Stake Point	Survey routine used to check the accuracy of benchmark and control point locations when re-occupying an established coordinate system. Also used to re-locate the position of benchmarks and control points.
Total Station	An electronic/optical instrument used in modern surveying. The total station is an electronic theodolite (transit) integrated with an electronic distance meter (EDM) to read slope distances from the instrument to a particular point.
Traverse	Survey routine used to move the surveying instrument from one control point to the next. Done by 1) surveying a new control point (foresight) where instrument will be moved, 2) moving instrument to new location, and 3) backsighting to previous station setup location.
Vertical Error	The Z value difference from a foresight to a backsight of a control point.

Total Station Procedures for the Columbia Habitat Monitoring Program

Topcon DS-205, Magnet 2.5.1

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SECTION 4: GLOSSARY

Term	Description
Assumed Coordinate System	Fictional coordinate system of a survey established by attributing the first occupied point of a new site survey with the following coordinates: 3000 northing, 2000 easting, 1000 elevation. All new site surveys will be attributed an assumed coordinate system during the initial survey.
Backsight	Survey routine used to establish a basis for horizontal, vertical, and angular measurements within the surveying instrument. Backsight checks are used to assure the continued accuracy of a survey.
Benchmark	A permanent control point (typically capped rebar) used to establish new site surveys, and establish revisit site surveys. There is a minimum of 3 benchmarks established at each site.
Control File	File containing benchmarks and control points from previous surveys that are used to re-occupy the established coordinate system.
Control Point	Any permanent or temporary location used to set up or orient the surveying instrument. Includes any station setup, benchmark, and backsight locations.
Established Coordinate System	Spatially accurate coordinate system (Universal Transverse Mercator) established after the first survey of a site. All revisit site surveys must re-occupy the exact same established coordinate system as the first survey.
Foresight	A foresight is a control point that will be used for a future station setup location.
Horizontal Error	The X and Y value difference from a foresight to a backsight at a control point.
New Site Survey	The topographic survey of a new site where an established coordinate system has not been previously established. New benchmarks and control points must be established. The survey is conducted in an assumed coordinate system.
Orientation	Location relative to a compass.
Re-occupy	To orient the surveying instrument into an established coordinate system for revisit site surveys using previously existing benchmarks and control points.
Resection	Survey routine used to re-occupy an established coordinate system by surveying at least 2 known benchmarks or control points from a centralized, previously unsurveyed point.
Revisit Site Survey	The topographic survey of a previously surveyed site where benchmarks and control points have been established. Survey is conducted in a previously established coordinate system.
Site	The specific point, location or length of stream where measurements are taken and metrics derived. Represents a single sample unit within a monitoring program's study design.

A. The care, organization, and general housekeeping of a vehicle are good indications of the attitude of the entire survey crew. Keep passenger compartments free of unnecessary clutter and equipment. Any equipment or material carried in the passenger compartment should be firmly secured.
B. Transport and store instruments in positions that are consistent with the carrying case design. Many instrument cases indicate the position in which they should be transported. Treat optical targets, prisms, tripods and survey rods with the same consideration.
C. Remember, loose equipment, out of place tools, and general clutter not only contributes to damage of the items, they also waste crew time in locating them and are a safety hazard.

Care of Tools

Improperly maintained tools can be a source of annoyance, as well as being a safety hazard. Each employee is responsible for keeping his or her tools and equipment in good condition. To prevent loss of small equipment and tools, avoid laying them on the ground, on vehicles, or on equipment which might be moved. When not in use, carry them in scabbards and pouches.

A. Repair or replace any driving tool that is burred or fractured on any part of the striking or driving face. Many surveyors have been injured by the "shrapnel" effect from gads and sledges which had ragged edges. The same is true for "bull points" or other tools which are driven.
B. Crooked or warped handles can cause injury as well as mishitting and damage to the tool. Promptly replace such handles and those that are cracked or broken. Handles should be firmly secured in all cutting and driving tools.

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Some suggestions for proper Survey Rod care are:

A. Maintain firm snugness in all metal fittings, but never tighten them to the point where they will unduly compress or injure the rod, strip threads or twist off bolts or screws.
B. Rods should be checked to be sure they are straight.
C. The level bubble should be calibrated periodically.
D. The rod point should be firmly attached and appropriate for the task at hand.
E. The rod should never be used as a wading staff.
F. When wet the rod should be inverted to drain water.
G. While surveying keep the rod away from overhead power-lines.

The most damage occurs to rods when being placed in or taken out of survey vehicles. The life and usefulness of rods can be significantly extended if compartments are constructed so that the rods are not riding on or against other equipment.

General Care and Maintenance of Surveying Equipment and Tools

Surveying equipment and tools are designed and constructed to provide years of reliable use.

The following general principles of care and servicing should be applied as a routine matter for all survey equipment and supplies:

A. Mud, dirt, water and vegetation are a transport media for invasive species and should be removed from all equipment before leaving a reach.
B. Instrument cases are a transportation device for invasive species as well as the instrument and should be cleaned internally and externally before leaving a reach.
C. All equipment and tools should be kept as clean and dry as is practical, particularly if they are to be transported or stored for any length of time.
D. Wooden surfaces should be wiped clean of caked mud or moisture prior to returning the equipment to the vehicle. The original painted or varnished surfaces should be repaired as often as needed to keep moisture from entering the wood.
E. Metal surfaces should be cleaned and wiped as dry as practicable. A coat of light oil should be applied to tapes and the ferrous metal parts of tools to prevent rusting during storage. Excess oil should be wiped off. No oil on aluminum, glass, plastic, fiberglass or wood.

Transporting

The major portion of damage to equipment and tools occurs when they are being placed into or taken out of the survey vehicle. Other damage occurs during transport, when equipment is jostled against other tools or equipment. Compartments (lined with carpeting, when possible) should be provided to keep equipment and supplies separated. This not only keeps the equipment from being damaged, it facilitates finding such items more rapidly. Heavier items should be carried in the lower parts of vehicles and they should never be in direct contact with other tools or equipment below them.

D. Keep wooden parts of tripods well painted or varnished to reduce moisture absorption and swelling or drying out and shrinking.
E. Replace top caps on tripods when not in use.

The most damage occurs to tripods when being placed in or taken out of survey vehicles. The life and usefulness of tripods can be significantly extended if compartments are constructed so that the tripods are not riding on or against other equipment.

Prisms

Each manufacturer of EDM's supplies special prisms and prism holders that are compatible with its equipment. The single lens, tiltable holder with provisions for direct connection on the top of a sectional or telescoping survey rod is the most common type used in most survey work. Such prism holders are generally equipped with a sighting target mounted above or below the prism to provide parallel sight between the sighting and measuring beams. The maintenance of parallel sight becomes more significant in the accuracy of measurements as the distance is decreased. The use of the tiltable holder, with properly mounted target, maintains the parallel sight relationship, particularly in rough terrain. The surveyor should understand the necessity for parallel sights and know what the telescope aiming point is for the type of EDM being used. It is important that the proper prism constant is used; otherwise a systematic error will be introduced in all the measurements made between a particular EDM and prism. The best way to verify that true measurements will be made is to test the EDM and prism on a baseline of a previously established distance.

Care of Prisms

As with any survey equipment, proper care will extend the useful life of sighting equipment.

A. When not in use, keep prisms in their proper containers with face covers in place. They should be kept clean and moisture free to ensure maximum light return. Clean the reflective surface with a camel hair brush or soft lens tissue.
B. Traverse kits should be treated as any other precision equipment. They should be transported in their carrying case in the proper compartments. They should never be put away wet or dirty. The tribrachs should be kept in the same adjusted condition as Total Station tribrachs.

Survey Rods

Survey rods are an essential tool for accurate surveying. A survey rod must be straight and capable of being leveled for control work. Rod length should always be kept to a minimum, never longer then absolutely necessary. The height indicated should be checked by using a tape; measuring from the rod tip to the center of the prism.
Care of Survey Rods

SECTION 1: INTRODUCTION

1.1 Policy Background

The 2008 Biological Opinion (BiOp) on the Federal Columbia River Power System (FCRPS) identified offsite mitigation actions, largely in the form of habitat restoration and changes in land management, as a means to offset mortality imposed by the FCRPS on anadromous salmonids. In 2010 the Bonneville Power Administration (BPA) began development of the Columbia Habitat Monitoring Program (CHaMP) to meet FCRPS Action Agency (2010) programmatic prescriptions for habitat monitoring, and also to help meet adaptive management requirements and other prescriptions of the 2008 BiOp.

CHaMP (BPA Project 2011-006) is a fish-centric habitat status and trend monitoring program designed for implementation across the Columbia River Basin's salmon and steelhead populations. The CHaMP protocol measures the quantity and quality of, and changes in, stream habitat for salmonid fishes of interest under the BiOp. CHaMP is the result of collaboration among BPA, the National Oceanic and Atmospheric Administration (NOAA) and other regional fish management agencies to implement a tributary habitat condition assessment program. CHaMP was also designed to help measure habitat responses to land management and stream restoration actions by evaluating the effectiveness of restoration, rehabilitation, and conservation actions across the basin. In 2010, BPA asked the Integrated Status and Effectiveness Monitoring Program (ISEMP), a BPA-funded project (2003-017) specifically tasked with assessing and developing standardized monitoring protocols for fish and fish habitat in the Columbia River Basin, to recommend a habitat protocol for BPA-funded Columbia River Basin monitoring programs to adopt. Based on ISEMP's initial recommendations (Bouwes et al. 2010), BPA and several collaborating agencies, with technical and coordination assistance from ISEMP, began to build CHaMP through the development of a set of coordinated proposals.

1.2 Topographic Survey

This manual outlines the procedures for operating the TopCon DS-205 Total Station with Magnet 2.5.1 in support of the CHaMP protocol. The Total Station is a fundamental tool used to conduct a topographic survey of the stream channel. The procedures outlined in this manual should be followed in order to conduct spatially accurate and repeatable surveys. For additional information regarding topographic sampling procedures, please reference the CHaMP protocol:

CHaMP (Columbia Habitat Monitoring Program). 2015. Scientific protocol for salmonid habitat surveys within the Columbia Habitat Monitoring Program. Prepared by the Columbia Habitat Monitoring Program.

Care of Tribrachs

Tribrachs are an integral part of the precision equipment and should be handled accordingly. They should be transported in separate compartments or other containers to prevent damage to the base surfaces, bulls eye level, and optical plummet eye piece. Over tightening of the tripod fastener screw can put undue pressure on the leveling plate.

Although the leveling screws are covered, dirt or dust can work into the threads and cause wear. Repairs should be done in the shop by someone experienced in such work, should such damages occur.

Adjustments of Tribrachs

An out of adjustment tribrach can cause small random errors and each tribrach should be routinely checked for centering. Careful adjustment with a plumb bob is quite fast and should provide a centering accuracy within 1 millimeter. A more accurate method is to rotate the tribrach 120 degrees over a smooth markable surface. For the first sighting, a soft pencil line is drawn on the tripod head around the tribrach base. The tribrach is carefully leveled and the sighting point marked. The tribrach is then rotated 120 degrees, carefully set in the pencil marks, re-leveled, and a new sighting point marked. Repeat this procedure. If the tribrach is slightly out of adjustment, the three rotational marks should form a triangle. The plummet should be sighted to the center of the triangle and the optical plummet adjusted to that setting. The test should be repeated to verify the adjustment.

Tripods

Tripods provide a fixed base for all types of surveying instruments and sighting equipment.

Types of Tripods

In the past, different equipment required different tripods. However, due to standardization by instrument manufacturers, most of today's equipment utilizes the same tripod. The same tripod can be used for total station, levels, and GPS. Tripods are made of either metal or wood composite. Wooden tripods are recommended for precision surveys to minimize errors because they are less subjected to expansion and contraction due to heat and cold than metal.

Care of Tripods

A stable tripod is required for precision measuring Instruments. A tripod should not have any loose joints or parts which might cause instability. Some suggestions for proper tripod care are:

A. Maintain firm snugness in all metal fittings, but never tighten them to the point where they will unduly compress or injure the wood, strip threads or twist off bolts or screws.
B. Tighten leg hinges only enough for each leg to just sustain its own weight when legs are spread out in their normal working position.
C. Keep metal tripod shoes tight and free of dirt.

Major Adjustments

When an instrument has been damaged or otherwise requires major adjustments, it will need to be sent to an authorized repair shop by the CHaMP Equipment Quartermaster. The instrument should be accompanied by a written statement indicating the types of repairs needed and details of possible causes for the incurred damages. In the case of electronic devices, the request should describe conditions under which the instrument does not function properly, i.e., coldness, dampness, etc. If a "loaner" is needed, this should also be indicated.

Wherever possible, the instrument should be "double cased" for shipping, with its case packed inside a cardboard container that is padded sufficiently.

Operators Manual

Each new instrument is furnished with an operator's manual. The Nikon Nivo 5.c manual is available at: *nikon-spectra.ru/doc/NivoC_Ver_A100.pdf* or on the champmonitoring.org website under crew resources in the 'field equipment manuals' tab. The manual may also be available on the instruments memory. The manual contains a description of the instrument, specifications of its various components and capabilities, and applications. The manual also contains basic instructions for use of the instrument and describes recommended servicing and adjusting methods. The operator's manual should be available for use. Each operator should thoroughly study the manual prior to use of the instrument, particularly whenever prescribed field adjustments are to be made. If the manual is lost, stolen, or damaged beyond use, a replacement copy should be obtained as soon as is practical.

Accessories

Tribrachs

A tribrach is the detachable base of all total stations and traverse kit type prism assemblies. Tribrachs are equipped with a bulls eye bubble for leveling and optical plummets for setting up precisely over a survey mark. The discussion on tribrachs is conducted in a separate section because they are being used with a wide variety of surveying equipment.

Use of Tribrachs

The ability to "leapfrog" between instrument occupy point and backsight setup location by using interchangeable tribrachs increases the speed, efficiency and accuracy of the traverse survey. Whenever possible, the tribrach should be detached from the instruments and placed on the tripods for TS setups. This procedure speeds up the setting up process and protects the instrument from accidents.

SECTION 2: TOPCON-MAGNET VERSION 2.5.1 PROCEDURES

2.1 New Site Setup Procedures

Reference: Section 5.1, Columbia Habitat Monitoring Program protocol

Equipment: Total station, tape measure, tripod, prism, prism pole, backsight setup (i.e., tribrach with riser/prism adapter, tripod, and prism or bipod, prism, and prism pole), pencils, field notebook

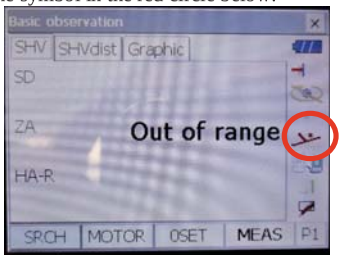
Objectives: The purpose of the initial survey is to establish and monument a small control network of benchmarks (BM) that can be relocated in subsequent years. The control network should maintain an equilateral spatial configuration that adequately spans the site length. Collect a sufficient amount of topographical points to accurately describe the geomorphic features of the stream.

- Choose a location for your first Total Station (TS) setup that is over one of the three BMs or at a location where all three benchmarks can be surveyed. The initial setup location should also have a maximized line of sight to the channel.
- Establish and monument the benchmark or control point (CP) for your first setup using an appropriate method (i.e., rebar with cap, nail and whiskers, or an "X" etched into a boulder.)
- Center and level the total station over the CP using the tripod and tribrach. The chosen location should provide a safe and stable work space for both instrument and surveyor; enabling 360 degree movement around the setup.
- Establish your backsight setup (i.e., tripod or bipod with prism) over one of your benchmarks. Measure the height of the prism before leaving your setup.
- Record all pertinent data in the field notebook. This includes the occupied point description, height of instrument, backsight point description, and height of backsight prism.

For a New Total Station, configurations and setting should be checked before proceeding with the Survey, see section 2.9.

1. Turn on the Instrument by pushing the green power button on the upper right of the dashboard:

2. Upon startup the actual screen displayed will vary. To open the level screen, select the symbol in the red circle below:



Note: if there is a line through Level icon circled above, level is turned off. To turn on level compensator, tap and hold stylus to icon and select Tilt cm: H,V.

3. The Tilt window opens and displays the electronic level bubble:

4. Level the instrument and select the program button as indicated below:

5. From the Program window select MAGNET Field:

Always keep the total station in a secure position while traveling to field sites which prevents it from bouncing around unnecessarily on particularly rough roads (i.e. in the front of the truck).

Care During Instrument Setups

Whenever possible, select instrument stations where operation is not dangerous to the instrument operator, other crew members, or the instrument. Select stable ground for the tripod feet. Do not set an instrument closely in front of or behind a vehicle or other large equipment which is likely to move without warning. Take a safe route to all setups.

A. At the site, clear debris and brush out of the way to provide a stable area for the tripod. Firmly plant the tripod with its legs widespread. Push along the legs downward, not vertically. On smooth surfaces, use some type of tripod leg restrainer to keep the legs from sliding outward.
B. Always have the tripod firmly set over the point before removing the instrument from its carrying case. Immediately secure the instrument to the tripod with the instrument fastener.
C. Never leave an instrument or its tribrach on the tripod without securing either to the tripod. Moderate pressure on the fastener screw is sufficient. Excessive tightening causes undue pressure on the foot screws and on the tribrach spring plate. Make sure the tribrach clamp is in the lock position.

Total Station Calibration

The CHaMP survey equipment endures a significant amount of rough conditions during field use and transport; the total stations are no exception, with their most common affliction being loss of proper calibration. A total station must be calibrated periodically to attain accurate measurements. Thus, it is wise to check that the instrument is operating within acceptable tolerances frequently to avoid collecting unusable data. If a total station undergoes any sort of trauma; such as a particularly rough truck ride, is banged or dropped, it absolutely must be calibrated before it is employed to collect data. Additionally, a calibration is advised if a crew encounters unexplainable errors during a survey.

The field calibration sequence can help the surveyor obtain horizontal corrections reasonably well, while vertical correction and EDM correction must be performed by a certified instrument technician. However, unless the instrument has been severely mistreated in some way, the Nikon Nivo C series Calibration routine in Section 2.12 should be sufficiently effective.

Normally, each instrument should be periodically checked at a Survey Standard Site (see Section 3) where the best conditions for testing are possible. Only the adjustments described in the Nikon Nivo C series Calibration Procedures should be made in the field. Do not "field strip" (dismantle) instruments.

D. Frequently clean the instrument externally. Any accumulation of dirt and dust can scratch the machined or polished surfaces and cause friction or sticking in the motions. Excessive dust within the electronics of the machine can also cause the instrument to overheat during operation.
E. Dirt and dust should be removed only with a clean soft cloth or with a camel hair brush. Compressed air can also be used to carefully blow particles off of the instrument.
F. Clean the external surfaces of lenses with compressed air or a fine lens brush and, if necessary, use a dry lens tissue. Do not use silicone treated tissues, as they can damage the coated optics. It is permissible to breathe on the lens before wiping it, but liquids, such as oil, benzene, water, etc., should never be used for cleaning purposes. DO NOT loosen or attempt to clean the internal surfaces of any lens.
G. Cover an instrument whenever it is uncased and not being used for any length of time, particularly if there is dust or moisture in the air.

Casing and Uncasing

Before removing an instrument, study the way it is placed and secured in the case. The instrument must be replaced in the same position when returned to the case.

Lifting - Instruments should be removed from the case with both hands. One hand on the instruments carrying handle; the other hand should support the base. One hand should continually be on the handle until the tribrach lock is engaged and the tripod fixing screw secured.

Do not grip where pressure will be exerted on tubular or circular level vials.

Instrument cases are a transportation device for invasive species as well as the instrument and should be cleaned internally and externally before leaving a reach. Keeping the case closed and locked while surveying can minimize accumulation of such species, as well as keep dirt and dust from entering, and is highly recommended.

Field Transport of Surveying Instruments

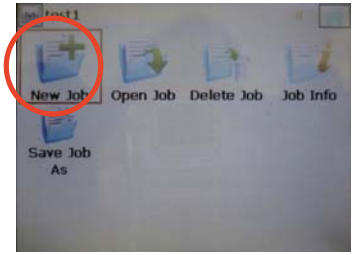
Do not "shoulder" or carry a tripod mounted Total Station. The instrument(s) should always be removed from the tripod(s) and secured in carrying case(s) when moved.

These precautions are necessary because the center spindle (center spigot or standing axis) of a total station is hollow and relatively short. When carried horizontally while on the tripod, the alidade's weight is an excessive load for the hollow centerpiece to bear. Instrument damage can result if the above precautions are ignored. Also, the instrument fastener can break, causing the total station to fall.

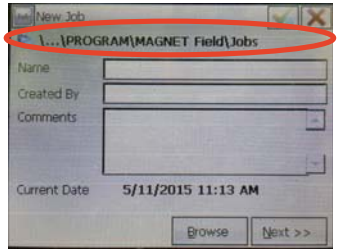
Transport and store instruments in positions that are consistent with the carrying case design. Many instrument cases indicate the position in which they should be transported.

