Tools" > "Toolbars"** > **"CIVIL"**. Then select **"Feature Lines"**. See Figure K-1. (or select **"Grading">"Draw Feature Line"** from the menu bar)

Figure K-1: AutoCAD Menu
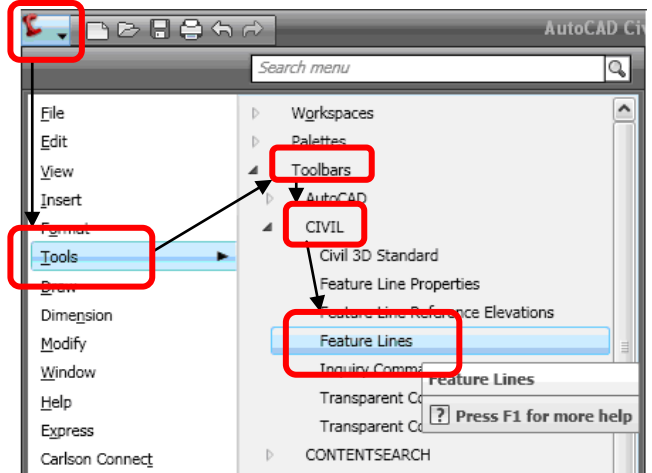
B. On the **"Feature Lines"** toolbar, select the button on the far left called **"Draw Feature Line"**. See Figure K-2.

Figure K-2: Features line toolbar
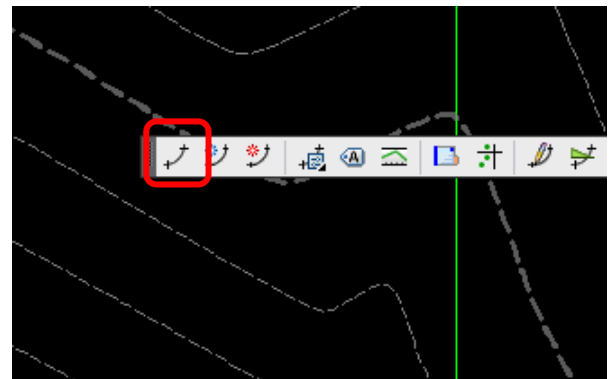
C. The **"Create Features Line"** dialog box will open. See Figure K-3.

1. Select a site. Every feature line needs a site on which to be built on and referenced to.

2. Check the name box and create a name for the feature line.

3. Select a style for the grading. The button to the right of the style drop-down box provides opportunity to edit the style.

4. Select a layer for the feature line and click "**OK**".

Figure K-3: "Create Features Line" dialog box
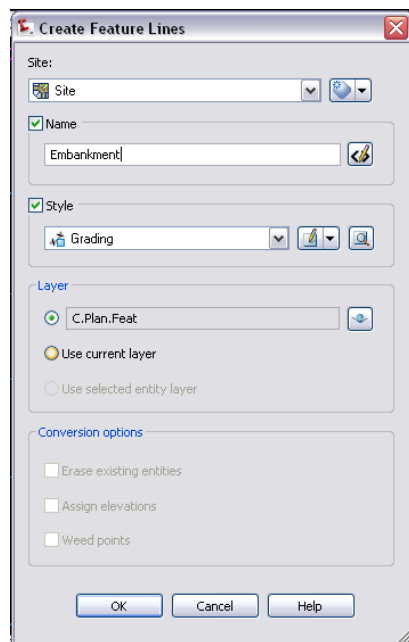
D. Specify the location of the feature line's initial point. Then input the elevation of the point.

E. Select the next points of the feature line and select the elevations for each point. Feature lines can be easily modified using buttons on the "**Feature Line**" toolbar. An elevation is not necessary for each point. A line segment can be a specific grade/slope or the point can be placed on the surface. For example, a rectangular embankment (150' by 50') will be constructed at a constant 35 foot elevation. See Figure K-4.

Figure K-4: Rectangular embankment
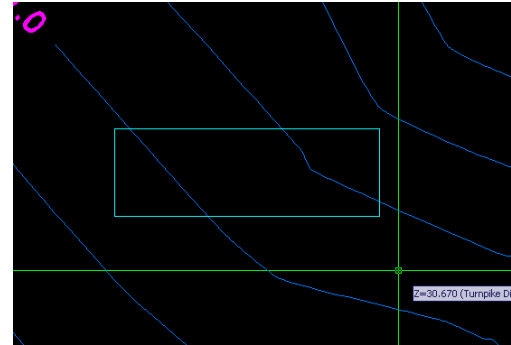
The feature line has now been completed. It would be beneficial to explore the "**Features Line**" toolbar in order to explore the functionality of it. Editing elevations, filleting, quick profiles, and splines are just a few of the abilities of the toolbar. Feature lines can also be created from polylines. The next step in determining the earthwork volumes of a project is to create a grading from the feature line to the surface.

XV. GRADING OBJECTS

Grading consists of defining a baseline with some elevation and criteria for defining the projection. The criteria used consist of a target: surface, elevation, relative elevation, distance, slope, or grade. The following procedure will create a 3:1 slope for the embankment feature line previously drawn.