6. The main menu will open, select Job:

7. Select New Job:

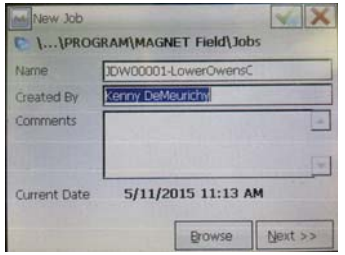


8. Note that in the New Job window the location of the job is displayed. Always use the Jobs folder! If file path below does not match use Browse button and navigate to Jobs folder.

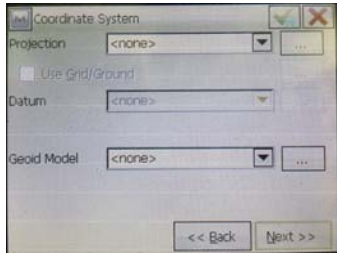


9. Enter a name for the new job, by tapping in the "Name" window with the stylus. The keyboard will open. Name the job using the following naming convention: **SiteID-Date-Organization** (e.g., **CBW05583-007395-20150710-ODFW**). When finished, click on the green check box.

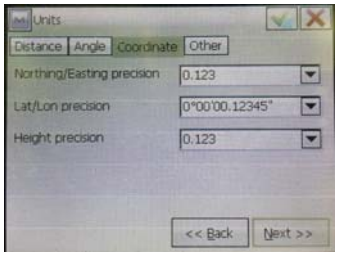
10. In the Created by field put your name, and select Next:



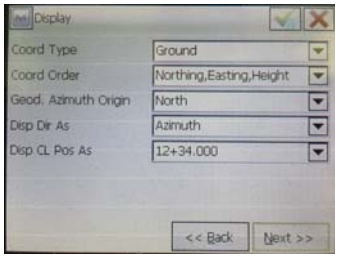
11. In the Coordinates System window choose the selections as below, select Next:



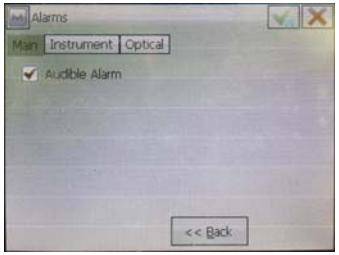
12. In the Units coordinate tab choose the selections as below, select Next:



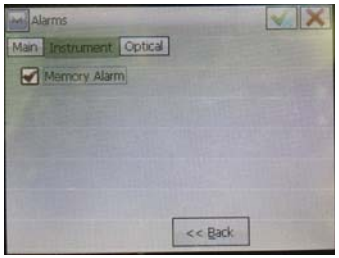
13. In the Display window choose the selections as below, select Next:



14. In the Alarms, Main window choose the selections as below.

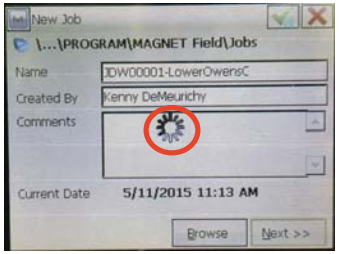


15. In the Alarms, Instrument window choose the selections as below:



16. In the Alarms, Optical window choose the selections as below, then select the green check mark:

17. The symbol below indicates the instrument is processing and saving the job:



3.4 Survey Equipment Maintenance

It is imperative to properly care for and maintain Survey equipment. Survey equipment is used in harsh conditions, exposed to extreme weather conditions, and is often subject to being jostled about during transportation. Proper care in the methods by which equipment is used, stored, transported, and adjusted is a major factor in the successful completion of the survey. Lack of good maintenance practices not only causes unjustified replacement costs, but can also seriously jeopardize the efficiency and accuracy of the entire survey.

The crew leader is responsible for ensuring that all crew members are properly trained in the use of equipment for its intended purpose and the maintenance of all survey instruments, tools, and accessories. Should the need for additional assistance, training, or repairs arise during the course of the season, a crew supervisor should be notified.

Total Stations

Total stations are today's primary measuring instruments, particularly on all baseline and control surveys. A total station is a battery operated electronic device that measures angles and distances, and then performs an on-board computation which ultimately results in a coordinate for a location.

Care of Total Stations

Although the instruments are ruggedly built, careless or rough use and unnecessary exposure to the elements can seriously damage them. The shafts, spindles, pendulums, and electronics of precision instruments can be compromised by one careless act or a continued lack of attention to prescribed procedures for the care and adjustment of the instrument. If handled appropriately, they will provide consistently good results with minimal downtime for repairs or professional adjustment. Some general guidelines for the care of these instruments are:

A. NEVER point the TS directly at the sun. The focused rays of the sun can damage sensitive internal parts.
B. Protect the TS from excessive heat. Heat can cause erratic readings and deterioration of components; as with any electronic equipment. Do not leave instruments in closed vehicles that are parked in the sun. Avoid rapid changes in temperature, particularly from extreme cold to warm, which can cause condensation in the internal parts of the instruments. Condensation can normally be avoided by leaving the instrument in its carrying case for at least 10 minutes and then opening the case to allow any trapped moisture to evaporate. An instrument taken from a warm office or vehicle to an extremely cold operating environment may require some time to adjust itself. The same type of precautions should be taken to let the instrument cool off slowly.
C. Although the instruments are very water resistant, keep them as dry as possible. The case and battery compartments should be left open, allowing the instrument to dry in a warm dry room when not in use; particularly after it has been exposed to moisture.

Examining the Data
At Station 2 this total station has demonstrated a vertical error. With one move it is already above MAE for vertical. The BS vertical error is -.035 m. This error is confirmed by staking bm3 and observing a -.036 m vertical error.
At Station 3 this TS demonstrated more vertical errors.

Loop closure: At station 3, the occupation of cp3 and stake out to bm1 should produce the highest error values. These values should be within CHaMP MAE for an Initial survey. If not data collection procedures should be evaluated and improved if necessary. Then another test should be conducted in a new job file. If errors are still not within MAE, there may be a problem with the TS.

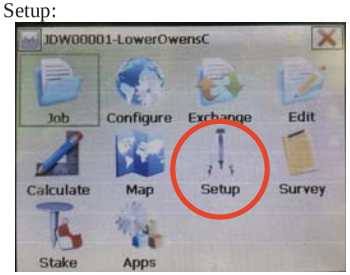
Excel can be used to further evaluate the point coordinates. The standard deviation, maximum and minimum formulas are helpful. Also look for a coordinate value that increases or decreases as the survey progress.

	Point	Northing	Easting	Elevation	Code
	7	1999.992	999.991	99.981	ck
	8	1999.992	999.992	99.985	cp1
	3	2000.000	1000.000	99.990	ck
	1000	2000.000	1000.000	100.000	BM1
STD Deviation		0.005	0.005	0.008	
Max-Min		0.009	0.009	0.019	

What is acceptable?
If these procedures are followed and the equipment is properly checked and adjusted a properly functioning total station and crew should be able to produce errors less than the CHaMP MAE for an Initial survey.

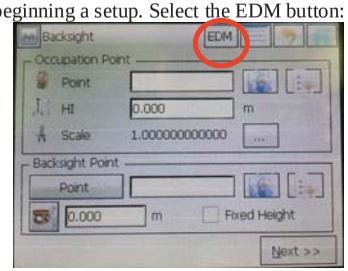
Please send instrument files from the SSS survey to the CHaMP Surveyor at:
kenny.demeurichy@usu.edu

18. The job is saved and the main menu is displayed. Note that the name of the current job file is in the upper left corner. Select Setup:

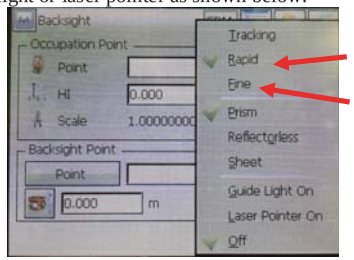


19. Select Backsight:

20. This is the Backsight, Point of Occupation window. Explore the buttons and settings that are available before beginning a setup. Select the EDM button:



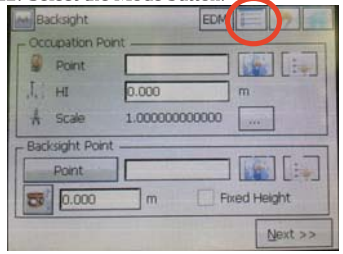
21. For topo work use the rapid setting, for control work use fine. Use Prism. No guide light or laser pointer as shown below.



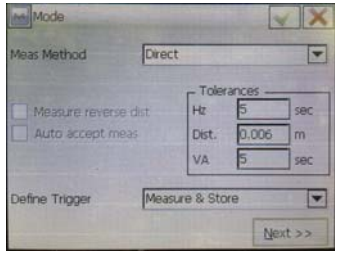
Topo work

Control or Benchmarks

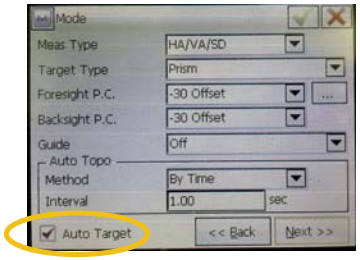
22. Select the Mode button:



23. Check the settings as below, then select next:

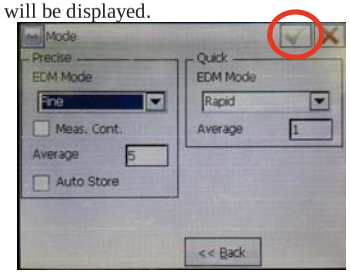


24. Check the settings below. You will visit this screen often. Pay attention to the Prism Constant: Foresight P.C. and Backsight P.C. Champ uses a -30 mm offset. The Auto Target option allows the TS to search for the prism when one of the measure buttons is activated. Select Next.

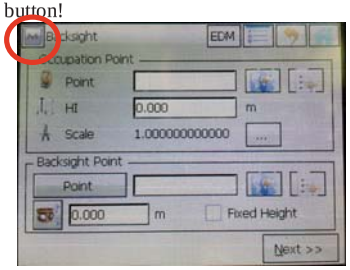


Auto Target enables the TS to search for the prism before conducting the measurement. There are situations when data collection with auto target disabled is a more efficient option. Dense vegetation between the TS and the prism will require the operator to make a decision based on experience on whether to use Auto Target or not. It is OK to uncheck (disable) Auto Target. See section 2.13 for more info.

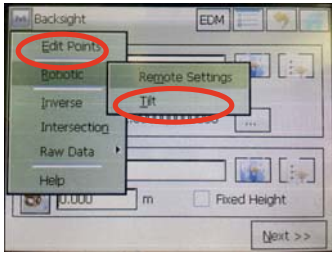
25. Check the settings as below, then select the green checkmark. The backsight window will be displayed.



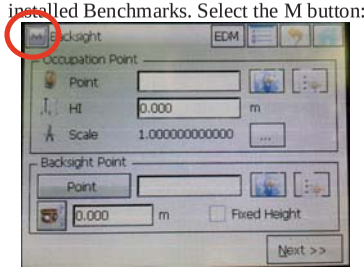
26. The M button in the left corner has available options, kind of like a "favorites" button!



27. The important options to note here are the availability to Edit Points and the Tilt button which allows easy access to the electronic level bubble:



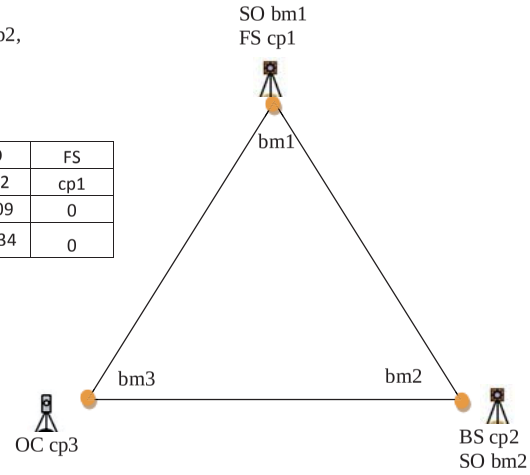
28. To begin the new site survey setup we are establishing an assumed coordinate system by creating coordinates for the installed Benchmarks. Select the M button:



Station 3

At station 3, occupy cp3, backsight cp2, stake out bm1 then foresight cp1.

	OC	BS	SO	SO	FS
code	bm3	cp2	bm1	bm2	cp1
HE	0	0.005	0.008	0.009	0
VE	0	-0.021	-0.039	-0.034	0

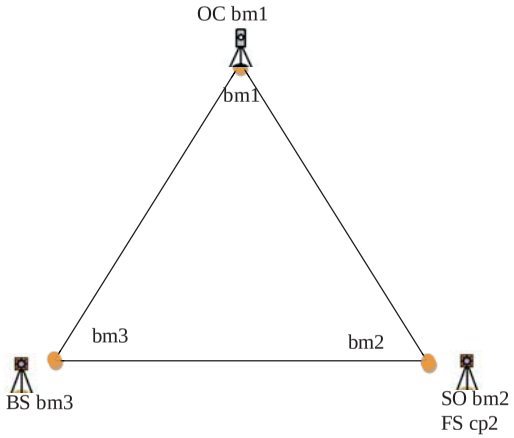


Usually by the third station if the TS has a problem it will be apparent.

Station 1

At station 1: occupy bm1, backsight bm 3, stake out bm2 then foresight cp2.
You will traverse to cp2.

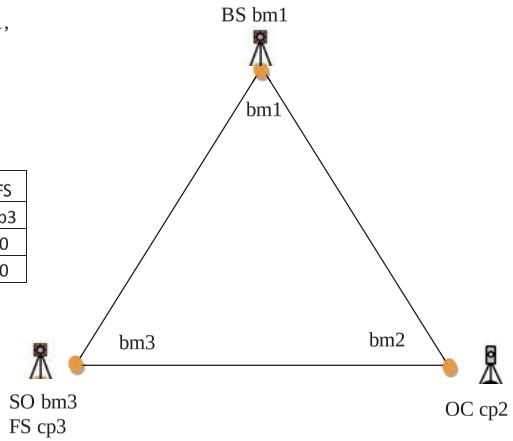
	OC	BS	SO	FS
code	bm1	bm3	bm2	cp2
HE	0	0.007	0.011	0
VE	0	-0.014	-0.013	0



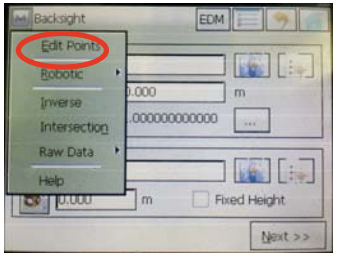
Station 2

At station 2, occupy cp2, backsight bm1, stake out bm3 then foresight cp3.
You will traverse to cp3.

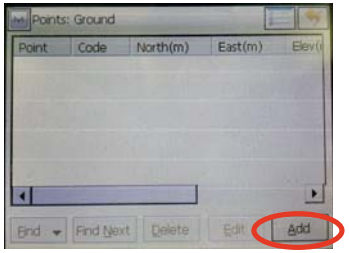
	OC	BS	SO	FS
code	cp2	bm1	bm3	cp3
HE	0	0.003	0.020	0
VE	0	-0.035	-0.036	0



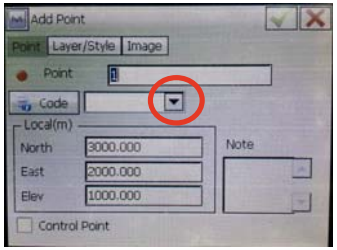
29. Select Edit Points:



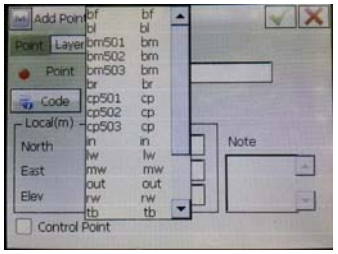
30. Select Add:



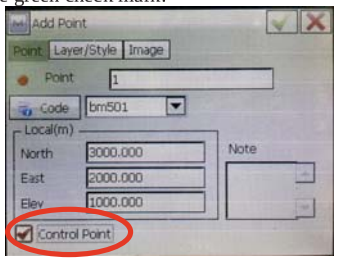
31. In the Add Points window edit the fields to the values shown below. Use N = 3000, E = 2000, Elev. = 1000. To select the code for the occupation point use the dropdown arrow:



32. The predefined codes are displayed. Select the currently occupied bm# or cp#, or enter in the new code:

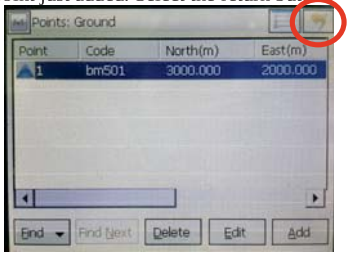


33. When all the fields are as below select the green check mark:

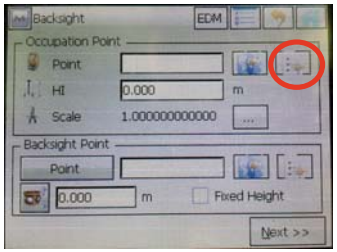


Note: With control point checked the coordinate will not be editable.

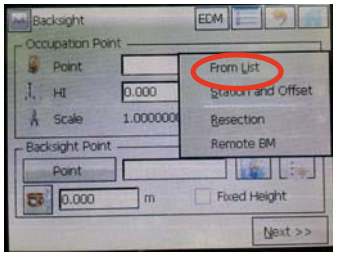
34. The points file is displayed including the point just added. Select the return button:



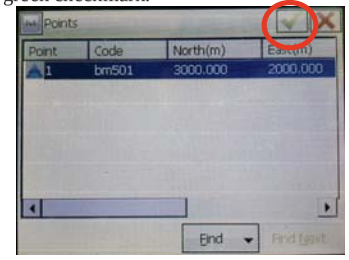
35. In the Backsight window select the List button:



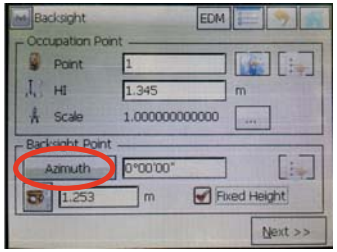
36. Select From List:



37. The points file is displayed. Select bm501 for the Occupation point. Select the green checkmark.

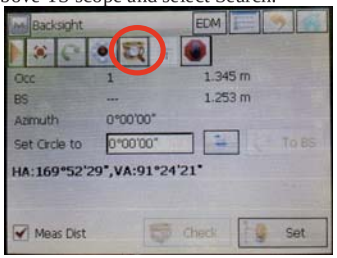


38. The backsight window displays the occupation point. Enter the instrument height (HI), Scale set to one. Under Backsight Point enter the following information for a new site survey: select Azimuth of zero and enter the height of the backsight prism that is being measured. If the backsight prism is on a tripod check the Fixed Height box. When complete select Next:



Note: if circled Backsight button above reads Point instead of Azimuth tap the button to toggle to Azimuth.

39. The next Backsight window is where the measurement will occur. Before Backsighting it is good practice, to check level bubble and prism constant. Point the TS near the Backsight Prism using ruff sight above TS scope and select Search:



Survey Standard Site Use for Instrument Testing

To obtain sufficient test results for the TS from the use of the SSS prior to beginning the survey all equipment should be thoroughly checked and adjusted. All tripods, tribrachs, prisms, and tape measures should be in excellent working condition to eliminate them as a contributor to error. The exception to this rule may be the total station itself. The TS should remain in the condition it was used for previous surveys to access the condition it was in while conducting those surveys.

If necessary the total station may be calibrated and retested later.

If enough equipment is available use a tripod and tribrach at all three benchmarks. Then it is only necessary to move the instrument and prisms.

It is also important for the personnel conducting the test to be very diligent in following good survey practice. Close is not good enough. For example: aim the TS at the prism in a very precise and consistent manner. For the Nikon: While looking through the telescope approach the prism from the same direction every time. Left to right, top to bottom. Use precise edm mode, etc.

The coordinates developed for each benchmark in the original survey of the SSS are the standard by which all measurements are tested. The test consists of traversing through all three benchmarks at least once. The instrument is set in all three locations, but the coordinates for the benchmarks are only occupied for the first setup. As you will see in the steps below new coordinates are measured for the benchmarks and saved as control points or ck points. The reason the survey is conducted in this manner is to look for the difference in the current survey coordinates verses the original survey coordinates. With a TS that is experiencing errors the measured coordinates for each setup will tend to drift away from the original coordinates for the benchmarks. For the vertical component, think of a cork screw; as it goes round and round it moves further down or up from its original location.

Remember: to obtain sufficient total station testing results, prior to beginning the survey, all equipment should be thoroughly checked and adjusted and the personnel must be diligent in following good surveying practice.

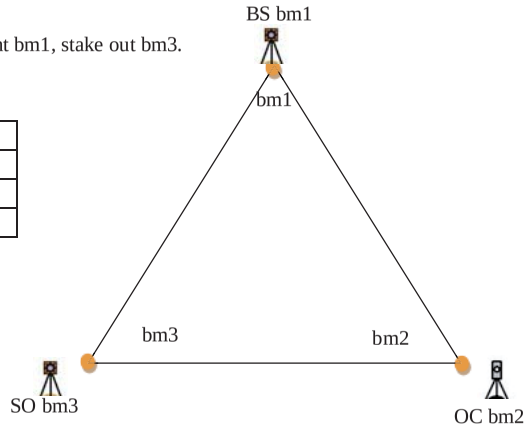
This test is conducted as a revisit survey therefore the coordinates for the SSS benchmarks must be imported to the total station.

Follow the steps for each station as outlined and be sure to keep good field notes.

Station 2

At Station 2: occupy bm2, backsight bm1, stake out bm3.

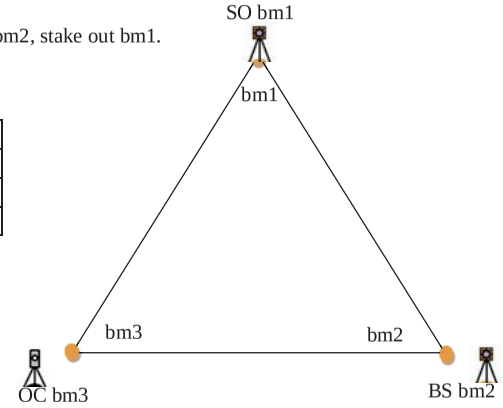
	OC	BS	SO	FS
code	bm2	bm1	bm3	
HE		?	?	
VE		?	?	



Station 3

At Station 3: occupy bm3, backsight bm2, stake out bm1.

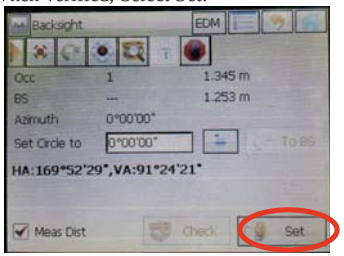
	OC	BS	SO	FS
code	bm3	bm2	bm1	
HE		?	?	
VE		?	?	



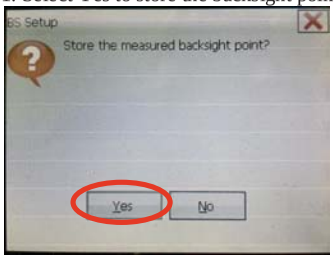
Upon completion of the survey the errors should be evaluated. See page 92 "Examining the Data". Please send all pertinent files to the CHaMP Surveyor for evaluation.

40. The TS motors will perform a search and locate the prism. The TS will stop moving when it locates the prism. Look through the telescope to verify the TS crosshairs are very near the center of the Prism. The crosshairs may not be positioned perfectly to the center of the Prism. This is normal as the Magnet software has the ability to calculate the exact center of the prism and incorporate the calculation into the coordinate measurement (X pointing technology). **As shown in step 20 and 21 be sure the EDM is set to Fine.**

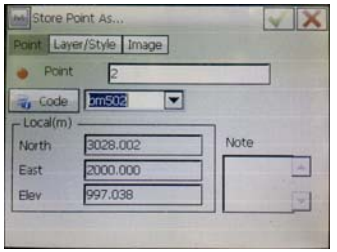
When verified, Select Set:



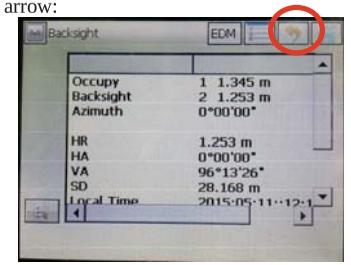
41. Select Yes to store the backsight point:



42. In the Store Point As window enter Point number 2 and bm502. Select the green checkmark:

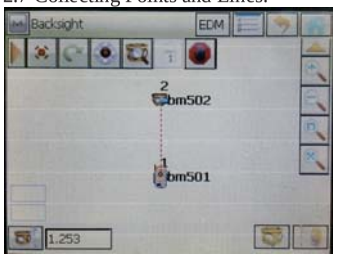


43. A report is generated. It is a good idea to be familiar with the report. Select the return arrow:



44. The Backsight is complete. Note the point of occupation and backsight point information are displayed.

45. **Select the M button, select View, select Map.** Check out the map. The TS is at point 1 and the BS is at point 2. The dotted line indicates the backsight azimuth. The map is very useful and will be explored in Section 2.7 Collecting Points and Lines.



46. The TS is centered and leveled over a benchmark, a backsight was measured and a coordinate system is established. What's next? Select the Home button in upper right corner to go to the Main menu and select **Survey, Topo**. With the coordinate system established it is now possible to set and survey additional benchmarks, control points or to begin topographic surveying. Be sure to use the correct EDM setting; use fine setting for control work and rapid for topo work.

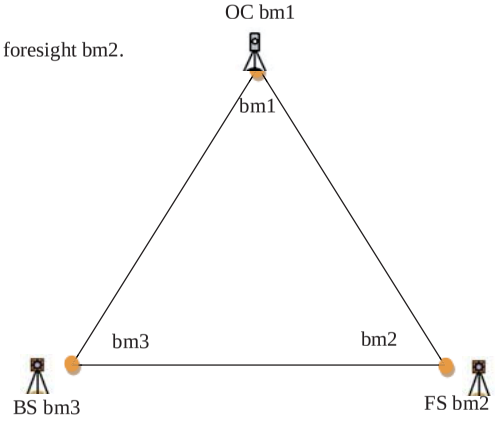
Initial Survey of the SSS
The initial survey of the SSS is critical as it is the standard by which all subsequent surveys will be judged. Do not establish a SSS with an instrument or equipment that is operating in a questionable manner.

All benchmarks must be occupied to check and confirm the coordinates of each benchmark.

Station 1

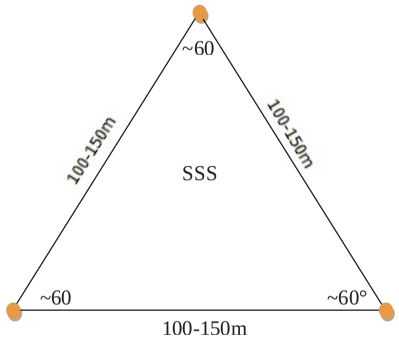
At Station 1: occupy bm1, backsight bm3, foresight bm2.

	OC	BS	SO	FS
code	bm1	bm3		bm2
HE				
VE				



and consistent manner. For the Nikon: While looking through the telescope approach the prism from the same direction every time. Left to right, top to bottom. Use precise edm mode, etc.

The site should consist at least three benchmarks spaced greater then 100 meters apart, preferably with angles approximately 60 degrees as shown in the diagram below. When possible set one benchmark about 10 meters higher or lower in elevation.



Legend

OC	Occupy
BS	Backsight
FS	Foresight
SO	Stake out
HE	Horizontal Error
VE	Vertical Error
	Benchmark
	Point of Occupation
	Backsight or Foresight point

2.2 Revisit Site Setup Procedures

Reference: Section 5.2, Columbia Habitat Monitoring Program protocol

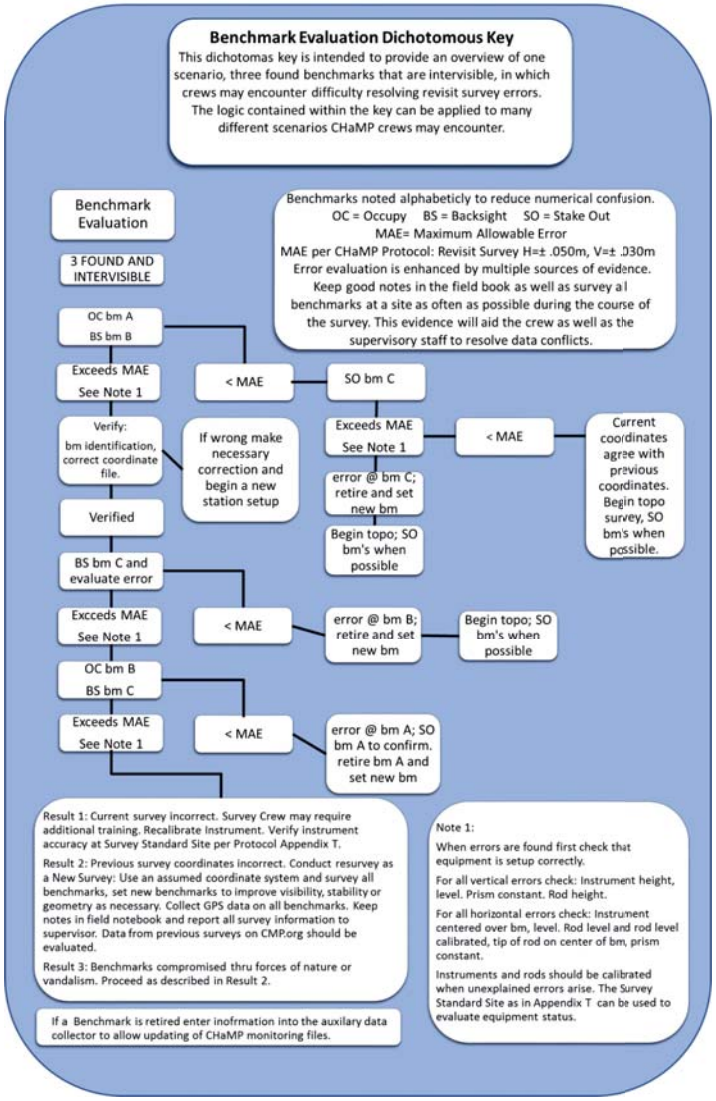
Equipment: Total station, tape measure, tripod, prism, prism pole, backsight setup (i.e., tribrach with riser/prism adapter, tripod, and prism or bipod, prism, and prism pole), pencils, field notebook

Objectives: The primary objective of the revisit survey setup procedure is to re-occupy the coordinate system established in previous visits using the existing control network (benchmarks).

- It is pertinent that the previously established Benchmarks (BM) be reoccupied to re-orient the total station (TS).
- Coordinates for the previously established BMs at each revisit site will be stored in the total station as a text file and will need to be imported to the new *.job as a CONTROL Layer. Points stored in this layer are ‘protected’ and therefore cannot be altered.
- Revisit sites will also have a previously defined ‘survey extent’ polygon stored in the total station as a *.dfx file which will also need to be imported to the new survey job as a ‘basemap.’ This will assist surveyors in replicating the same boundaries set by prior crews.
- All previously established BMs and Control Points (CPs) will be relocated and flagged where possible. When all three BMs cannot be located or the BM placement is unacceptable due to a poor spatial configuration, a new BM(s) will need to be installed.
- When new BMs are established, old BMs will be left in place and used to reorient the TS at the beginning of the survey. All usable BMs will be surveyed from as many total station setup locations as necessary.

Before Beginning: Total Station configurations and settings should be completed before proceeding with the Survey.

Use the benchmark evaluation dichotomous key to assist in determining which benchmark contains errors beyond Maximum Allowable Error, MAE.



3.2 Survey standard site use and development

Survey Standard Site Development

The Survey Standard Site (SSS) shall be developed to create a set of benchmarks with an accurately established coordinate system that can be utilized as a test site for equipment as well as crew development. Whenever possible the SSS should be in a location easily accessible to multiple crews, such as near a bunkhouse or a CHaMP collaborators office.

SSS utilization examples:

- The crew encounters unexplained errors in a survey.
- The crew encounters resurveys with large errors relative to the original surveys.
- The instrument or equipment has endured a traumatic event.
- The crew is unsure of a survey results.
- The site can be used to perform an Instrument calibration.
- The site can be used to develop crew member skills.

Criteria for site development:

- Established with more than usual care by an experienced crew.
- Established with calibrated and properly maintained equipment.
- Established with the traverse function using face left and face right.
- Use Precise EDM setting.
- Preferably can be established using multiple instruments and technologies.
- Benchmarks set in stable locations.
- Resurveyed yearly after spring thaw.
- Strong geometrical site layout.
- A surveyed traverse consisting of at least three benchmarks.
- When possible set one benchmark about 10 meters higher or lower in elevation.

To obtain sufficient results prior to beginning the survey all equipment should be thoroughly checked and adjusted. All tripods, tribrachs, prisms, and tape measures should be in excellent working condition to eliminate them as a contributor to error. The exception to this rule may be the total station itself. The TS should remain in the condition it was used for previous surveys to access the condition it was in while conducting those surveys. If necessary the total station may be calibrated and retested later.

If enough equipment is available use a tripod and tribrach at all three benchmarks. Then it is only necessary to move the instrument and prisms.

It is also important for the personnel conducting the test to be very diligent in following good survey practice. Close is not good enough. For example: aim the TS at the prism in a very precise

- Stay on task and take pride in being the fastest gunner you can be; on the flip side, be the most efficient rodman you can be!
- Think of yourselves as a 'survey team', rather than 'rodman vs. gunner'; do whatever you can to make your teammates task easier and more pleasurable.
- Communicate *clearly*!
- Perform backsight checks when the rodman has to take more time to get into position for a topographic point.
- Work moving downstream when surveying in-channel topo.
- When conducting topo work the rod bubble level should be close to center, but not necessarily perfect. Do not 'hyper-focus' on the bubble.
- Use two rods whenever possible, especially in areas where it takes substantial time for the rodman to get into place; don't let the Aux. person sit idle, should they finish first.
    - When surveying with two rodmen, each prism should *alternate* 'showing glass' to the gunner. Only the prism being measured should be pointed toward the gunner.
    - Good communication and predictability is key when using two rodmen
    - One rodman should be the leader and the other(s) follow.
- Make sure your prism is in good shape and reasonably clean.

Settings:

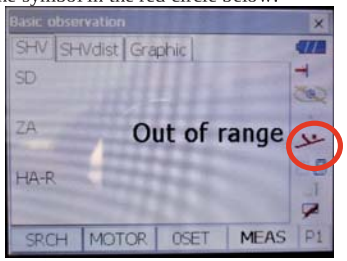
- Always use "rapid" EDM while collecting topo; use "fine" only when shooting benchmarks, etc.
- "Sheet" can be used with a prism or other rudimentary reflector; however, remember that the machine will not hold the offset of the prism. Thus, make sure offset is "0" (i.e. prism face must be removed from the target face and re-applied on the opposite side)
- Use Auto Target whenever possible; if the shooting is such that Auto Target is slowing the survey down, temporarily turn it off and resume once conditions are more conducive.
    - Conditions that may make Auto Target *less* efficient include: very close shots, shots in a fast-moving stream causing the prism to shake, shooting through vegetation, and shooting when the heat is such that heat waves occur.
- All settings in Magnet are designed to override settings in the Topcon onboard software. Always use the settings in the Magnet software. The only settings in the Topcon onboard software that may be changed are described in the CHaMP Manual: Topcon DS-205, Magnet 2.5.1, Section 2.12, DS Onboard Software Settings.

Wrap-up:

Most importantly, remember that not everyone's mind works the same; therefore, it is best to customize a method that generally works best for ***you***; as long as all important features are captured effectively, it ultimately doesn't matter in which order it was collected. Follow a sequence that balances both speed and quality of the survey at hand; each site is a little different and may dictate or contribute to the decision of which method will work best. As each team completes more surveys together, a system that best suits their specific work environment will soon develop and each step will become second nature. Happy surveying!

1. Turn on the Instrument by pushing the green power button on the upper right of the dashboard:

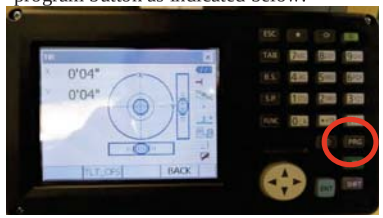
2. Upon startup the actual screen displayed will vary. To open the level screen, select the symbol in the red circle below:



Note: if there is a line through Level icon circled above, level is turned off. To turn on level compensator, tap and hold stylus to icon and select top option.

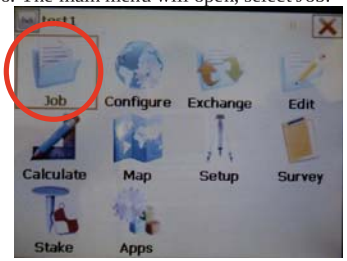
3. The Tilt window opens and displays the electronic level bubble:

4. Level the instrument and select the program button as indicated below:

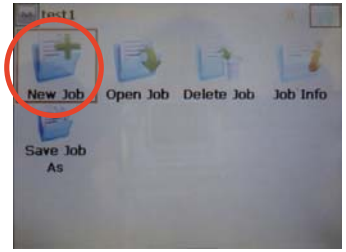


5. From the Program window select MAGNET Field:

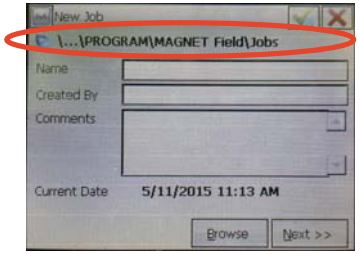
6. The main menu will open, select Job:



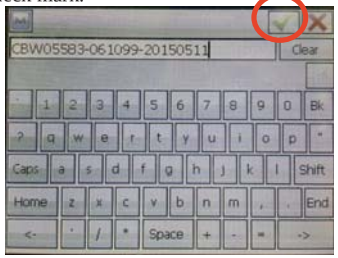
7. Select New Job:



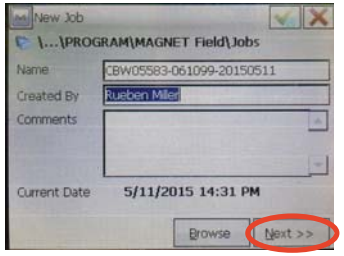
8. Note that in the New Job window the location of where the job is stored is displayed. If file path below does not match use Browse button and navigate to Jobs folder.



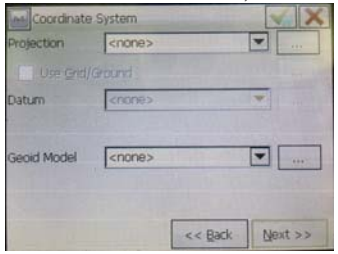
9. To enter information, with the stylus tap in the window and the keyboard will open. Name the job with the correct CHaMP identifier for the reach. Select the green check mark.



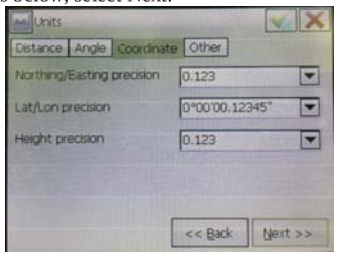
10. In the Created by field put your name, and select Next:



11. In the Coordinates System window choose the selections as below, select Next:



12. In the Units window select the Coordinate tab, and choose the selections as below, select Next:



- Once a code that can be a line is selected, the "line number window" pops up, as does the button to the right that allows the selection of several options:
  - Use "Add to Beginning" to add to the "beginning end" of a previously established line.
  - Use "Insert" to fill in or better define a feature, in the middle of a line.
    - The gunner must select a line segment from the Map; the next point collected will be inserted between to two points of the selected line segment.
  - Use "Add to End" to add to the *end* of a previously established line.
- In the Line Number field use alpha-numeric symbols to identify each new line or left and right sides of the stream (e.g. 1r, 2L , r1, L2 etc.) Do not add to CHaMP codes.
- Finish out a single line whenever possible.
- When surveying banks work on one side of the river at a time, as it is easier for the rodman to mentally keep track of each point surveyed to help prevent toe and top breakline crossing.
- The rodman can create markings on the shore as a reminder of where previous survey points/lines have been collected.
- Complete all lines in the section of the site you are currently working, then fill in with topo points; remember, having more breaklines will ultimately minimize points needed to effectively describe the stream topography.

General Topography:

- Minimize changing codes and/or rod height whenever possible.
- As the rodman, work moving towards and away from the gunner (rather than side to side or sporadically) whenever possible; this minimizes the amount of adjustment needed to find the prism at each new point for the gunner.
- As the gunner, anticipate and follow the prism when the rodman moves to a new point so that the second they set it down, the measure button is pressed.
- With reference to above, the rodman should work in a manner that allows the gunner to somewhat predict where the prism is going next.
- At the beginning of the survey, the rodman should develop a plan of attack for the survey at hand and communicate a summary to the gunner.
- Utilize "Quick Codes" whenever possible; especially when the codes are constantly being changed while surveying.
- Always raise and lower the rod a substantial amount, rather than very small increments; this will make it far easier to notice errors during processing.
- While in Auto Target mode, zero in on the prism center as close as ***easily*** possible, so that the instrument does not need to spend as much time searching to find the prism. This will also save battery life throughout the survey, by minimizing motor usage by the instrument.

SECTION 3: SURVEYING BEST PRACTICES

3.1 Tips for an efficient survey

Topographic surveying can be accomplished more efficiently by altering workflows to utilize the intricacies of the instrument available. Each individual survey platform (e.g., Survey Pro, Topcon Magnet, Leica, etc.) has a unique way of doing things and there are often tools and options within the software that can be difficult to find but can speed things up once discovered. In this document, a variety of tips will be provided to inform crews of some common practices that will ultimately speed up the topographic survey. Desirable tool options will be described, promoting more efficient surveying by enabling crews to maximize the features of the Topcon DS 205 instruments.