A. To create a grading, first open the "**Grading Creation Tools**" toolbar by selecting the "**Menu Browser**" > "**Grading**" > then select "**Create Grading…**". See Figure L-1.

B. In order to create a grading, a grading group must first be created. On the "**Grading Creation Tools**" toolbar, select the "**Set the Grading Group**" button located on the far left of the toolbar. This will open the "**Create Grading Group**" dialog box.

1. Once in the "**Grading Group**" dialog box, name the grading group and provide a description if desired. See Figure L-2.

Figure L-1: Opening Grading Creation Toolbar
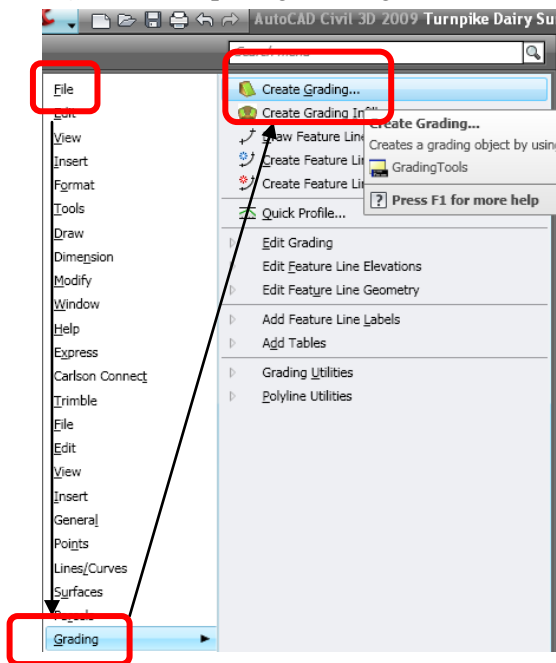
2. Make sure to check automatic surface creation and select the surface style.

3. Check the volume base surface box and select the base surface of the grading. Usually this will be the main natural ground surface.

4. Select "**OK**".

Figure L-2: Creating Grading Group
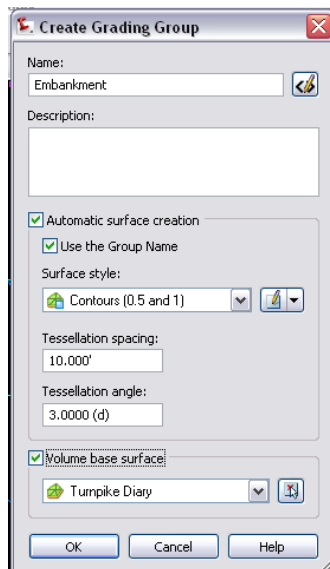
C. The **"Create Surface"** dialog box will open and check that the conditions of the surface are satisfactory and click **"OK"**. See Figure L-3.

Figure L-3: Creating Surface
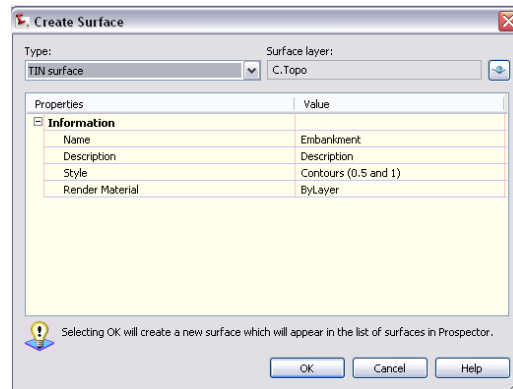
D. Next step would be to confirm the target surface by selecting the **"Set the Target Surface"** button. It's the second button from the left on the **"Grading Creation Tools"** toolbar. Confirm the target surface in the dialog box and click **"OK"**.

E. Within the **"Grading Creation Tools"** toolbar, a dropdown box is located. The box contains the grading criteria. Select the appropriate criteria. For this example, **"Project to Surface (Cut and Fill)"** will be selected since the grading will go from the feature line to the base surface.

Note: If grading criteria selection is limited in the drop-down box, select the button adjacent to the drop-down (on the left) called "Select a Criteria Set". Select **"USDA"** as the criteria set.

F. To Create the actual grading select the **"Create Grading"** button located two buttons to the right of the drop-down box. Select the arrow immediately adjacent to the button that reveals the drop-down. Select the "**Create grading"** button. See Figure L-4.

G. Select the feature that is intended to be graded then select the side that grading will occur. Since the example is an embankment, the side to be graded is outside of the feature

Figure L-4: Grading Creation Toolbar
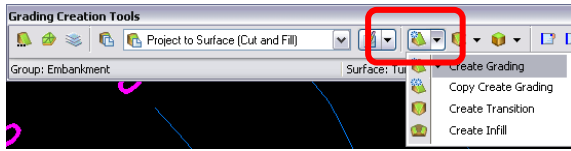
line rectangle. Simple click outside (or inside) of the feature line to pick the side of grading.

H. Specify whether the grading will apply to the entire length by typing "Yes" or "No" then press **"Enter"**. (This example was applied to the entire length.)

I. Decide whether a grade (in percent) or a slope (proportion of run:rise) will be specified then press **"Enter"**. The example will use slope.

J. Specify the slope or grade by entering the desired slope (4:1, 3:1, 2:1) in the command line when prompted. 4:1 slope will be used for the example. (A: Cut Slope; B: Fill Slope)

K. If the "Panorama" palette appears, click the green check mark in the upper right hand corner.

L. The grading for the side slopes is now complete (see Figure L-5 for an illustration).

Figure L-5: Grading Surfaces
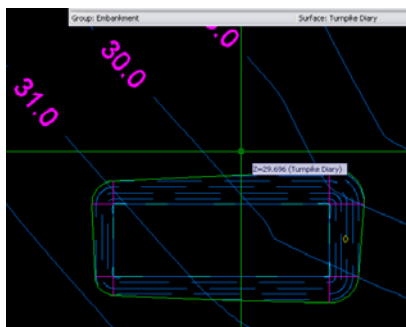
M. In order for the cut and fill calculations to be accurate, one must "create an infill".

N. To "create an infill", select the arrow directly adjacent to the **"Create Grading"** button to reveal the drop down box. See Figure L-4. Select **"Create Infill"**.

O. Select the area within the feature line in order to infill the volume between the base surface and the embankment surface. Press **"Enter"**.

Now that the feature line, grading, and infill steps have been done, the model of the desired embankment has been complete. Rotating the drawing into an isometric view displays the embankment in three dimensions. See Figure L-5.

Figure L-5: 3D View of Embankment
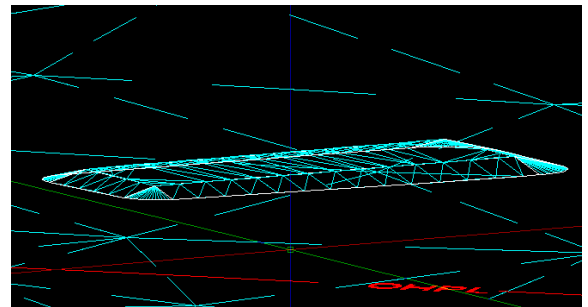
XVI. COMPARING SURFACES AND CUT/FILL VOLUMES

Now that the model has been successfully drawn, the surfaces can be compared in order to determine the correct cut/fill volumes. The example will only require fill since it is entirely elevated above the natural ground.

A. The first step is to open the panorama palette by selecting the **"Menu Browser"** > **"Surfaces" > "Utilities"** > then select **"Volumes".** See Figure M-1.

Figure M-1: AutoCAD menu
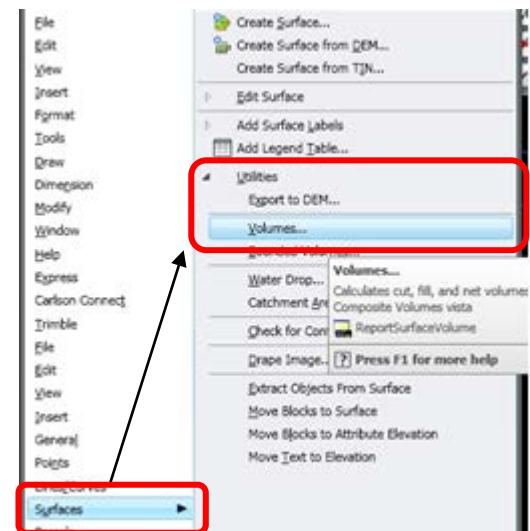
B. Now that the **"Panorama"** palette is open, select the **"Create the new volume entry"** button on the upper left hand corner of the palette. See Figure M-2.

C. In the volume entry line, select a base surface and a comparison surface. Usually the base

surface is the natural ground and the comparison surface is the surface of the feature created. See Figure M-2.

D. The cut/fill is displayed on the screen. See Figure M-2.

Figure M-2: Compare Volumes

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SECTION D PLANIMETERING PROCEDURE

The procedure outlined below will be followed when planimetering an area to determine the extent of a practice.

I.   INSTRUCTIONS FOR THE PARTICULAR PLANIMETER.

A. Adjust the tracer point of planimeter so that it will be near but not touching the surface of the paper or photograph. The area planimetered should be on one sheet of paper and on a smooth surface.

B. Place the tracer point near the center of area to be planimetered. Position pole arm at approximately a right angle to tracer arm. An approximate run of the tracer point around the boundary will show if the setting is one which permits ease of operation.

C. Select starting point on boundary of area to be measured. Place tracer point on this starting point.

D. Take and record initial reading. The planimeter should be read to the nearest one-hundredth of a square inch. If preferred, the dial and measuring wheel scale may be set at zero for this initial reading. In making this zero setting, lift carriage slightly and rotate the measuring wheel, touching only the plastic drum.

E. Follow center of area boundary line with tracer point, moving clockwise. Stop on starting point. Take and record second reading to the nearest one-hundredth square inch.

F. Subtract first reading from second reading. This difference is the <u>check</u> <u>area</u> to be used in checking the accuracy of the planimetering.