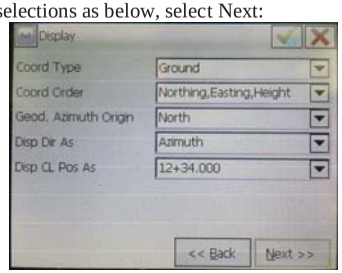
Set-up:

- Upon arrival of a new site, always walk the entire stretch and familiarize yourself with the area in which you will be working.
- Whenever possible, install one benchmark at a good place from which to begin surveying to eliminate an unnecessary Traverse.
- When considering where to install benchmarks and control points broaden your view from the immediate stream channel. Collect topo data from further away of the stream wherever vegetation /conditions permit. The DS205 maximum range, with Auto Target activated is 1000 meters. The optimum distance for surveying is approximately 200 meters. The total station's measuring process is faster when the gun is farther away from the target, while smaller adjustments are needed to site the prism. Employing this practice as a top priority in your survey will promote efficiency. Use of radios is crucial to communicate over longer distances.
- Do ***not*** set up in the streambed if it is at all avoidable; the ground is not stable (e.g., your tripod will often slowly sink; compromising the accuracy of your survey) and the possibility of a traumatic incident occurring to the total station is greatly increased.

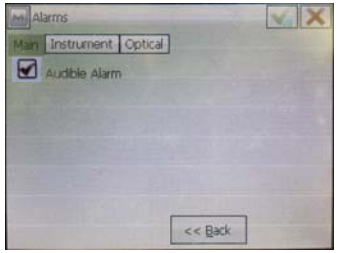
Linework:

Topcon Magnet allows the user to keep as many lines open as they can keep track of. The gunner must work with the rodman to produce a method that works for *both* ends of the survey efficiently and effectively; both parties need to be able to keep track of what has been surveyed and what still needs to be surveyed.

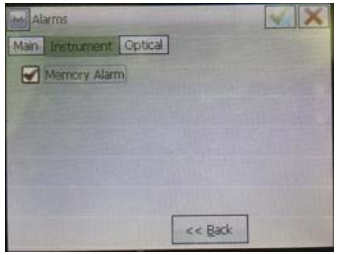
13. In the Display window choose the selections as below, select Next:



14. In the Alarms, Main window choose the selections as below:

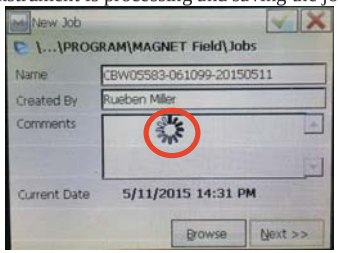


15. In the Alarms, Instrument window choose the selections as below:



16. In the Alarms, Optical window choose the selections as below, then select the green check mark:

17. The symbol below indicates the instrument is processing and saving the job:



18. The job is saved and the main menu is displayed. Note that the name of the current job file is in the upper left corner.

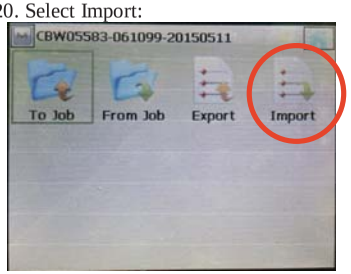
To conduct the revisit survey the previously established coordinate system must be re-occupied. This can be accomplished by importing the control coordinates and survey extent from the previous survey.

The imports for a Revisit survey are:

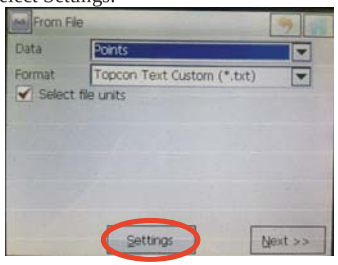
1) Control*.txt
2) SurveyExtent*.dxf.

19. To import point data in the txt file. From the main menu select Exchange:

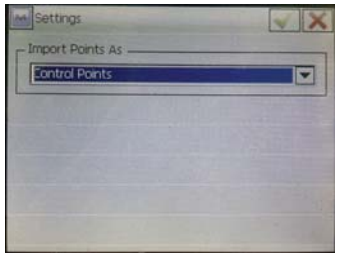
20. Select Import:



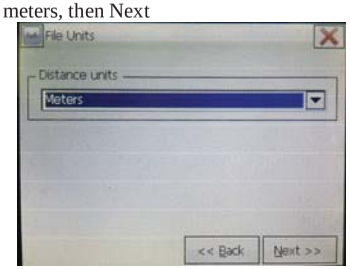
21. Populate the fields as below and make sure Select file units is checked. Then select Settings:



22. In the Settings window select Control Points, then select the green check mark and Next:



23. In the Distance Units window select meters, then Next



2.13 Auto Target Utilization

The Topcon DS total stations available to some crews contain technology that requires explanation. Specifically the Auto Target function utilizes X-pointing technology that that provides fast and reliable automatic aiming with accurate angle readings and eliminates the fine aiming adjustment which can add to operator fatigue and requires additional time.

The consistency of aiming from the DS "X-pointing technology" means that aiming at benchmarks and control will be consistent with aiming to each topographic point, which is valuable to incorporating survey backsight errors into geomorphic change detection. If the technology is utilized an overall reduction in time and effort to conduct the survey will occur at most sites. At densely vegetated sites it will be more efficient to survey with auto target off.

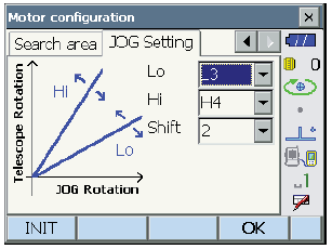
The concept for utilizing the technology is to put the total station into use with the Auto target on and then learn through experience when to disable the system.

1) Use correct instrument settings as described in Champ Topcon User Manual Sections.
2) Turn on Auto Target.
3) By hand Aim TS near prism and select rapid measure.
4) If total station does not find the prism, by hand aim the TS near the prism, look thru the telescope, consider advising the rodman to move the prism slightly in any direction to gain better line of sight, next using the tangent screws aim directly at the center of the prism and then select the rapid measure.
5) If the TS will not take the measurement, turn off auto target, and commence measurement by aiming directly at the center of the prism with the tangent screws.
6) If the TS still fails move the rod-prism to a position with a better line of sight.

Automatic aiming occurs even when the target is occluded up to 40%. This means that the instrument must be able to see 60% of the prism for Auto target to be successful. Utilizing the steps above the crew will calibrate their eye to determine what the 60% threshold looks like.

Collecting data very close to any total station can be a challenge. With Topcon DS and a large 3" prism commonly used by Champ crews the minimum measurement distance is 1.3 meters and the maximum is 1000 meters with Auto target engaged. On the lower end of this range the stability of the prism is more of an issue than at the longer distances. The rod man must hold the rod/prism steady during the measurement process especially when close to the instrument. Another method to collect topo data near an instrument setup location is to traverse to the next setup location and then complete the survey near the previous setup location. The crews will have to learn from experience what distances near the total station data can be collected efficiently versus moving the instrument to a new location and then surveying near the backsight setup location. This provides for utilizing all the technological features of the instrument.

7. On the JOG Setting tab adjust the values until you are happy with the movement of the TS while rotating the horizontal and vertical adjustment knobs (Tangent screws).

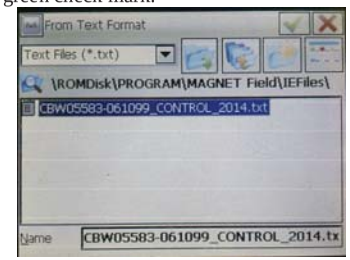


Set the Jog turning speed for vertical and horizontal rotation of the telescope. The "Shift" point signifies the Jog turning speed at which telescope rotation switches from the Lo speed setting to the Hi speed setting.The higher the "Shift" point setting, the faster the Jog turning speed needed to activate the Hi speed setting.

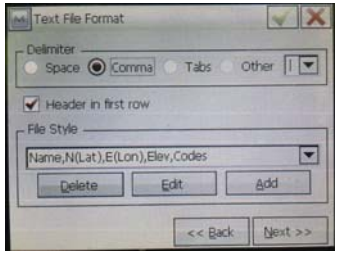
Items set and options (*: Factory setting)
(1) Lo : 1 to 4 (3*) (steps. 4 is fastest)
(2) Hi : 1 to 7 (4*) (steps. 7 is fastest)
(3) Shift : 1 to 6 (2*) (steps)

Press **[INIT]** to return JOG Setting tab settings only to their factory settings.

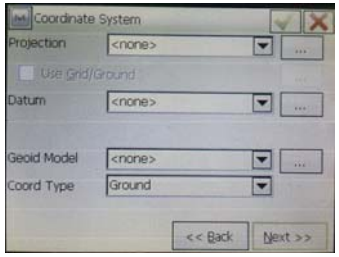
24. Browse to and select the control.txt file located in IEFiles folder, then select the green check mark:



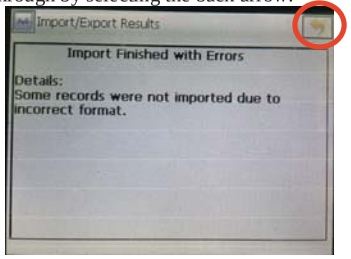
25. The Text File Format settings are very important, when they are correct select Next:



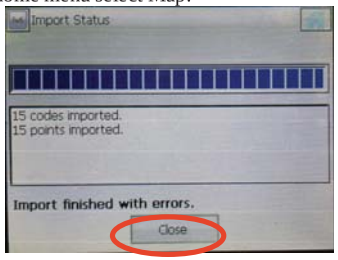
26. Select the coordinate settings as below, then select Next:



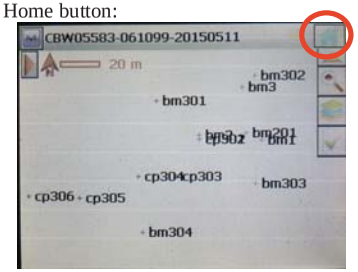
27. If you get this warning just push on through by selecting the back arrow:



28. The Import Status is displayed and all of the 15 points were imported.
Select Close and go to the Map, Select Home button in upper right, and from home menu select Map:

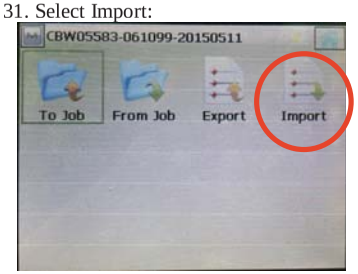


29. The map shows the points. Select the Home button:

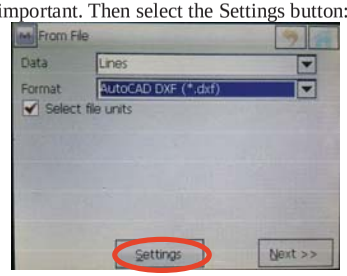


30. To import the Survey Extent dxf, From the main menu select Exchange:

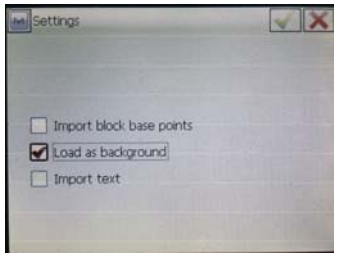
31. Select Import:



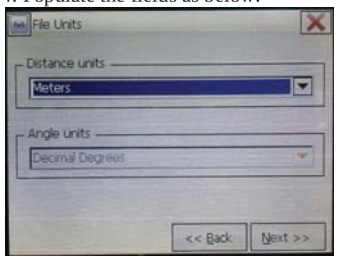
32. Populate the fields as shown below. The check box for Select file units is very important. Then select the Settings button:



33. Select the check boxes as below, then select the green check mark, then select next:



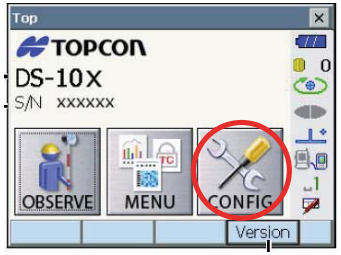
34. Populate the fields as below:



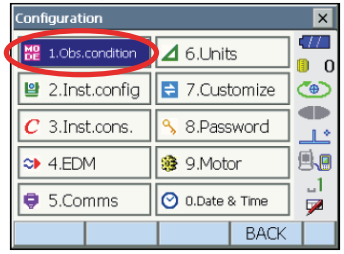
35. Browse to and select the Survey Extent dxf, located in IEFiles folder, then select green check mark:

These settings are in the onboard Topcon software, not in Magnet.

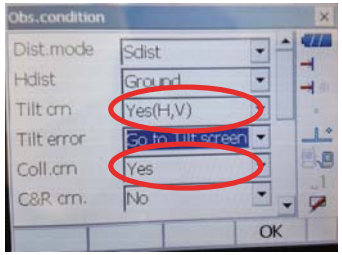
1. Go to this window: You may have to press the PRG button on the dashboard: Select CONFIG:



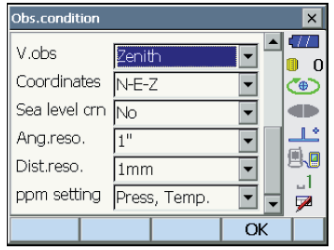
2. Select, Obs.condition:



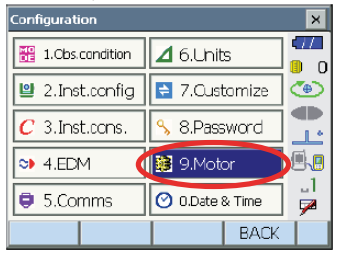
3. In the Obs.condition window be sure that the Tilt crn is set to "Yes(H,V)" and that the Coll. crn is set to "Yes"



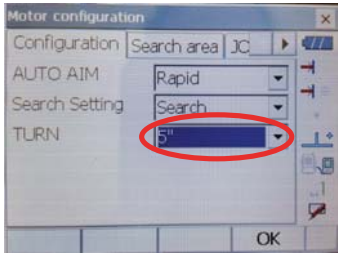
4. Scroll down to check the items below, then select OK.



5. Next. In the configuration window select, Motor:



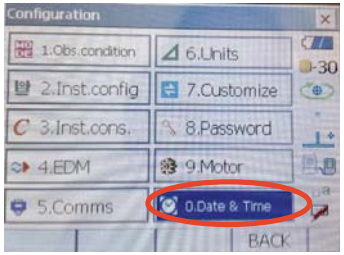
6. On the Configuration tab set the Turn to 5":



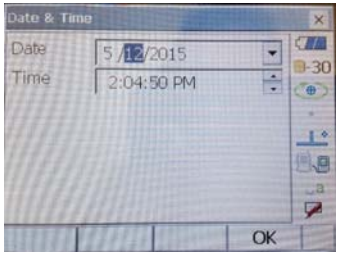
The time is set in the onboard Topcon software, not in Magnet. If necessary select the PRG button to escape from the Magnet software.

1. In the window below select CONFIG.

2. Select Date & Time:

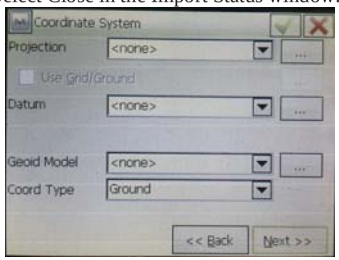


3. Set the current date and time. When complete select OK:

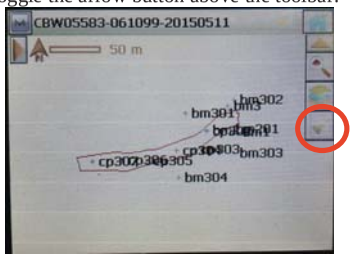


2.12 DS Onboard Software Settings:

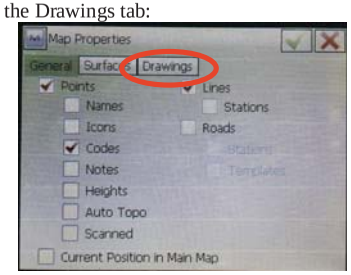
36. Use the Coordinate System settings below, then select the green check mark. Select Close in the Import Status window:



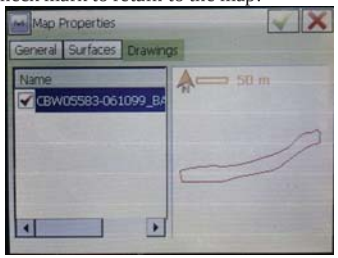
37. Go to the Map and have a look. Select Home button in upper right, and from home menu select Map: Success, points and a survey extent. Select the Map Properties icon. If properties icon is not displayed toggle the arrow button above the toolbar.



38. In the Map Properties window select the Drawings tab:

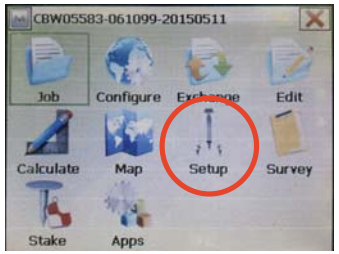


39. The Drawings tab displays the dxf that is available. The survey extent dxf can be shut off by unchecking. Select the green check mark to return to the map:



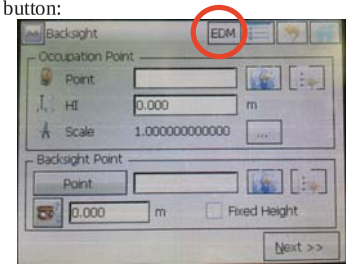
Now that the points and survey extent have been imported the reoccupation of the previous coordinate system can begin. Go to the Home Screen. Select Home button at top right of screen with house symbol:

40. In the Home screen, Select Setup:

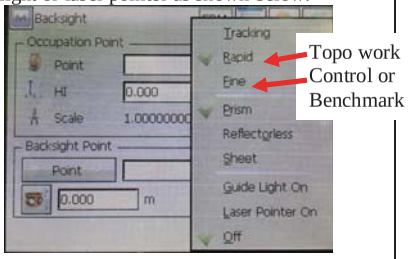


41. Select Backsight:

42. This is the Backsight, Point of Occupation window. Lets explore the buttons and settings that are available before beginning a setup. Select the EDM button:

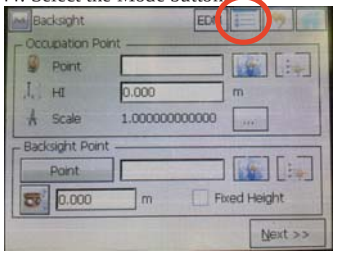


43. For topo work use the rapid setting, for control work use fine. Use Prism. No guide light or laser pointer as shown below.

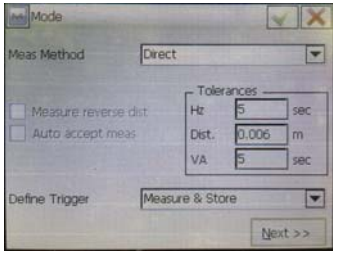


Topo work Control or Benchmark

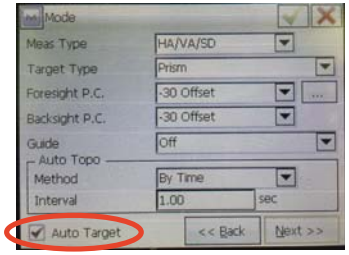
44. Select the Mode button:



45. Check the settings as below, then select next:



46. Check the settings as below. You will visit this screen often. Pay attention to the Prism Constant: Foresight P.C. and Backsight P.C. Champ uses a -30 mm offset. The Auto Target option allows the TS to search for the prism when one of the measure buttons is activated.

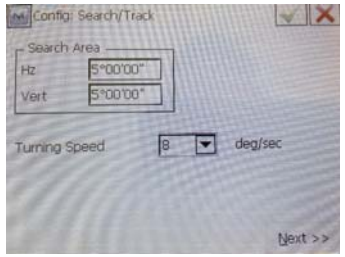


2.10 Search/Track Settings

To find the Search/Track setting from the Main menu, select Configure, select Survey:

The Search Track settings can be used to allow the instrument a better opportunity of quickly locating the prism in vegetated environments and improve battery life.

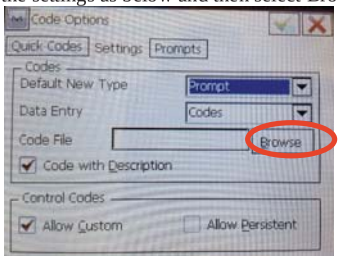
1) Turning Speed: In Theory, the slower the instrument turns the better the chance it will have to identify the prism in vegetation. The default setting is 16 deg/sec. Crews will have to experiment with this setting to find what works best. Try 8 deg/sec.
2) Search Area: This setting will reduce the area the instrument has to search to find the prism, thus the instrument should find the prism sooner. If the instrument fails to find the prism it will fail sooner. Additionally, battery life is improved by reducing the amount of work the motors must do to find the prism. This is accomplished by reducing the search area from the standard setting of 15 degrees. Try 5 degrees and adjust as necessary.



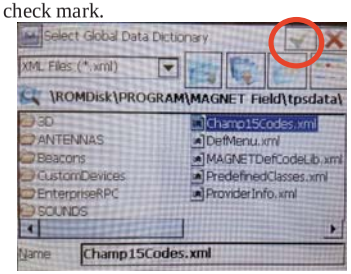
2.11 Time Settings

The correct time is important in the Survey tools used by Champ for data analysis.

4. In the Settings tab; check the settings as below and then select Browse.



5. Browse to and select the Champ15Codes.xml code file which should be in the following total station memory location: ROMDisk\PROGRAM\MAGNET FIELD\TPSDATA. When complete, select the Green check mark.

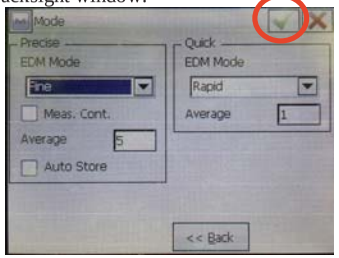


This completes part 3, Code library is set.

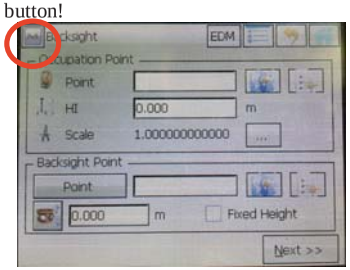
The Total Station default configurations and settings are now set. To conduct a survey, simply go to the main menu and select New Job to begin.

Note: The Champ15 Job file is not to be used as a template, it simply contains the settings desired for the TS for Champ surveys. The TS remembers the settings from the last job and applies them to a new job.

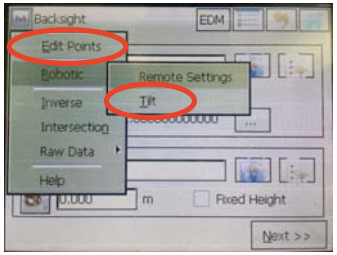
47. Check the settings as below, then select the green checkmark to return to the Backsight window.



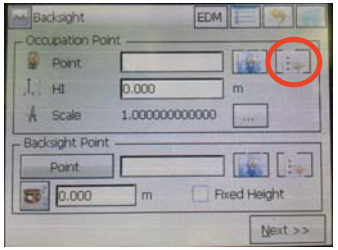
48. The M button in the left corner has available options, similar to a "favorites" button!



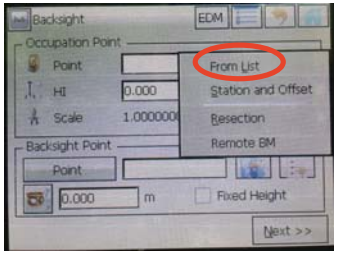
49. The important options to note here are the availability to Edit Points and the Tilt button which allows easy access to the electronic level bubble:



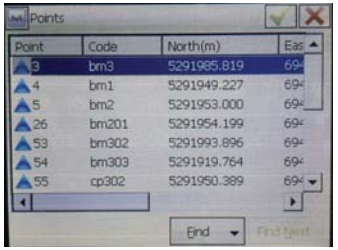
50. Begin the setup, Find the Point of Occupation in the file; there are two options to do so, the Map button or the select Point list button. Select the Point list button:



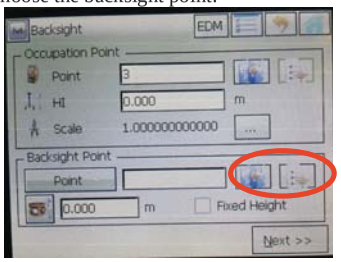
51. Select From List:



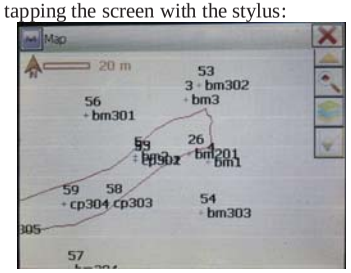
52. The Points list displays all the points imported from the control text file. Select the occupation point, then select the green check mark:



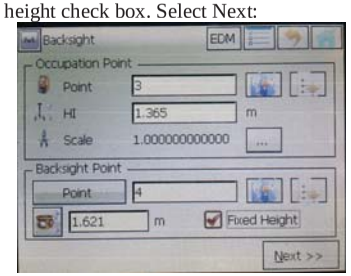
53. Point 3 is now the occupation point. Next use the map button or the list button to choose the backsight point:



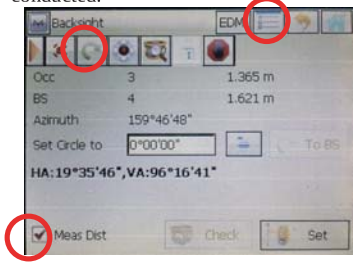
54. If Select by Map is chosen, the map is displayed. Select the backsight point by tapping the screen with the stylus:



55. The Occupation point and backsight point have been selected. Enter the height for each. Champ protocol requires using a tripod at the backsight thus select the fixed height check box. Select Next:

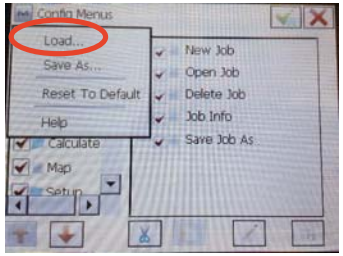


56. In the Backsight window verify the information, check the prism constant and be sure auto target is on, by checking prism icon and Mode window settings respectively. Use the check box to select Measure Distance, aim the TS near the prism at the backsight and select Set. The TS motors will conduct a search to locate the prism and then a measurement will be conducted:

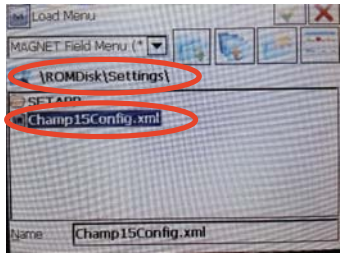


Backsight report evaluation on next page!

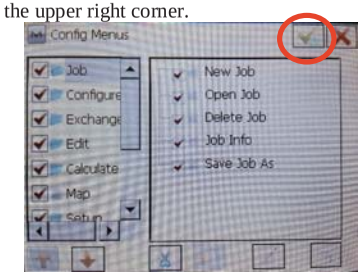
3. Select Load.



4. Browse to the location shown below, select the Champ15Config.xml and select the Green check mark.



This completes part 2. The menu configurations are set. Return to the main menu by selecting the Green check mark in the upper right corner.

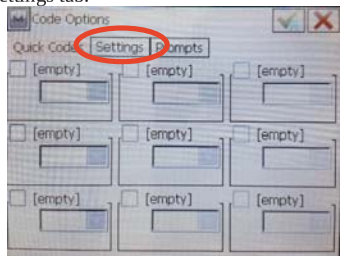


Part 3. Configure Codes

1. In the Home screen select Configure:

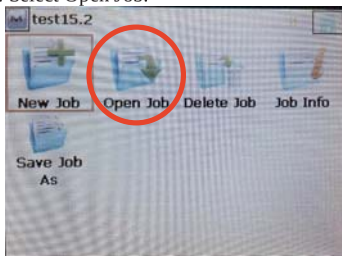
2. Select Codes

3. In the "Code Option" window select the Settings tab.

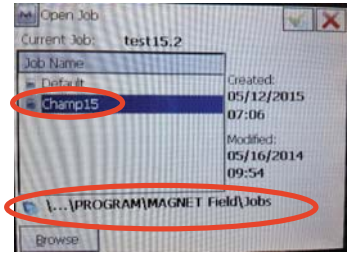


5. In the Main menu select Job:

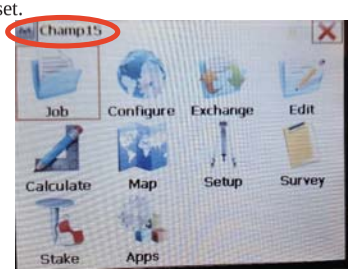
6. Select Open Job:



7. Browse to the location shown below and select the Champ15 job. Then select the Green check mark:



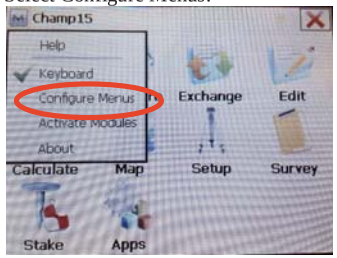
8. Note that the name of the job is displayed in the upper left corner of the screen.
This completes part 1, the job file (mjf) is set.



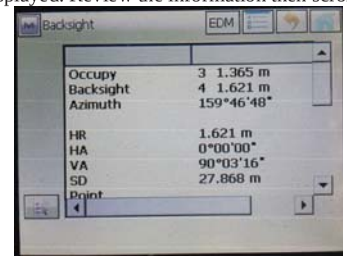
Part 2. Configure Menus

1. In the home screen, select the M in the upper left corner.

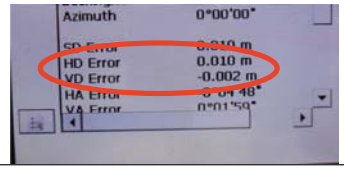
2. Select Configure Menus.



The backsight report is displayed. Review the information then scroll down:



In the Backsight report you must review the HD Error and VD Error. These values must be less then MAE per Champ Protocol:



Maximum Acceptable Errors

Revisit survey H= <0.05m and V= <0.03m

If a reported error value is larger then Maximum Allowable Error refer to the Benchmark evaluation dichotomous key in the Champ Protocol for instruction.

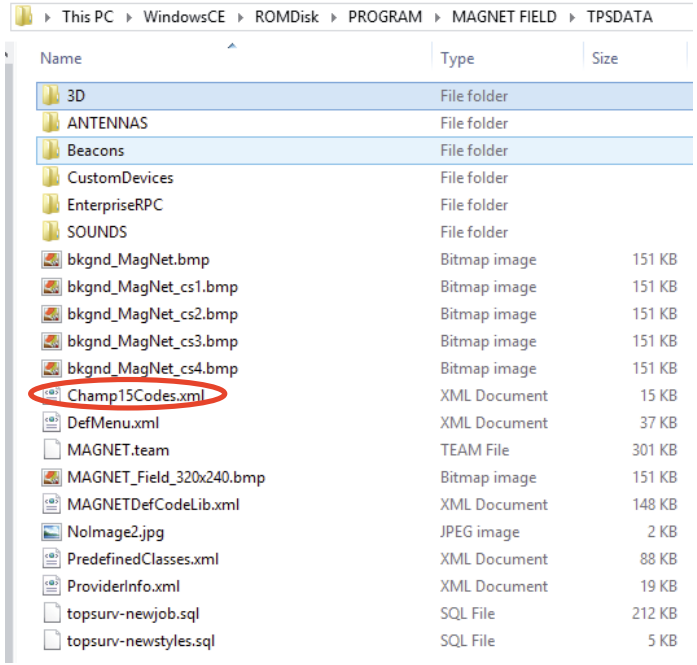
If the values are acceptable, select the Home button.
The existing site coordinate system has been re-occupied. If other benchmarks are intervisible from the current location the Stake Point Procedure should be used to evaluate. Otherwise you may set more control or begin topographic data collection.

2.3 Stake Point Procedure

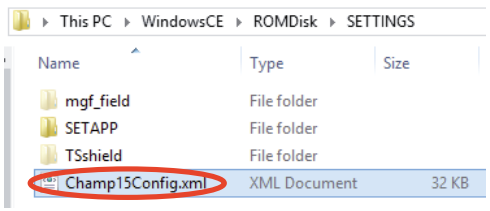
The Stake Points method is used for checking to a bm or cp. It is also helpful for finding a lost point. The prerequisite for using the Stake point method is that there must be a pre-existing coordinate, for the point you are shooting to, in the coordinate file. The stake point method calculates a new measured coordinate verses a coordinate stored in the file (control coordinate) and provides the accumulated errors that have propagated throughout survey. These errors can come from several sources, including previous survey errors, when a BM or CP has been compromised (moved), or the current survey errors. Deciphering where the error lies can be difficult (see Section 5.4 for troubleshooting tips), but knowing there is an error empowers the crew to make good decisions to begin reducing errors. Example 1 is for a backsight check and for a check to a pre-existing BM or CP that has been located. Example 2 is for locating a lost BM or CP.

For stake point to commence a setup must have already been completed. For TS setup procedures refer to 2.2 Revisit Site setup.

2. On the TS using windows CE upload the Champ15Codes.xml to the location below:



3. On the TS using windows CE upload the Champ15Config.xml to the location below:



4. Disconnect the data cable from the TS.

2.9 Configurations and Settings

The information provided here describes how to set and install the configurations and settings to be used by CHaMP crews for a Topcon DS-205 total station using Magnet version 2.5.1 software.

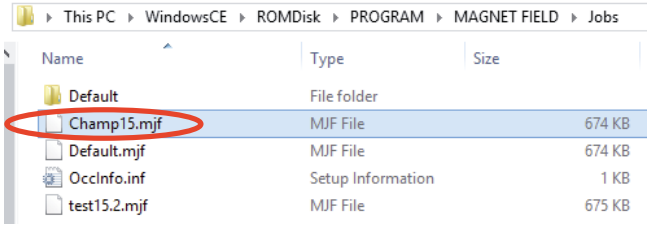
The configuration process need be done only one time and then each survey can be conducted by simply starting a New Job. The configuration set up is a three part process that consists of installing three files in three locations on the total station memory and then setting file paths in Magnet.

The files required are:

1. Champ15.mjf. A job file.
2. Champ15Config.xml Menu configuration file.
3. Champ15Codes.xml The code library.

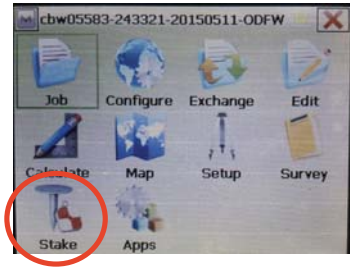
Part 1. Set .mjf example file:

1. On the TS using windows CE upload the Champ15.mjf to the location below:

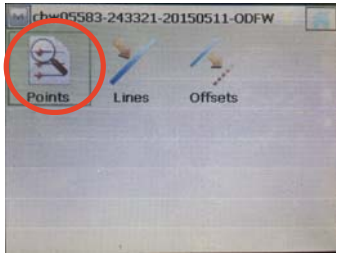


Example 1: Check to a located BM or CP.

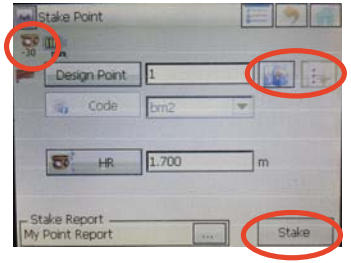
1. In this scenario the crew has traversed along the stream and has determined there is line of sight through the vegetation to a benchmark. The Stake point procedure is used to check the condition of the current survey relative to the coordinate for the benchmark to be staked. From the main menu select stake:



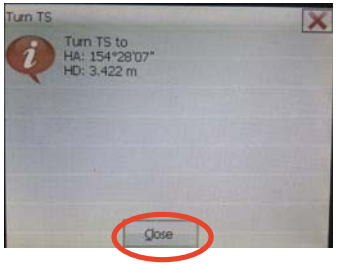
2. Select Points



3. Design Point field: select the point to be checked to, use either choose from map or from list to do so. Enter the rod height (HR) and check that prism constant in upper left is at -30mm. Select Stake.

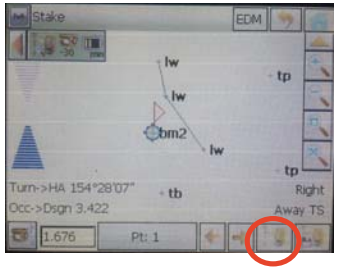


4. If the window below appears, select Close.

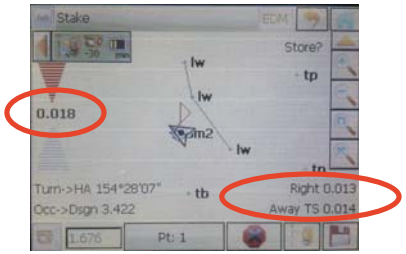


Four different views are available to display Stake information/results. To change the view, select M, View in upper left of screen. This is the Map view.

5. From the Stake window, aim TS near prism and select precise measure, the Instrument will search for the prism and measure:



6. The instrument will calculate and display the differences in coordinates between the design point selected and the currently measured location. In this case the difference is away 0.014 meters, right 0.013 meters and a vertical difference of .018 meters.

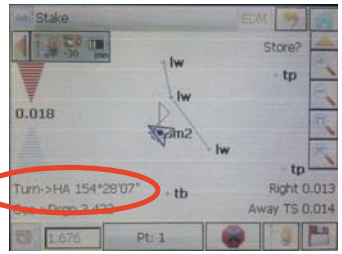


7. These values must be compared to Champ MAE. Champ Protocol gives a horizontal and vertical error.

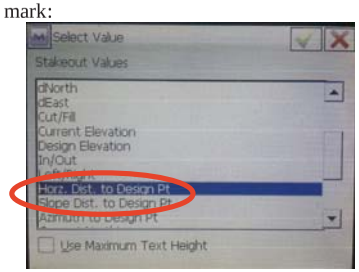
Maximum Acceptable Errors

Revisit survey H= <0.05m and V= <0.03m

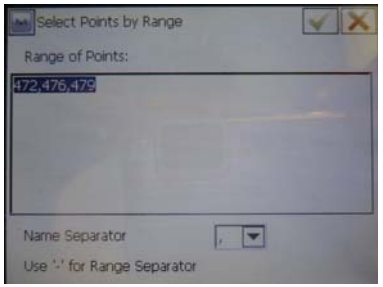
8. If there is no horizontal error display on the Stake window, with the stylus tap in the area of the screen indicated below.



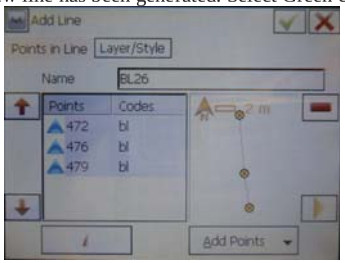
9. The Select Value window will offer viewing options. Select Horz. Dist. To Design Pt. Then select the green check mark:



49. In this example the select By Range method is used and a list of point numbers is input. Select Green check mark.

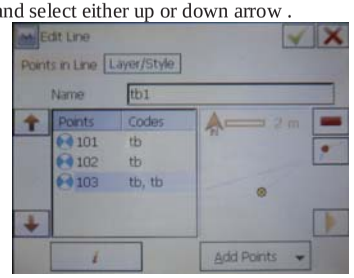


50. As displayed below a new line has been generated. Select Green check mark to confirm.

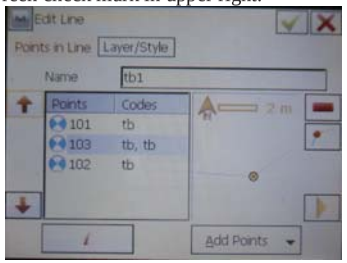


"Add Line" tool is used when crew failed to start a line when collecting points in the field.

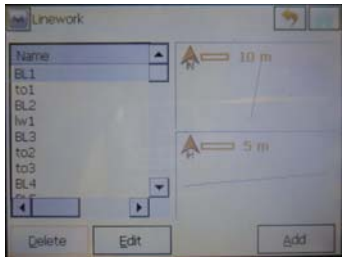
44. After points have been selected using one of the "Find" options they will be added to the end of the line. In example below point 103 has been added to the end of specified line. If you want to move the point to different location on line highlight point and select either up or down arrow .



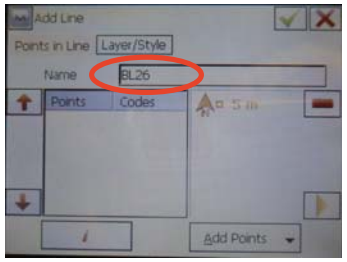
45. As you can see below point has been moved to different position on line. After desired edits to line have been made select Green check mark in upper right.



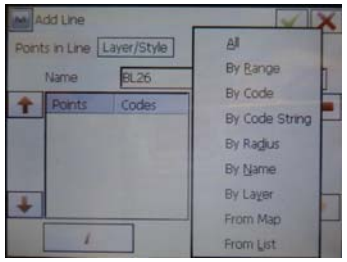
46. Another option from Linework window is to add a line. Select "Add" to open Add line window.



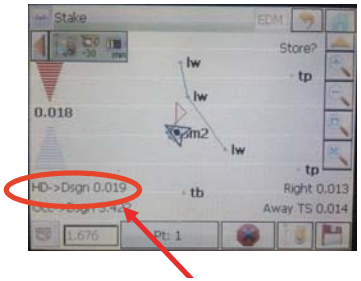
47. Input name of new line. Ensure that name does not conflict with other lines.



48. Select Add Points to begin generating the line. Choose a selection tool and designate the points you wish to form the line.