G. Follow boundary line for two additional turns before stopping. Take and record the third reading. Subtract first reading from the third reading and divide by 3. This is the <u>average</u> <u>area</u> for three times around the boundary.

H. Determine whether the <u>average</u> <u>area</u> is within allowable tolerance of <u>check</u> <u>area</u> determined in step 6 above. The difference between the <u>check</u> <u>area</u> and <u>average</u> <u>area</u> should be within tolerance listed in Table FL1--2 for Planimetering Tolerance of Certifying Amounts. If the tolerance is exceeded, the entire planimetering operation should be repeated. If within tolerance, the <u>average</u> <u>area</u> to the nearest one-hundredth square inch should be used as the area planimetered. This area should be converted to acres or other appropriate units. Certification of extent of practices on an acreage basis should be made to nearest 0.1 acre.

Example

First reading   = 1.24 square inches

Second reading   = 3.40 square inches

Check area   = 3.40- 1.24 = 2.16 square inches

Tolerance,   = $\pm$ 0.03 or 2.13 to 2.19
from Table FL1-2

Third reading = 7.75 square inches

Average area   = $\dfrac{7.75 - 1.24}{3}$ = $\dfrac{6.51}{3}$ = 2.17 sq in.

The 2.17 square inches is within allowable tolerance and would be used to convert to acres or other units.

NOTE: *Recordings of planimetering should be made and kept to substantiate certifications.*

I. When spot-checking an outlined area which has been measured by a planimeter, the spot-checker should follow the above procedure . However, in comparing the results with the certified amounts, the planimetering tolerances for spot checking listed in Table FL1-2 should be used. Using the 2.17 square inches determined above as the certified amount, the spot-check tolerance would be $\pm$ .06 or 2.11 to 2.23 square inches. When the planimeter measures in acres, the measurement must be converted to square inches in order to use the tolerances in Table FL1-2.

Table FL1D-1 Planimetering Tolerances

Area Planimetered in square inches.	Planimetering Tolerance for Certifying Amounts	Planimetering Tolerance for Spot Checking
0.01 - 0.99	$\pm$ 0.01 square inches	$\pm$ 0.02 square inches
1.00 - 1.99	$\pm$ 0.02 square inches	$\pm$ 0.04 square inches
2.00 - 2.99	$\pm$ 0 .03 square inches	$\pm$ 0.06 square inches
3.00 - 3.99	$\pm$ 0 .04 square inches	$\pm$ 0.08 square inches
4.00 - 4.99	$\pm$ 0 .05 square inches	$\pm$ 0.10 square inches
5.00 - 5.99	$\pm$ 0.06 square inches	$\pm$ 0.12 square inches
6.00 - 6.99	$\pm$ 0.07 square inches	$\pm$ 0.14 square inches
7.00 - 7.99	$\pm$ 0.08 square inches	$\pm$ 0.16 square inches
8.00 - 9.99	$\pm$ 0.09 square inches	$\pm$ 0.18 square inches
10.00 and above	$\pm$ 1.00 percent	$\pm$ 2.00 percent

Table FL1D-2 - Stadia Reduction Tables

Degrees	0		1		2		3		Degrees
Minutes	Hor. Dist.	Elev. Diff.	Hor. Dist.	Elev. Diff.	Hor. Dist.	Elev. Diff.	Hor. Dist.	Elev. Diff.	Minutes
0	100.00	0.00	99.97	1.74	99.88	3.49	99.73	5.23	0
2	100.00	0.06	99.97	1.80	99.87	3.55	99.72	5.28	2
4	100.00	0.12	99.97	1.86	99.87	3.60	99.71	5.34	4
6	100.00	0.17	99.96	1.92	99.87	3.66	99.71	5.40	6
8	100.00	0.23	99.96	1.98	99.86	3.72	99.70	5.46	8
10	**100.00**	**0.29**	**99.96**	**2.04**	**99.86**	**3.78**	**99.69**	**5.52**	**10**
12	100.00	0.35	99.96	2.09	99.85	3.84	99.69	5.57	12
14	100.00	0.41	99.95	2.15	99.85	3.89	99.68	5.63	14
16	100.00	0.47	99.95	2.21	99.84	3.95	99.68	5.69	16
18	100.00	0.52	99.95	2.27	99.84	4.01	99.67	5.75	18
20	**100.00**	**0.58**	**99.95**	**2.33**	**99.83**	**4.07**	**99.66**	**5.80**	**20**
22	100.00	0.64	99.94	2.38	99.83	4.13	99.66	5.86	22
24	100.00	0.70	99.94	2.44	99.82	4.18	99.65	5.92	24
26	99.99	0.76	99.94	2.50	99.82	4.24	99.64	5.98	26
28	99.99	0.81	99.93	2.56	99.81	4.30	99.63	6.04	28
30	**99.99**	**0.87**	**99.93**	**2.62**	**99.81**	**4.36**	**99.63**	**6.09**	**30**
32	99.99	0.93	99.93	2.67	99.80	4.42	99.62	6.15	32
34	99.99	0.99	99.93	2.73	99.80	4.47	99.61	6.21	34
36	99.99	1.05	99.92	2.79	99.79	4.53	99.61	6.27	36
38	99.99	1.11	99.92	2.85	99.79	4.59	99.60	6.32	38
40	**99.99**	**1.16**	**99.92**	**2.91**	**99.78**	**4.65**	**99.59**	**6.38**	**40**
42	99.99	1.22	99.91	2.97	99.78	4.71	99.58	6.44	42
44	99.98	1.28	99.91	3.02	99.77	4.76	99.58	6.50	44
46	99.98	1.34	99.90	3.08	99.77	4.82	99.57	6.56	46
48	99.98	1.40	99.90	3.14	99.76	4.88	99.56	6.61	48
50	**99.98**	**1.45**	**99.90**	**3.20**	**99.76**	**4.94**	**99.55**	**6.67**	**50**
52	99.98	1.51	99.89	3.26	99.75	4.99	99.55	6.73	52
54	99.98	1.57	99.89	3.31	99.74	5.05	99.54	6.79	54
56	99.97	1.63	99.89	3.37	99.74	5.11	99.53	6.84	56
58	99.97	1.69	99.88	3.43	99.73	5.17	99.52	6.90	58
60	**99.97**	**1.74**	**99.88**	**3.49**	**99.73**	**5.23**	**99.51**	**6.96**	**60**