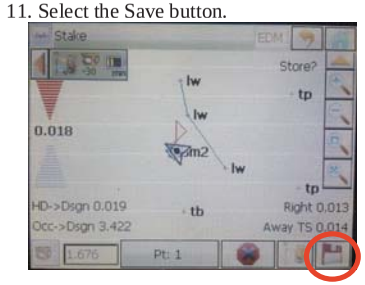


10. The value displayed is the horizontal error.

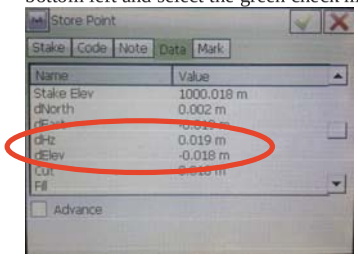


Horizontal Error

11. Select the Save button.



12. The Stake report will be displayed. Once again review the horizontal (dHz) and vertical (dElev) errors. Uncheck Advance at bottom left and select the green check mark:



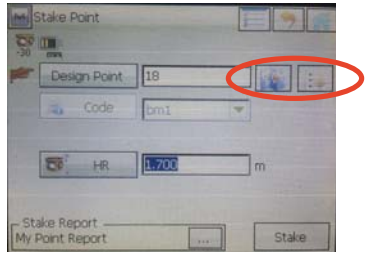
The found benchmark has been evaluated and meets the CHaMP protocol error tolerance standards.

Example 2: Finding a lost point.

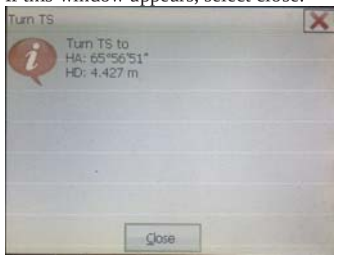
If you know the general location of a point, use the magnetic locator to search the area. The TS can be used to find the location of a stored coordinate for a point that cannot be found easily in the field.

1. Navigate to the Stake point window from the Home screen, select Points.

2. In this example we are searching for point #18 (bm1). In the Stake Point window select the point to be located using select From List or From Map options, enter the rod height and check the prism constant, then select Stake.



3. If this window appears, select close:

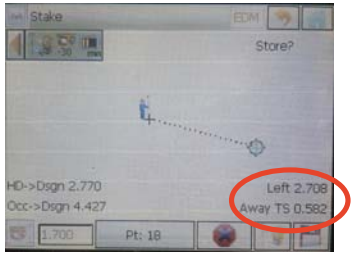


4. The Stake window will open:

Other views are available to display Stake window by selecting M, View. This is the Overhead view.

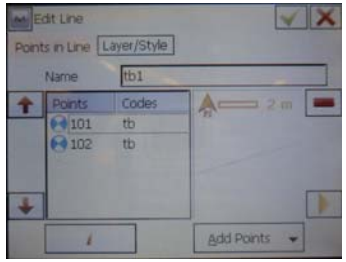
5. Send the rodman to the general area where the lost point is located. Aim the TS near the prism and select Precise:

6. The results are displayed. The TS provides directions to the lost point. Tell the rodman to move roughly the distances displayed. Move away from TS 0.58 m and left of TS 2.7 m.

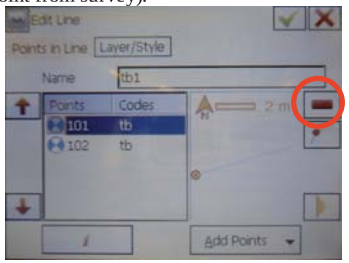


7. Now Measure again and direct the rodman. Tell the rodman to move roughly the distances displayed. Move away 0.86m and right of TS 0.126m

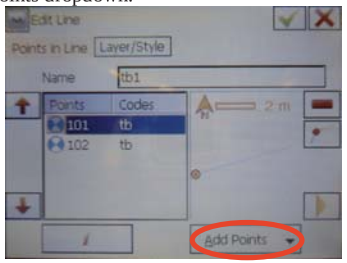
40. The Edit Line window displays all points associated with the line:



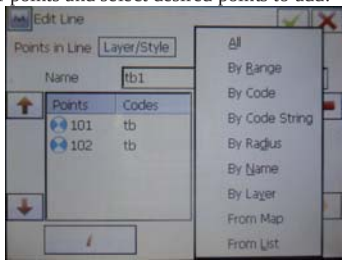
41. Remove a point from a line by highlighting the desired point and selecting the remove button as circled below. (Note: removing point from line does not delete point from survey).



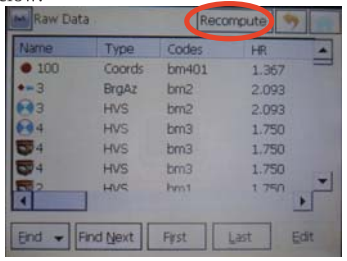
42. To add points to the line select the Add Points dropdown.



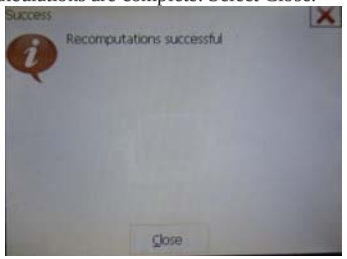
43. There are various ways to select points to add to line. The "By range" option allows you to select multiple points by inputting point numbers associated with desired points separated by commas, as shown in edit point procedure above. All specified points will be added to the line. Selecting points to add "By code" is less likely to fit your editing needs. It allows you to designate a code and adds all points with that code to the line. We will not use "By Code String" or "By Radius". By Name allows you to input a specific point number and it will add that point to line. "By Layer" will not be used. Selecting "From Map" allows you to manually select points to add from map view by tapping desired point. "From List" allows you to scroll through sequential list of points and select desired points to add.



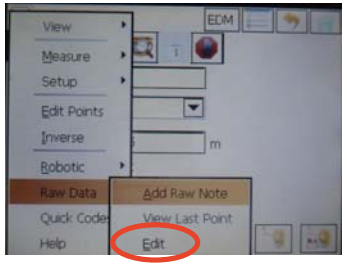
34. After all desired Adjustments have been carried in the Raw Data window select the Recompute button in upper right as shown below.



35. The next window confirms that calculations are complete. Select Close.



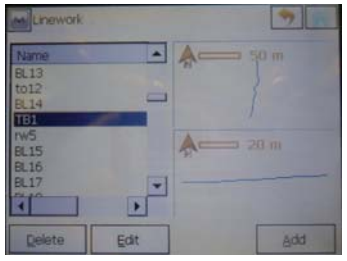
36. The Raw Data window can also be accessed from Sideshot-Direct window by selecting M button, select Raw Data, select Edit:



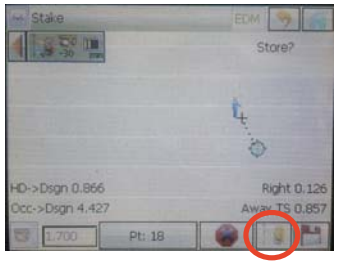
37. Now we will explore line editing capabilities of MAGNET software. From home Menu select Edit, select Linework. The "Linework" window contains a list of all lines created during survey:

38. To delete a line use scroll bar to find the desired line, highlight the line and select Delete button. Confirm delete by selecting Yes in pop up window.

39. To edit a specific line select line from list and select Edit.



8. Measure again and if necessary tell the rodman where to move. The rodman should be looking for the lost point and digging around in the vegetation or in the ground. Tell the rodman where to look: BINGO! When the control point is located level the rod on the point and aim TS near prism then select Precise measure:



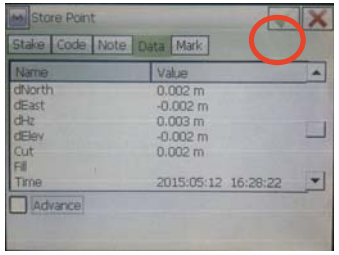
9. With the rod centered and leveled on the control point the measured results are now the error between the original and the new survey coordinates. Determine whether these values are within Champ MAE:

If the values are not within MAE refer to the Benchmark Dichotomous key.

Maximum Acceptable Errors

Revisit survey H= <0.05m and V= <0.03m

10. Save the results by selecting the save button circled above. Check the results again uncheck Advance at bottom and select the green check mark:



The point that crew was unable to locate with the magnetic locater was found using the stored coordinate and the total station. The error values were examined and determined to be acceptable

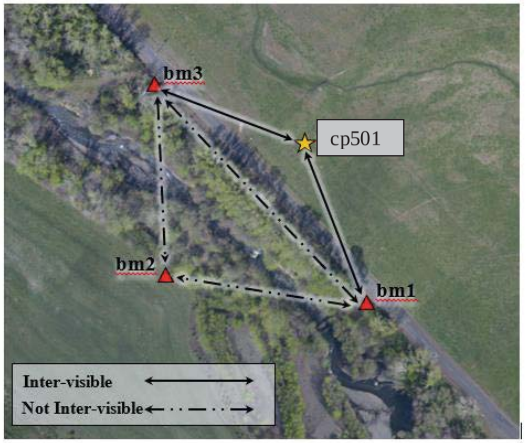
2.4 Resection Procedure

Reference: Section 5.2, Columbia Habitat Monitoring Program protocol

A resection is only performed at revisits when there are no inter-visible benchmarks. It is always preferable to set up the instrument over a known point (benchmark) and backsight to a known point (benchmark) when performing a station setup at revisit sites (Section 2.2). If this cannot be done, use the Resection procedure.

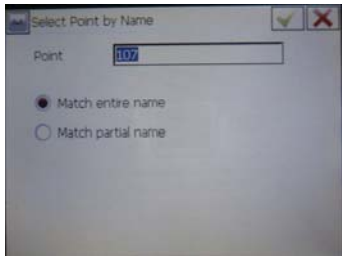
To set up a total station and record points in a given coordinate system, the instrument first needs to be positioned and oriented. Resectioning is a process that allows the instrument to calculate a coordinate for its position based on triangulation between two or more points (benchmarks or control points) with known coordinates. A resection works best when the geometry of the known points relative to the total station are well distributed in space surrounding the instrument (i.e., not clustered in same quadrant), and well distributed over the area you wish to survey.

In the example below, point cp501 will be the new point of occupation and the resection will utilize bm1 and bm3. Bm2 was set in a field and was subsequently destroyed by a tractor. Use all available benchmarks or control to conduct a resection. Three or more points allow for a more robust calculation and analysis of the new point of occupation coordinate. A minimum of two known points are needed to conduct a resection.

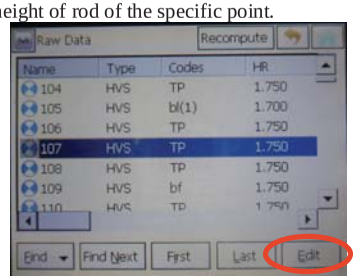


Before Beginning: Total Station configurations and setting should be completed before proceeding with the Resection, see section 2.9.

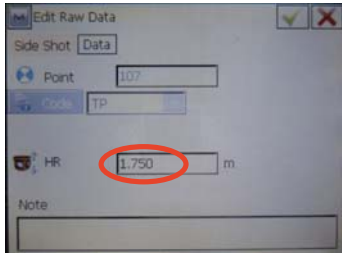
29. Input the point number associated with the point you wish to find and select green check mark.



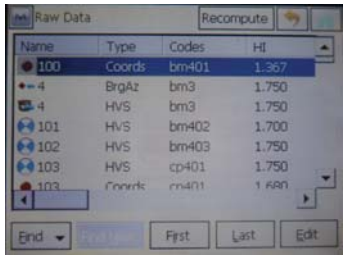
30. Tool has found and selected the specified point. Select Edit to adjust the height of rod of the specific point.



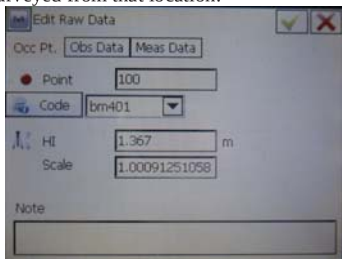
31. Only the HR field is editable for points that are not Occupied or Backsight points. To adjust the height of rod, input new height of rod into the HR field. Select green check mark.



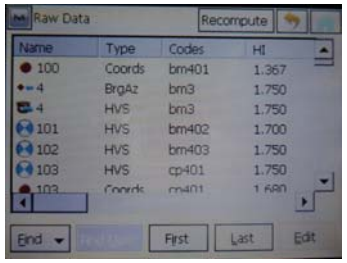
32. In the "Raw Data" window we will explore the options when editing Occupy or Backsight points. To identify occupy and backsight points, look at "Type" column. These points are identified as "Coords" and "BrgAz" respectively. They also have unique name icons. Select an occupy point and select edit.



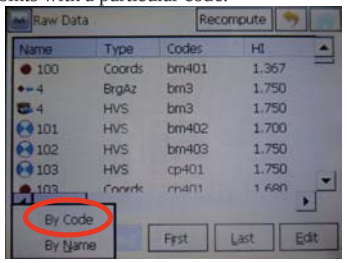
33. Occupy and backsight points allow more editing options like the codes and point number. Adjusting the height of instrument (HI) for occupy point will affect all points surveyed from that location.



24. The "Raw Data" window displays all data associated with each point in the survey. Similar to the "Edit Point" window, you can either scroll to select desired points or use the "Find" options. The "First" and "Last" buttons jump to first point or last point.

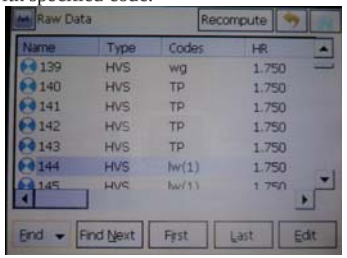


25. In "Raw Data" window there are only two find options (seen below);"By Code" and "By Name". Select By Code to find points with a particular code.

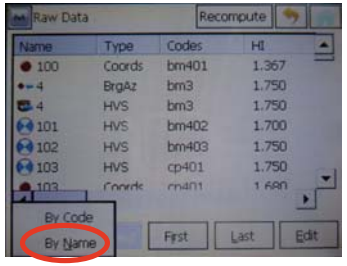


26. Next, use the drop down next to Code field and select desired code. Select green check mark.

27. Tool will select first point with that code in point sequence. In this example the input was "lw" Select find next to go to next point with specified code.

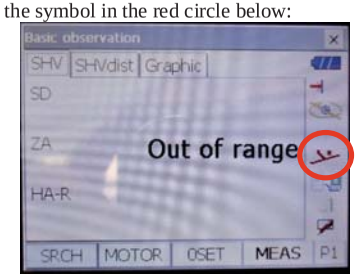


28. Explore the "By Name" find option. From Find options select By Name.



1. Turn on and level instrument.
Turn on the Instrument by pushing the green power button on the upper right of the dashboard:

2. Upon startup the actual screen displayed will vary. To open the level screen, select the symbol in the red circle below:

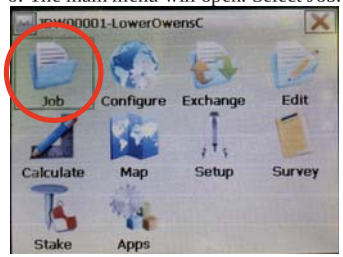


3. The Tilt screen opens and displays the electronic level bubble. Level the instrument.

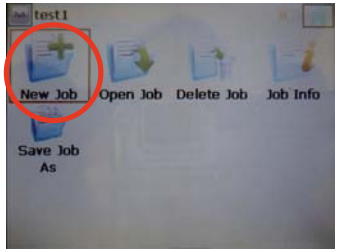
4. Select the program (PRG) button.

5. Start a new survey. From the Program screen select MAGNET Field:

6. The main menu will open. Select Job.

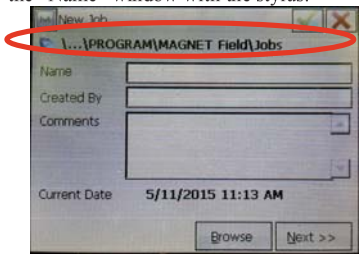


7. Then select New Job:

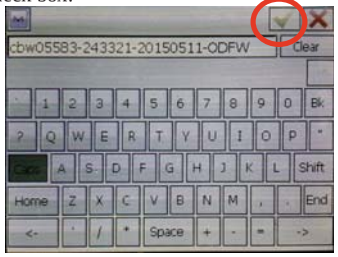


8. The New Job screen will open. Note that the location where the job will be stored is displayed. Keep this set to "\...\PROGRAM\MAGNET Field\Jobs". If file path does not match use Browse button to navigate to correct folder.

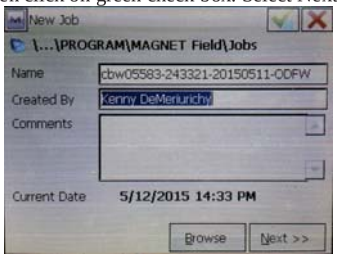
Enter a name for the new job, by tapping in the "Name" window with the stylus:



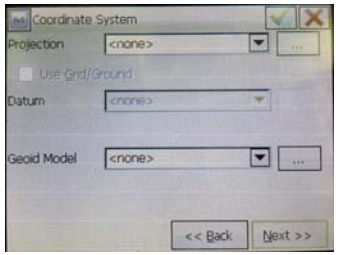
9. The keyboard will open. Name the job using the following naming convention: **SiteID-Date-Organization** (e.g., **CBW05583-007395-20150710-ODFW**). When finished, click on the green check box.



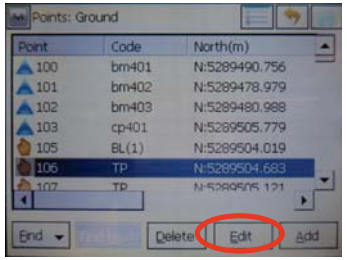
10. In the Created by field put your name, then click on green check box. Select Next.



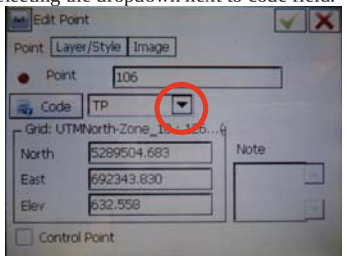
11. In the Coordinates System screen, choose the selections indicated below. Select Next.



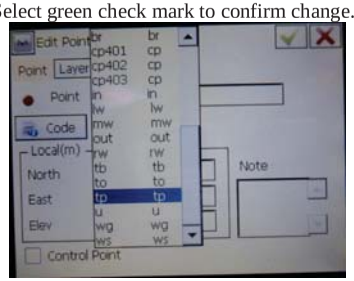
20. To edit a point, highlight desired point and select Edit.



21. The Edit Point window displays the point number, code, and coordinates of selected point. The code can be changed by selecting the dropdown next to code field.

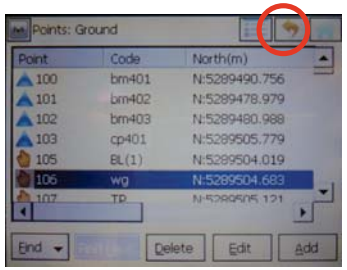


22. A list of CHaMP codes will be displayed. Scroll and select desired code. Select green check mark to confirm change.



Be very careful when editing Raw data, there is no undo and there is no way to recover the original measurement information!

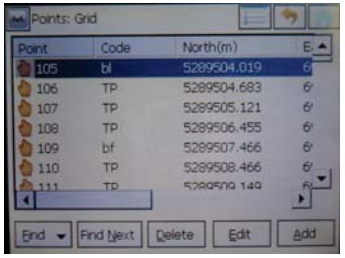
23. Next we will learn to edit the Height of rod information associated with the survey points. Navigate to the "Raw Data" window. From "Edit point" window select return button.



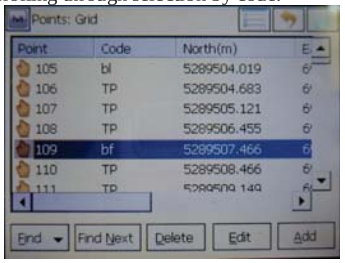
From next window select Raw Data.

Be very careful when editing Raw data, there is no undo and there is no way to recover the original measurement information!

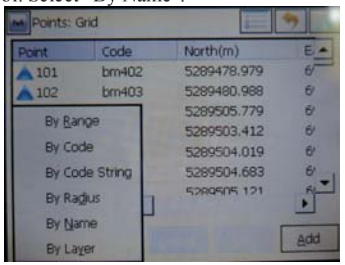
14. In the next window the first point in number sequence with one of the selected codes has been highlighted. Select Find Next to highlight next point with one of the selected codes.



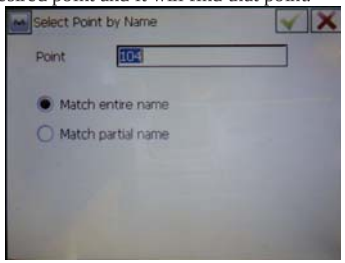
15. Continue selecting Find Next to continue scrolling through selection by code.



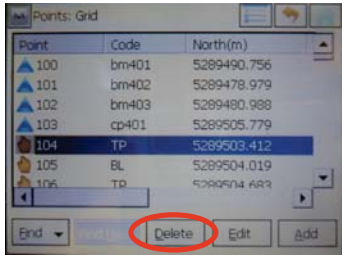
16. Now we will explore another selection tool. Select "By Name".