Table FL1D-2 - Stadia Reduction Tables

Degrees	4		5		6		7		Degrees
Minutes	Hor. Dist.	Elev. Diff.	Hor. Dist.	Elev. Diff.	Hor. Dist.	Elev. Diff.	Hor. Dist.	Elev. Diff.	**Minutes**
0	99.51	6.96	99.24	8.68	98.91	10.40	98.51	12.10	0
2	99.51	7.02	99.23	8.74	98.90	10.45	98.50	12.15	2
4	99.50	7.07	99.22	8.80	98.88	10.51	98.49	12.21	4
6	99.49	7.13	99.21	8.85	98.87	10.57	98.47	12.27	6
8	99.48	7.19	99.20	8.91	98.86	10.62	98.46	12.32	8
10	**99.47**	**7.25**	**99.19**	**8.97**	**98.85**	**10.68**	**98.44**	**12.38**	**10**
12	99.46	7.30	99.18	9.03	98.83	10.74	98.43	12.43	12
14	99.46	7.36	99.17	9.08	98.82	10.79	98.41	12.49	14
16	99.45	7.42	99.16	9.14	98.81	10.85	98.40	12.55	16
18	99.44	7.48	99.15	9.20	98.80	10.91	98.39	12.60	18
20	**99.43**	**7.53**	**99.14**	**9.25**	**98.78**	**10.96**	**98.37**	**12.66**	**20**
22	99.42	7.59	99.13	9.31	98.77	11.02	98.36	12.72	22
24	99.41	7.65	99.11	9.37	98.76	11.08	98.34	12.77	24
26	99.40	7.71	99.10	9.43	98.74	11.13	98.33	12.83	26
28	99.39	7.76	99.09	9.48	98.73	11.19	98.31	12.88	28
30	**99.38**	**7.82**	**99.08**	**9.54**	**98.72**	**11.25**	**98.30**	**12.94**	**30**
32	99.38	7.88	99.07	9.60	98.71	11.30	98.28	13.00	32
34	99.37	7.94	99.06	9.65	98.69	11.36	98.27	13.05	34
36	99.36	7.99	99.05	9.71	98.68	11.42	98.25	13.11	36
38	99.35	8.05	99.04	9.77	98.67	11.47	98.24	13.17	38
40	**99.34**	**8.11**	**99.03**	**9.83**	**98.65**	**11.53**	**98.22**	**13.22**	**40**
42	99.33	8.17	99.01	9.88	98.64	11.59	98.20	13.28	42
44	99.32	8.22	99.00	9.94	98.63	11.64	98.19	13.33	44
46	99.31	8.28	98.99	10.00	98.61	11.70	98.17	13.39	46
48	99.30	8.34	98.98	10.05	98.60	11.76	98.16	13.45	48
50	**99.29**	**8.40**	**98.97**	**10.11**	**98.58**	**11.81**	**98.14**	**13.50**	**50**
52	99.28	8.45	98.96	10.17	98.57	11.87	98.13	13.56	52
54	99.27	8.51	98.94	10.22	98.56	11.93	98.11	13.61	54
56	99.26	8.57	98.93	10.28	98.54	11.98	98.10	13.67	56
58	99.25	8.63	98.92	10.34	98.53	12.04	98.08	13.73	58
60	**99.24**	**8.68**	**98.91**	**10.40**	**98.51**	**12.10**	**98.06**	**13.78**	**60**