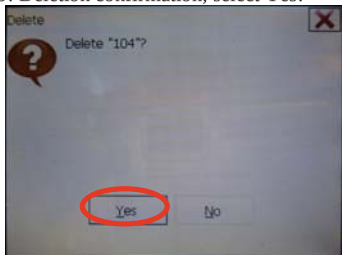
17. In the "Select Point by Name" window there are two options. Match entire name allows you to input the point number of desired point and it will find that point.



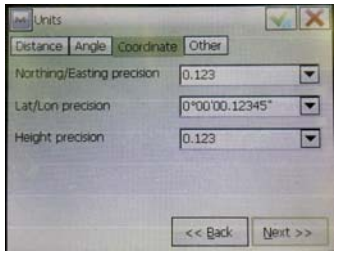
18. Now that we have explored the tools associated with selecting points we will explore the editing capabilities. A point can be deleted by highlighting and then selecting Delete:



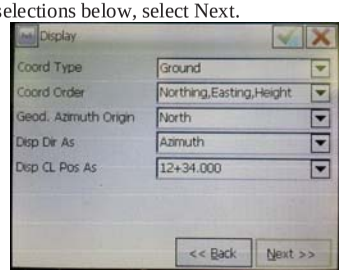
19. Deletion confirmation; select Yes.



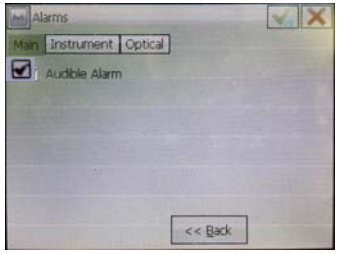
12. In the Units window under the Coordinate tab, choose the selections below. Select Next.



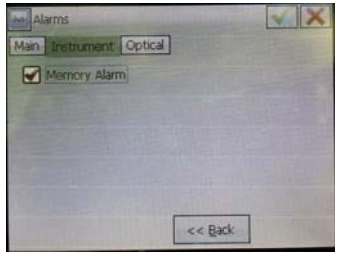
13. In the Display window, choose the selections below, select Next.



14. In the Alarms window; in the Main tab select Audible Alarm:

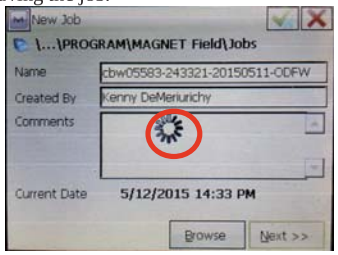


15. In the Instrument tab check Memory Alarm:



16. In the Optical tab uncheck Grid/Ground Warning (see below). When settings have been checked, select the green check box:

17. The symbol on the screen below indicates the instrument is processing and saving the job.



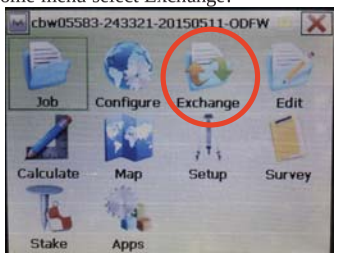
18. The job is saved and the main menu is displayed. Note that the name of the current job file is in the upper part of window.

To conduct a resection for the revisit survey the previously established coordinate system must be re-occupied. This can be accomplished by importing the control coordinates and survey extent from the previous survey.

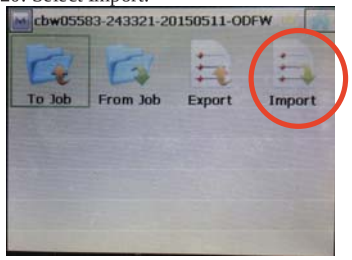
The imports for a Revisit survey need to be down loaded from the CHaMP website (www.champmonitoring.org). Files needed include:

1) Control*.txt
2) SurveyExtent*.dxf.

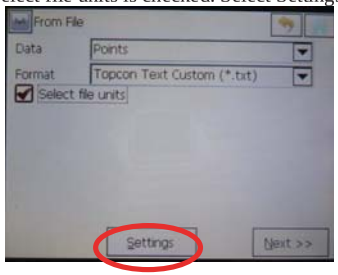
19. The points that will be imported are the benchmarks from the previous survey. To import point data in a txt file. From the home menu select Exchange:



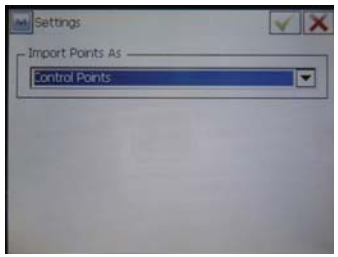
20. Select Import.



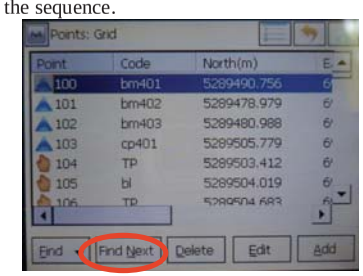
21. Populate the fields as below and ensure Select file units is checked. Select Settings.



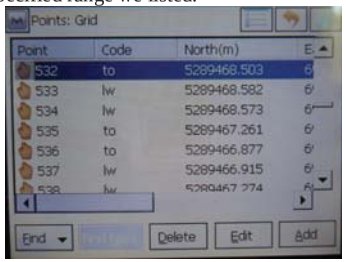
22. In the Settings window under Import Points As, select Control Points. Select the green check mark:



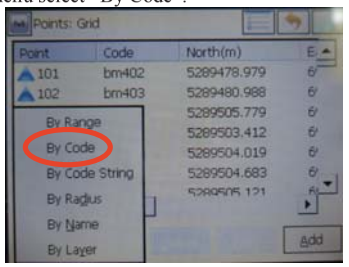
9. As seen below, the tool has found and selected the point associated with the first number in the range we inputted. Select "Find Next" to find and select next point in the sequence.



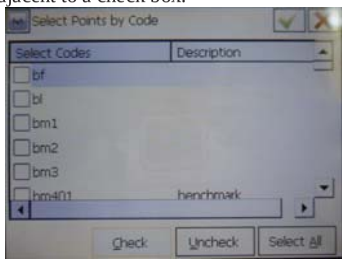
10. In the figure below, the tool has selected the next point in the specified range. The "Find Next" option is no longer available because we have cycled through the entire specified range we listed.



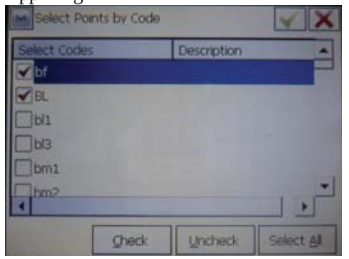
11. Next we will explore some other options of selecting points. Select Find and from menu select "By Code".



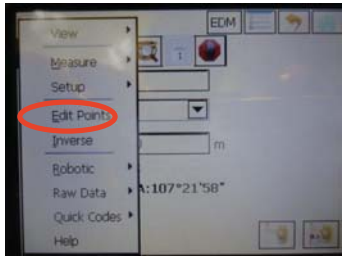
12. The select By Code option is used to select points with the desired code. The window displays the codes used in survey adjacent to a check box.



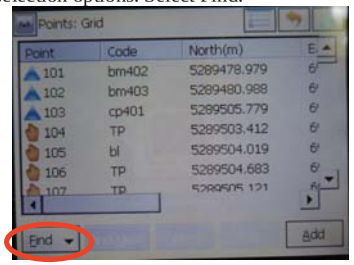
13. Select the boxes next to the code(s) you desire to find. Then select Green check mark in upper right corner.



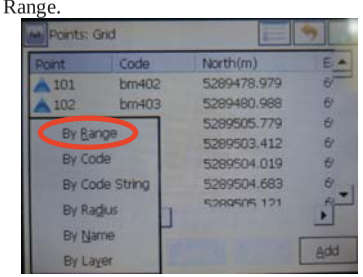
5. Select Edit Points:



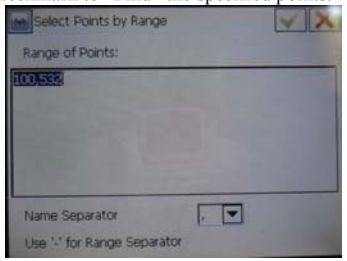
6. In the Edit Points window the coordinates and code of each point is displayed. From this window you can scroll and select any point that needs editing or use the "Find" options. Now we will explore the point selection options. Select Find.



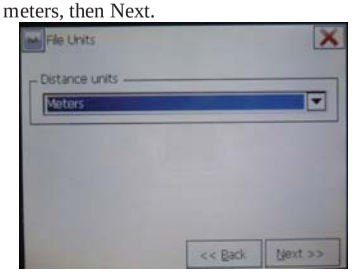
7. The "Find" drop down menu provides an assortment of tools that can help locate a particular point or multiple points within survey data. First we will explore the utility of selecting points "By Range". Select By Range.



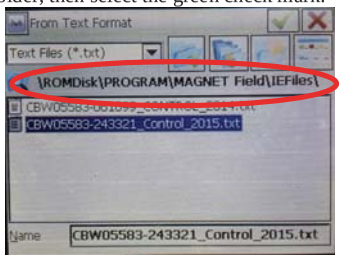
8. The "Range of Points" box allows you to input the point numbers associated with the points you wish to find, separated by commas as shown below. Select Green checkmark to "Find" the specified points.



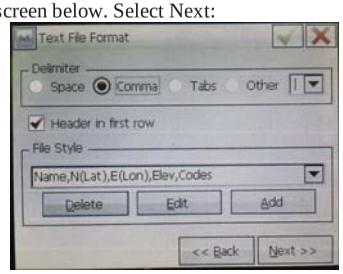
23. In the Distance Units window select meters, then Next.



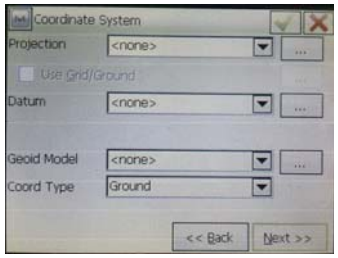
24. Browse to and select the control.txt file for designated site located in the IEFiles folder, then select the green check mark:



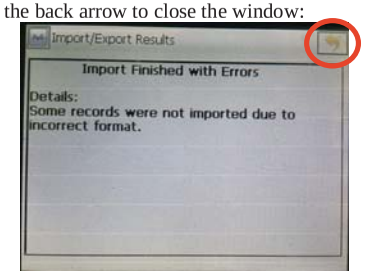
25. The Text File Format settings are very important. Check to see that they match the screen below. Select Next:



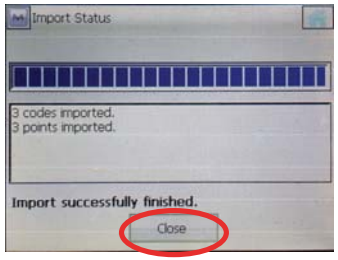
26. Select the coordinate settings as below, then select Next:



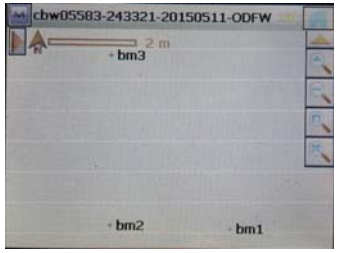
27. If you get the following warning, select the back arrow to close the window:



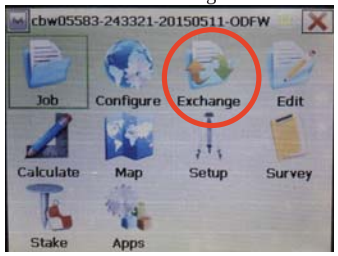
28. The Import Status is displayed. Select Close:



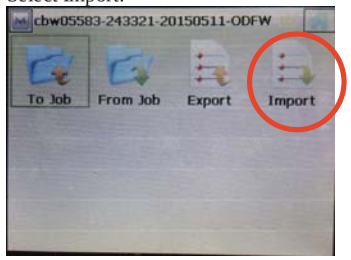
29. Go to the Map by selecting home button in upper right and then Map from home menu. The map displays all the imported points:



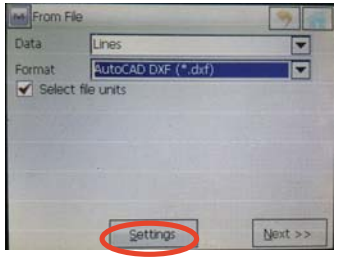
30. Import survey extent. Now that the previous survey control points are in the Job file, add the previous survey extent. To import the Survey Extent dxf, from the home menu select Exchange:



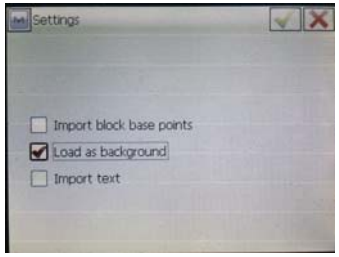
31. Select Import:



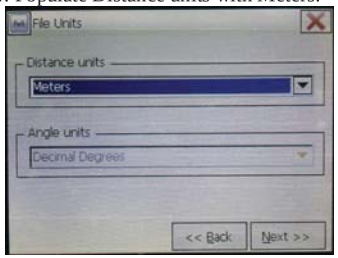
32. Populate the fields as shown below. The check box for Select file units is very important. Then select the Settings button:



33. Select the check boxes as below, then select the green check mark, then select next:



34. Populate Distance units with Meters:



2.8 Editing Point and Line Data

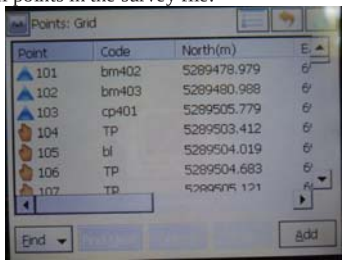
The primary objective of the edit point and line procedures is to make adjustments in the field to survey errors in order to ensure clean CHaMP surveys. Features in the program used for editing include:

- The "Edit Point" window to delete errant points and change the code of points.
- The "Raw Data" window to adjust height of rod (HR) values for individual topographic points.
- The "Linework" window to delete errant lines, remove and add points to lines, and move location of points on lines.

1. Access the edit point features from Home menu or from the "Sideshot_Direct" window. To begin, lets access Edit points from Home menu. Select Edit:

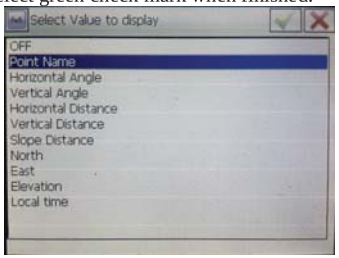
2. Select Points:

3. The following window displays a list of all points in the survey file.

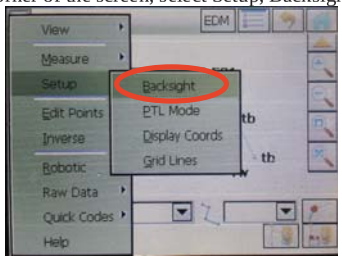


4. Before exploring the edit options lets navigate to edit point window from the Sideshot-Direct window. From the Sideshot-Direct window, select M button in upper left corner.

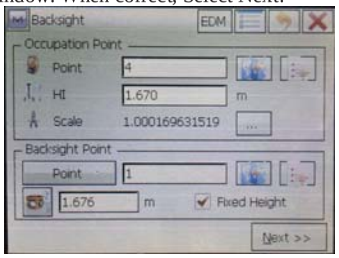
4. With the stylus tap on Point 18 or the grey box. There is a multitude of information that can be displayed. Choose wisely, as the Map screen can get very busy with this information, quick codes, points and lines. Select green check mark when finished.



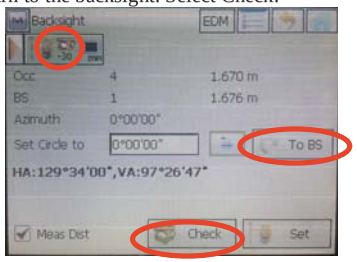
5. Champ protocol requires that as the survey progresses, the backsight must be checked every 50 to 100 points. To check the backsight, select the M in the upper left corner of the screen, select Setup, Backsight:



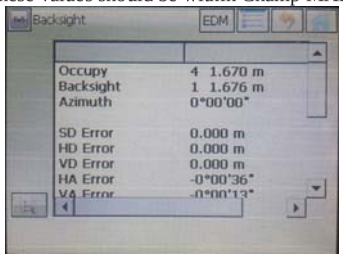
6. Verify the information in the Backsight window. When correct, Select Next:



7. In this window verify the -30 prism constant is set, select To BS. The TS should turn to the backsight. Select Check.



8. The backsight report is displayed. Check the values for HD Error and VD Error. These values should be within Champ MAE.

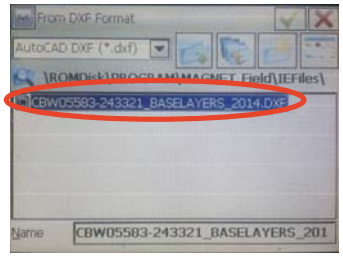


Maximum Acceptable Errors
Initial survey
H= <0.03m and V= <0.015m
Revisit survey
H= <0.05m and V= <0.03m

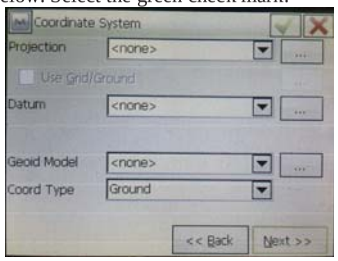
If the MAE is not within Vertical tolerance check the height of the instrument and the height of the rod, center and level the instrument, and recheck.

If the MAE is not within Horizontal tolerance, center and level the instrument and BS setup, reset the BS with the Set button, and re-evaluate the errors. Record all error values in the field notebook.

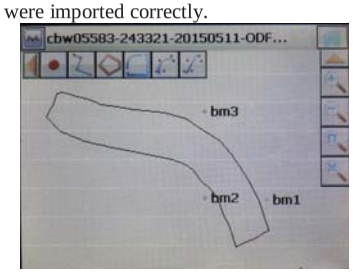
35. Browse to and select the Survey Extent dxf for designated site, select green check mark.



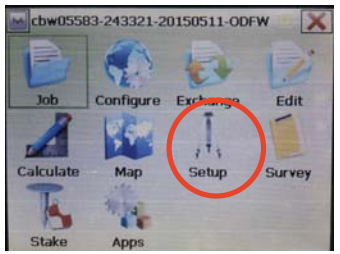
36. Use the Coordinate System settings below. Select the green check mark.



37. Go to the Map and confirm that the survey control network and survey extent were imported correctly.

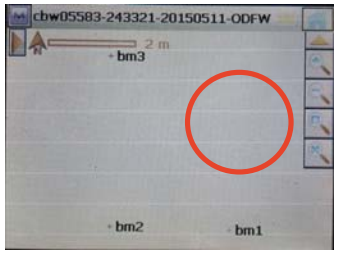


38. Now that the points and survey extent have been imported the reoccupation of the previous coordinate system can begin. Go to the Home Screen in the Home screen, Select Setup:

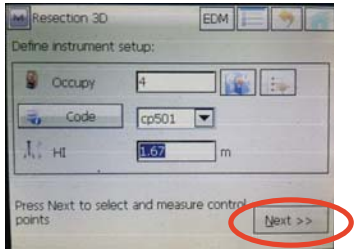


39. Select Resection:

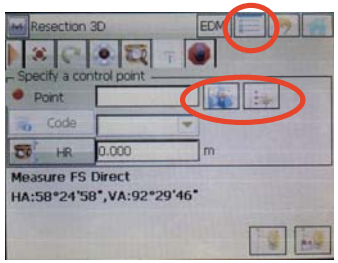
Conducting a resection creates a coordinate for a new point. The new point being created will be somewhere inside the red circle:



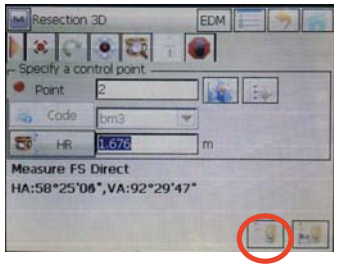
40. This is the Resection 3D window. Enter the identifier information for the new point being created, which includes the point number, Code (bm# or cp#) and height of instrument. Select Next:



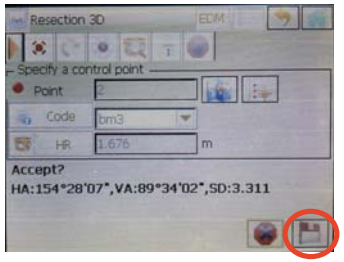
41. The first point measured in the resection should be the point that is furthest from your current location. Before proceeding check Prism constant and confirm Auto-target is on by checking the settings at top right of screen. Use the Map button or the select from list button to select the first point to be used in the resection, and enter the HR.