Table FL1D-2 - Stadia Reduction Tables

Degrees	8		9		10		11		Degrees
Minutes	Hor. Dist.	Elev. Diff.	Hor. Dist.	Elev. Diff.	Hor. Dist.	Elev. Diff.	Hor. Dist.	Elev. Diff.	**Minutes**
0	98.06	13.78	97.55	15.45	96.98	17.10	96.36	18.73	0
2	98.05	13.84	97.53	15.51	96.96	17.16	96.34	18.78	2
4	98.03	13.89	97.52	15.56	96.94	17.21	96.32	18.84	4
6	98.01	13.95	97.50	15.62	96.92	17.26	96.29	18.89	6
8	98.00	14.01	97.48	15.67	96.90	17.32	96.27	18.95	8
10	**97.98**	**14.06**	**97.46**	**15.73**	**96.88**	**17.37**	**96.25**	**19.00**	**10**
12	97.97	14.12	97.44	15.78	96.86	17.43	96.23	19.05	12
14	97.95	14.17	97.43	15.84	96.84	17.48	96.21	19.11	14
16	97.93	14.23	97.41	15.89	96.82	17.54	96.18	19.16	16
18	97.92	14.28	97.39	15.95	96.80	17.59	96.16	19.21	18
20	**97.90**	**14.34**	**97.37**	**16.00**	**96.78**	**17.65**	**96.14**	**19.27**	**20**
22	97.88	14.40	97.35	16.06	96.76	17.70	96.12	19.32	22
24	97.87	14.45	97.33	16.11	96.74	17.76	96.09	19.38	24
26	97.85	14.51	97.31	16.17	96.72	17.81	96.07	19.43	26
28	97.83	14.56	97.29	16.22	96.70	17.86	96.05	19.48	28
30	**97.82**	**14.62**	**97.28**	**16.28**	**96.68**	**17.92**	**96.03**	**19.54**	**30**
32	97.80	14.67	97.26	16.33	96.66	17.97	96.00	19.59	32
34	97.78	14.73	97.24	16.39	96.64	18.03	95.98	19.64	34
36	97.76	14.79	97.22	16.44	96.62	18.08	95.96	19.70	36
38	97.75	14.84	97.20	16.50	96.60	18.14	95.93	19.75	38
40	**97.73**	**14.90**	**97.18**	**16.55**	**96.57**	**18.19**	**95.91**	**19.80**	**40**
42	97.71	14.95	97.16	16.61	96.55	18.24	95.89	19.86	42
44	97.69	15.01	97.14	16.66	96.53	18.30	95.86	19.91	44
46	97.68	15.06	97.12	16.72	96.51	18.35	95.84	19.96	46
48	97.66	15.12	97.10	16.77	96.49	18.41	95.82	20.02	48
50	**97.64**	**15.17**	**97.08**	**16.83**	**96.47**	**18.46**	**95.79**	**20.07**	**50**
52	97.62	15.23	97.06	16.88	96.45	18.51	95.77	20.12	52
54	97.61	15.28	97.04	16.94	96.42	18.57	95.75	20.18	54
56	97.59	15.34	97.02	16.99	96.40	18.62	95.72	20.23	56
58	97.57	15.40	97.00	17.05	96.38	18.68	95.70	20.28	58
60	**97.55**	**15.45**	**96.98**	**17.10**	**96.36**	**18.73**	**95.68**	**20.34**	**60**

Table FL1D-2 - Stadia Reduction Tables

Degrees	12		13		14		15		Degrees
Minutes	Hor. Dist.	Elev. Diff.	Hor. Dist	Elev. Diff.	Hor. Dist	Elev. Diff.	Hor. Dist	Elev. Diff.	**Minutes**
0	95.68	20.34	94.94	21.92	94.15	23.47	93.30	25.00	0
2	95.65	20.39	94.91	21.97	94.12	23.52	93.27	25.05	2
4	95.63	20.44	94.89	22.02	94.09	23.58	93.24	25.10	4
6	95.61	20.50	94.86	22.08	94.07	23.63	93.21	25.15	6
8	95.58	20.55	94.84	22.13	94.04	23.68	93.18	25.20	8
10	**95.56**	**20.60**	**94.81**	**22.18**	**94.01**	**23.73**	**93.16**	**25.25**	**10**
12	95.53	20.66	94.79	22.23	93.98	23.78	93.13	25.30	12
14	95.51	20.71	94.76	22.28	93.95	23.83	93.10	25.35	14
16	95.49	20.76	94.73	22.34	93.93	23.88	93.07	25.40	16
18	95.46	20.81	94.71	22.39	93.90	23.93	93.04	25.45	18
20	**95.44**	**20.87**	**94.68**	**22.44**	**93.87**	**23.99**	**93.01**	**25.50**	**20**
22	95.41	20.92	94.66	22.49	93.84	24.04	92.98	25.55	22
24	95.39	20.97	94.63	22.54	93.82	24.09	92.95	25.60	24
26	95.36	21.03	94.60	22.60	93.79	24.14	92.92	25.65	26
28	95.34	21.08	94.58	22.65	93.76	24.19	92.89	25.70	28
30	**95.32**	**21.13**	**94.55**	**22.70**	**93.73**	**24.24**	**92.86**	**25.75**	**30**
32	95.29	21.18	94.52	22.75	93.70	24.29	92.83	25.80	32
34	95.27	21.24	94.50	22.80	93.67	24.34	92.80	25.85	34
36	95.24	21.29	94.47	22.85	93.65	24.39	92.77	25.90	36
38	95.22	21.34	94.44	22.91	93.62	24.44	92.74	25.95	38
40	**95.19**	**21.39**	**94.42**	**22.96**	**93.59**	**24.49**	**92.71**	**26.00**	**40**
42	95.17	21.45	94.39	23.01	93.56	24.55	92.68	26.05	42
44	95.14	21.50	94.36	23.06	93.53	24.60	92.65	26.10	44
46	95.12	21.55	94.34	23.11	93.50	24.65	92.62	26.15	46
48	95.09	21.60	94.31	23.16	93.47	24.70	92.59	26.20	48
50	**95.07**	**21.66**	**94.28**	**23.22**	**93.45**	**24.75**	**92.56**	**26.25**	**50**
52	95.04	21.71	94.26	23.27	93.42	24.80	92.53	26.30	52
54	95.02	21.76	94.23	23.32	93.39	24.85	92.49	26.35	54
56	94.99	21.81	94.20	23.37	93.36	24.90	92.46	26.40	56
58	94.97	21.87	94.17	23.42	93.33	24.95	92.43	26.45	58
60	**94.94**	**21.92**	**94.15**	**23.47**	**93.30**	**25.00**	**92.40**	**26.50**	**60**

Exhibit FL1D-1 - Laying Out a Curve without A Transit
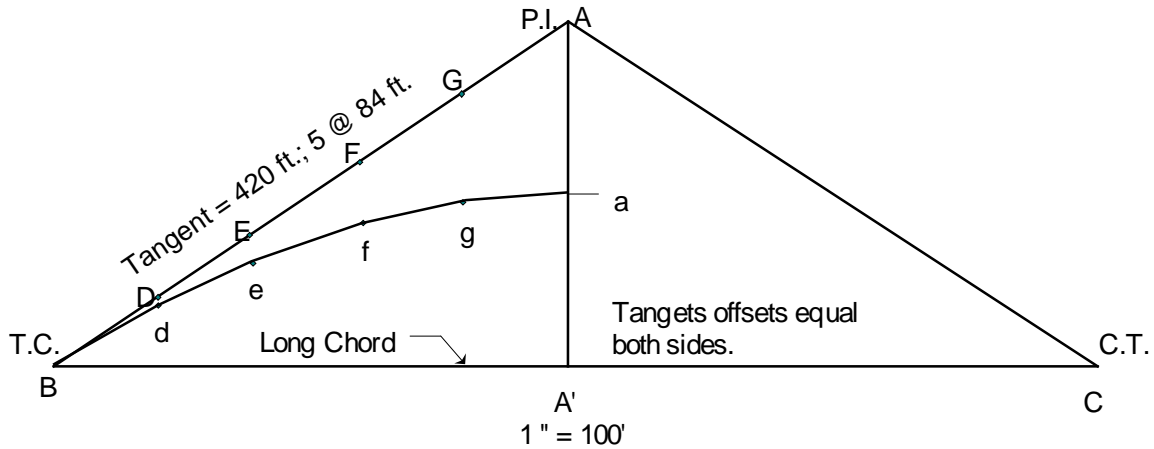
1. Select tangent points and stake.
2. Sight P.I. and stake tangent. segments of the tangent
3. Determine tangent length e.g. 420 ft.
4. Divide tangent length into equal increments and stake. e.g., 84 ft. lengths with n = 5
5. Stake long chord (any interval)
6. Measure distance from long chord to P.I. = 238 ft. Divide by 2 and stake point a. @ 119 ft.
7. $Dd = Aa/n^2$ =119/25 = 4.76 distances are

$Ee = 4Dd = 4(4.76) = 19.0$ long chord.

$Ff = 9Dd = 9(4.76) = 42.8$

$Gg = 16Dd = 16(4.76) = 76.2$

Definitions:

n = number of equal

Dd, Ee, etc., = tangent offset

$Dd = Aa/n^2$

$Ee = 2^2 Dd$

$Ff = 3^2 Dd$

$Gg = 4^2 Dd$ and so on

NOTE: Tangent offset

perpendicular to the

Table FL1D-3 Map Scales and Equivalents

MAP SCALES AND EQUIVALENTS								
FRACTIONAL SCALE	FEET PER INCH	IN. PER 1000 FT.	INCHES PER MILE	MILES PER INCH	METERS PER IN.	ACRES PER SQ. INCH	SQ. IN. PER ACRE	SQ. MII. PER SQ. INCH
1:500	41.667	24.000	126.720	0.008	12.700	0.0399	25.091	0.00006
1:600	50.000	20.000	105.600	0.009	15.240	0.0574	17.424	0.00009
1:1000	83.333	12.000	63.360	0.016	25.400	0.1594	6.273	0.00025
1:1200	100.000	10.000	52.800	0.019	30.480	0.2296	4.356	0.00036
1:1500	125.000	8.000	42.240	0.024	38.100	0.3587	2.788	0.00056
1:2000	166.667	6.000	31.680	0.032	50.800	0.6377	1.568	0.00100
1:2400	200.000	5.000	26.400	0.038	60.960	0.9183	1.089	0.00143
1:2500	208.333	4.800	25.344	0.039	63.500	0.9964	1.004	0.00156
1:3000	250.000	4.000	21.120	0.047	76.200	1.4348	0.697	0.00224
1:3600	300.000	3.333	17.600	0.057	91.440	2.0661	0.484	0.00323
1:4000	333.333	3.000	15.840	0.063	101.600	2.5508	0.392	0.00399
1:4800	400.000	2.500	13.200	0.076	121.920	3.6731	0.272	0.00574
1:5000	416.667	2.400	12.672	0.079	127.000	3.9856	0.251	0.00623
1:6000	500.000	2.000	10.560	0.095	152.400	5.7392	0.174	0.00897
1:7000	583.333	1.714	9.051	0.110	177.800	7.8117	0.128	0.01221
1:7200	600.000	1.667	8.800	0.114	182.880	8.2645	0.121	0.01291
1:7920	660.000	1.515	8.000	0.125	201.168	10.0000	0.100	0.01563
1:8000	666.667	1.500	7.920	0.126	203.200	10.2030	0.098	0.01594
1:8400	700.000	1.429	7.543	0.133	213.360	11.2489	0.089	0.01758
1:9000	750.000	1.333	7.040	0.142	228.600	12.9132	0.077	0.02018
1:9600	800.000	1.250	6.600	0.152	243.840	14.6924	0.068	0.02296
1:10000	833.333	1.200	6.336	0.158	254.001	15.9423	0.063	0.02491
1:10800	900.000	1.111	5.867	0.170	274.321	18.5950	0.054	0.02905
1:12000	1000.000	1.000	5.280	0.189	304.801	22.9568	0.044	0.03587
1:13200	1100.000	0.909	4.800	0.208	335.281	27.7778	0.036	0.04340
1:14400	1200.000	0.833	4.400	0.227	365.761	33.0579	0.030	0.05165
1:15000	1250.000	0.800	4.224	0.237	381.001	35.8701	0.028	0.05605
1:15600	1300.000	0.769	4.062	0.246	396.241	38.7971	0.026	0.06062
1:15840	1320.000	0.758	4.000	0.250	402.337	40.0000	0.025	0.06250
1:16000	1333.333	0.750	3.960	0.253	406.401	40.8122	0.025	0.06377
1:16800	1400.000	0.714	3.771	0.265	426.721	44.9954	0.022	0.07031
1:18000	1500.000	0.667	3.520	0.284	457.201	51.6529	0.019	0.08071
1:19200	1600.000	0.625	3.300	0.303	487.681	58.7695	0.017	0.09183
1:20000	1666.667	0.600	3.168	0.316	508.001	63.7690	0.016	0.09964
1:20400	1700.000	0.588	3.106	0.322	518.161	66.3453	0.015	0.10366
1:21120	1760.000	0.568	3.000	0.333	536.449	71.1111	0.014	0.11111
1:21600	1800.000	0.556	2.933	0.341	548.641	74.3802	0.013	0.11622
1:22800	1900.000	0.526	2.779	0.360	579.121	82.8742	0.012	0.12949
1:24000	2000.000	0.500	2.640	0.379	609.601	91.8274	0.011	0.14348
1:25000	2083.333	0.480	2.534	0.395	635.001	99.6391	0.010	0.15569
1:31680	2640.000	0.379	2.000	0.500	804.674	160.0000	0.006	0.25000
1:48000	4000.000	0.250	1.320	0.758	1219.202	367.3095	0.003	0.57392
1:62500	5208.333	0.192	1.014	0.986	1587.503	622.7442	0.002	0.97304
1:63360	5280.000	0.189	1.000	1.000	1609.347	640.0000	0.002	1.00000
1:96000	8000.000	0.125	0.660	1.515	2438.405	1469.2378	0.001	2.29568
1:1:125000	10416.667	0.096	0.507	1.973	3175.006	2490.9767	0.000	3.89215
1:126720	10560.000	0.095	0.500	2.000	3218.694	2560.0000	0.000	4.00000
1:250000	20833.333	0.048	0.253	3.946	6350.013	9963.9067	0.000	15.56860
1:253440	21120.000	0.047	0.250	4.000	6437.389	10240.0000	0.000	16.00000
1:500000	41666.667	0.024	0.127	7.891	12700.025	39855.6270	0.000	62.27442
1:1000000	83333.333	0.012	0.063	15.783	25400.050	159422.5079	0.000	249.09767
FORMULAS	$\dfrac{SCALE}{12}$	$\dfrac{12000}{SCALE}$	$\dfrac{63360}{SCALE}$	$\dfrac{SCALE}{63360}$	Ft. per in. x 0.3048006	$\dfrac{SCALE^2}{43560 \times 144}$	$\dfrac{43560 \times 144}{SCALE^2}$	$\dfrac{(Ft. \ per \ in.)^2}{(5280)^2}$