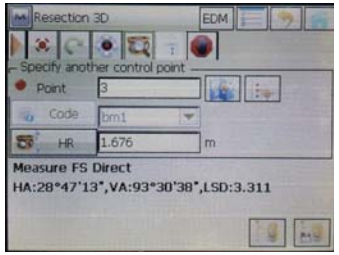
42. Once the point information is correct aim the TS at prism over selected point, then select the Precise measure button:



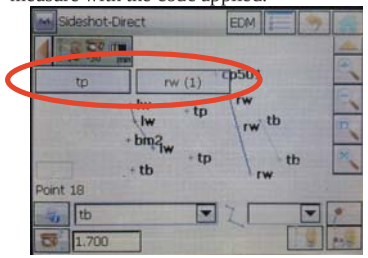
43. Next select save button circled below.



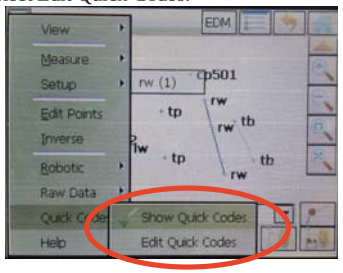
44. Select the second point to be measured for the resection calculation and input the correct HR. Aim the TS, then select the Precise measure button. Once shot is measured select Save button.



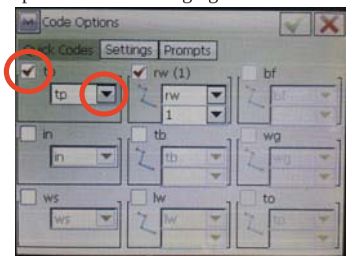
Quick Codes: Observe these buttons. These are Quick Codes. They are very efficient for point collection. Simply tap the button to measure with the code applied.



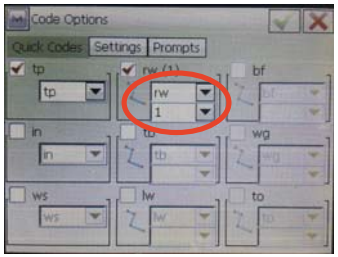
1. To set up quick codes, select the M button, select Show Quick Codes, and then select Edit Quick Codes.



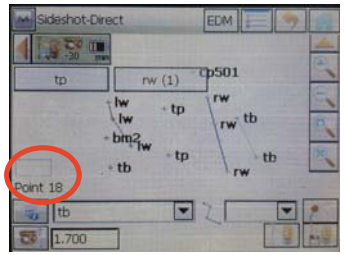
2. The check boxes below turn on the quick code buttons in the map screen while the dropdown allows changing of the code.



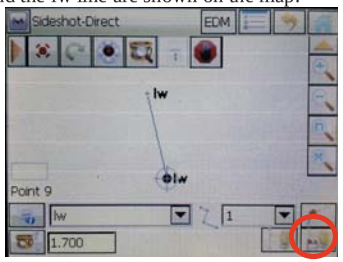
Line codes have a corresponding field to differentiate lines through numbers or other designations as circled below. Select green check mark when finished.



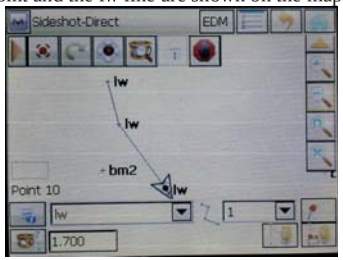
3. In the Map window there is one more thing to explore: Notice the grey box and the Point 18.



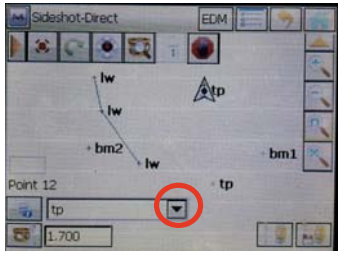
4. To measure the next point in the line, select the Rapid button: The second point and the lw line are shown on the map.



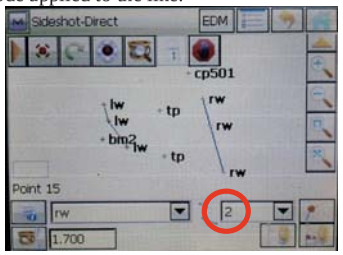
5. To measure the next point in the line, select the Rapid button again. The third point and the lw line are shown on the map.



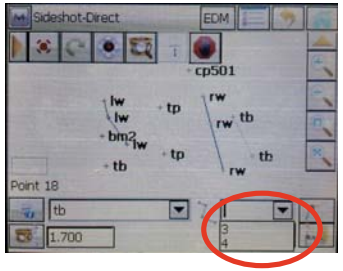
6. To collect point data select the desired code with the drop down arrow and select Rapid. Remember always check the Height of Rod in the bottom left of the screen!



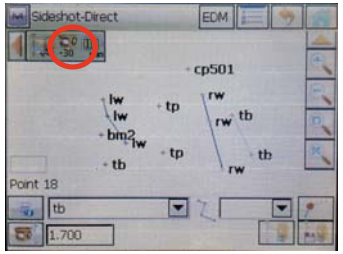
7. In this view the crew has surveyed lw, rw and some tp data. It is suggested that the line numbers are incremented regardless of the code applied to the line:



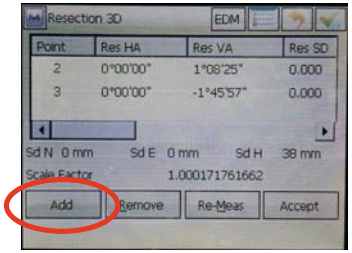
8. Top of bank (tb) lines, 3 and 4 are being surveyed simultaneously by changing the line number.



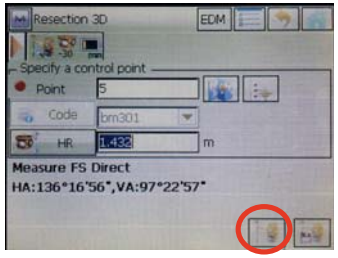
9. The crew is running two tb lines at the same time, line 3 and line 4. Note the -30 prism constant is correct:



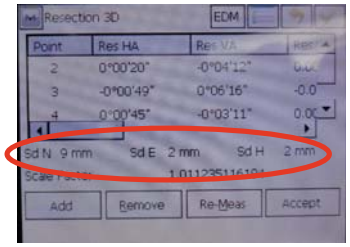
45. The resection report will be displayed. If there are other benchmarks visible, select Add to include them in the resection calculation:



46. Select the third point to be used in the resection and input correct HR. Select Precise measure button:



47. The resection report will be displayed. To include another point in the resection calculation select Add. If all the bms available have been surveyed review the displayed Standard deviations Sd N, Sd E and Sd H. If these values are within MAE, select Accept.



How to determine horizontal (H) or vertical (V) errors from the information provided in the Resection 3D window:

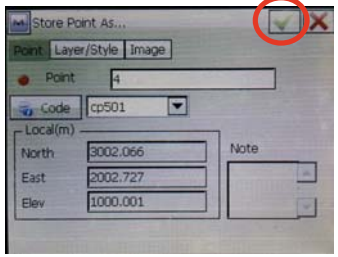
Horizontal error = $\sqrt{SdN^2 + SdE^2}$

Vertical Error =Sd H

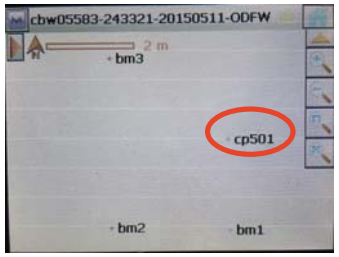
Maximum Acceptable Errors

Resection H= <0.07m and V= <0.05m

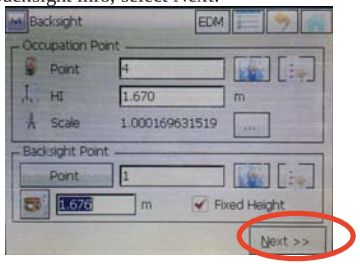
48. In this window there is an opportunity to change the code or point number. The Calculated coordinates are displayed. Select the green check mark:



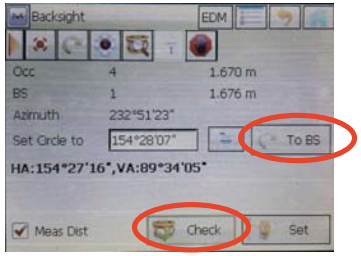
49. Go to the map and have a look at the results. Does the calculated point look spatially correct?



50. Check the Backsight. Always use the first point of the resection for the Backsight. Go to the Main menu, Select Survey, Select Topo, Select M, select Setup, select backsight, Check the Backsight info, select Next:



Select the To BS button. TS should turn to BS location, aim the TS near the prism and select Check:



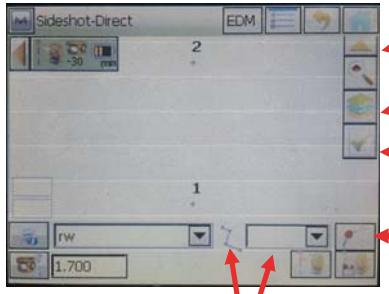
Maximum Acceptable Errors

Revisit H= <0.05m and V= <0.03m

If the values are acceptable, select the Home button. If error values are unacceptable utilize the Benchmark Dichotomous Key.

The existing site coordinate system has been re-occupied. You may set more benchmarks to meet visibility requirements or begin topographic data collection.

Map view continued…



Arrow changes the options in toolbar

Map Layers

Map Properties

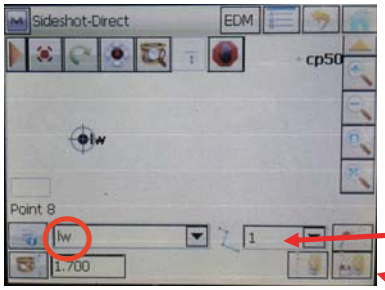
Line-work options

A Line code (rw) is selected: Note the line symbol and number drop down

Map Properties window allows user to display information regarding the topographic points in survey. Useful information available includes point Code and Name (Number).

Enough of that! Let's collect some topo in the map view.
Each line segment is assigned a number. The line begins when a number is assigned and the line ends when use of the number is stopped.

3. Begin a left wetted line by selecting lw in the code dropdown and enter a number in the line # field. Each unique line segment must have a unique line number. Check the prism constant in upper left toolbar using toggle arrow. Check the HR setting for every measurement. Press the Rapid measurement button: The first lw point is shown in the map.



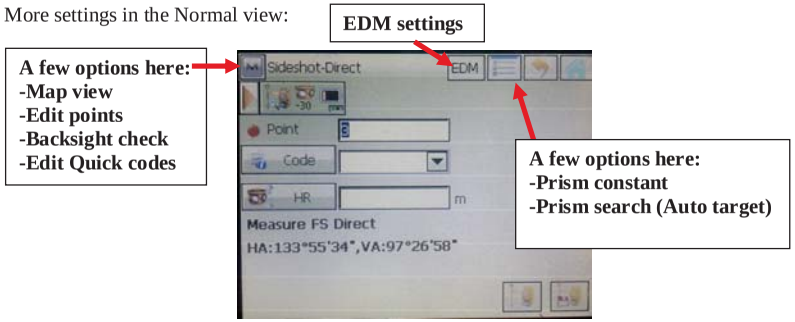
Line Numbers: Magnet and the Champ toolbar will accept any reasonable number or letter in the line number field. Example: Crews may use code tb and line number r1 to survey top of bank river right line 1.

Codes: Do not add numbers or letters to the Champ topographic Codes.

Line number

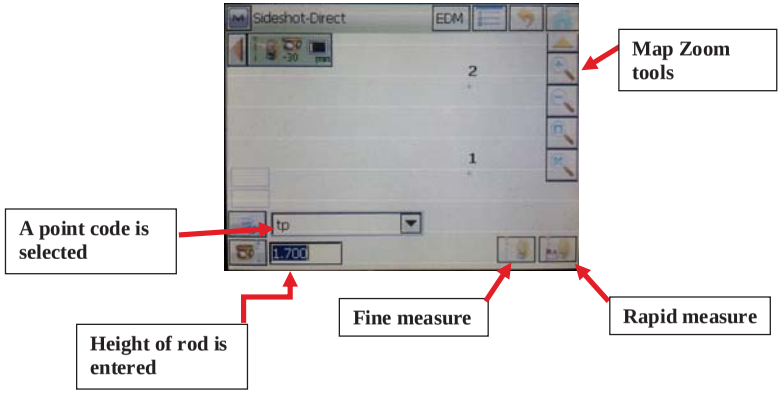
Rapid Measurement button

More settings in the Normal view:



From the Normal view above, Select M in the upper left hand corner. Select View, select Map.

The Map view. Note the points previously surveyed are displayed:



2.5 Traverse Procedures

Reference: Section 5.3, Columbia Habitat Monitoring Program protocol

Equipment: Total station, tape measure, tripod, prism, prism pole, backsight setup (i.e., tribrach with riser/prism adapter, tripod, and prism or bipod, prism, and prism pole), pencils, field notebook.

Objective: The traverse procedures will occur when moving the Total Station setup location. The Traverse mode propagates the coordinate system, remembers important information, and promotes the crew to follow the proper survey methodology. A traverse requires a normal Station Setup with two points (current setup location and backsight), and a new point which is referred to as a Foresight. When traversing, set up a tripod/bipod over the foresight and measure the height of the prism.

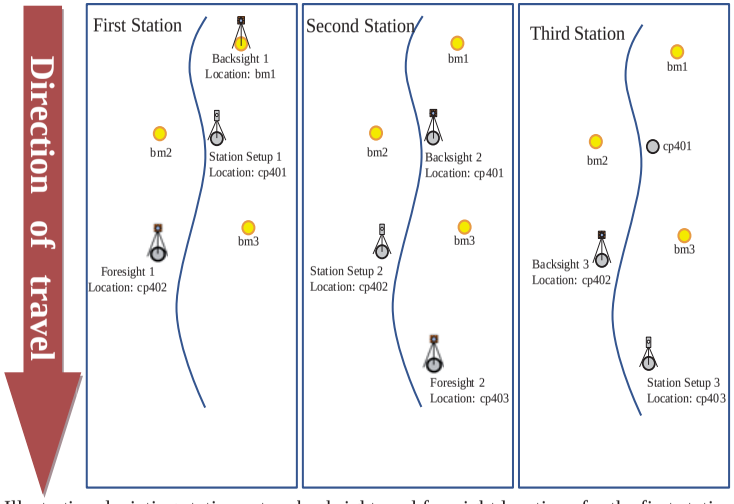
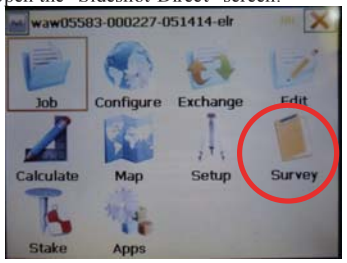


Illustration depicting station setup, backsight, and foresight locations for the first station setup, after traversing to the second station setup, and after traversing to the third station setup.

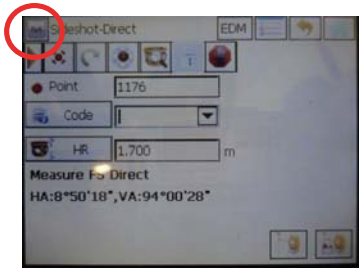
1. Locate an adequate location to move the Total Station (TS) that maximizes both the view of the next section of stream you intend to survey and provides line of sight to as many previous control points (CP)s and benchmarks (BM)s as possible. Install a new Control Point (CP) in selected location (nail and whiskers, rebar and cap. Set up and level Prism with tribrach and tripod over point and record the height of prism in notebook.

2. From Main menu, select Survey. This will open the "Sideshot-Direct" screen.

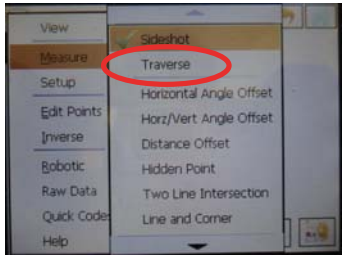


3. Select Topo:

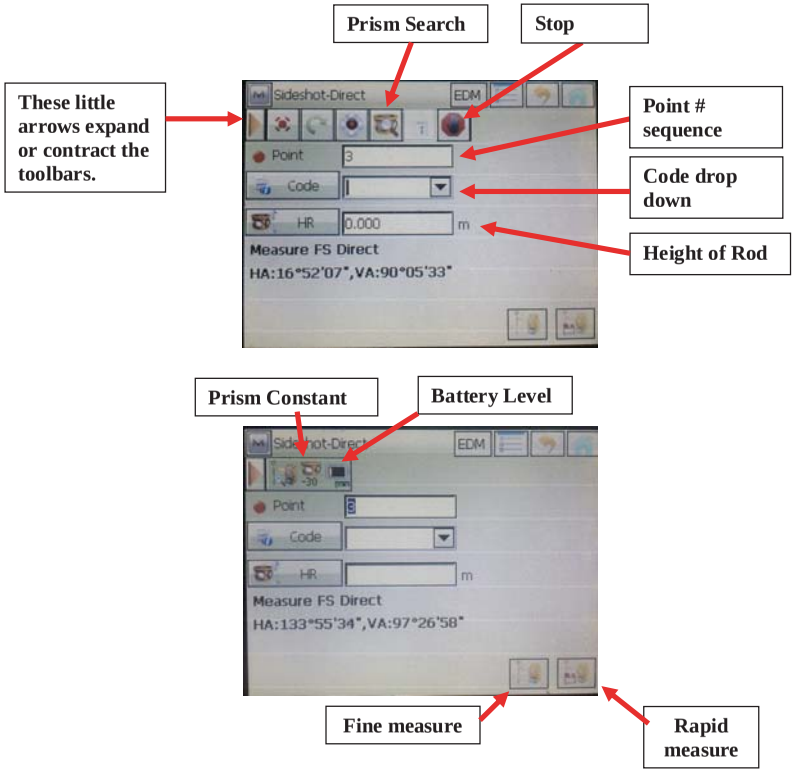
4. In the "Sideshot-Direct" screen, select the M button in upper left corner.



5. From the dropdown, select Measure, Traverse:



Explanation of some of the tools and options available: Collection of topographic data can be done in two windows (views) which have several handy tools and settings available. The "Sideshot-Direct" window, which is the "Normal" view, and the "Quick Shot" view. Collecting points and lines using the "Normal" view is outlined below.

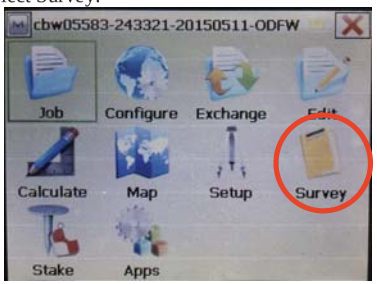


2.7 Collecting Points and Lines

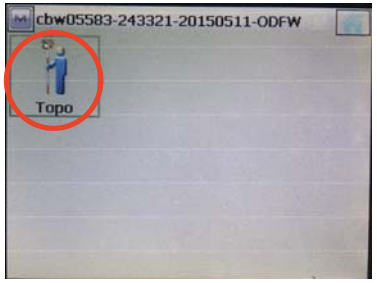
Collect a sufficient amount of topographical points and lines to accurately describe the geomorphic features of the stream. Collecting lines and points in the field allows the observers (the crew) to effectively communicate the field conditions to the office. Collecting line data in the field is superior to drawing lines in the office. Magnet has the capability of collecting many lines simultaneously.

Before beginning to collect topo points the TS should be centered and leveled over a benchmark or control point, a backsight was measured and a coordinate system exists. With the coordinate system established it is now possible to begin topographic surveying.

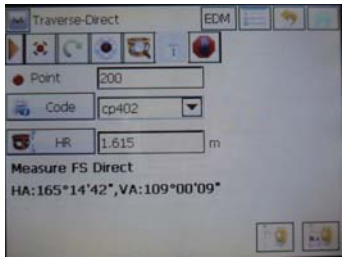
1. From the main menu select Survey:



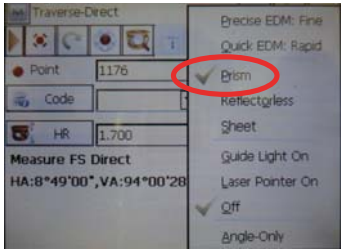
2. Select Topo:



6. In the Traverse-Direct screen input the point number and the code of new CP (Foresight), as well as, the height of Prism (HR) located over the CP. In the example below, cp402 is used as code because it is the second control point established during survey. This is the location you are moving to.

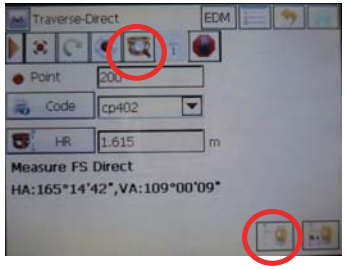


7. Before conducting the traverse, check the EDM settings by selecting the EDM button. Check that Prism is selected:

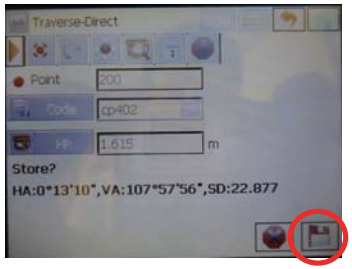


8. Check the EDM mode in Config: Survey Settings.
Precise EDM: Fine, and Quick EDM: Rapid (see below). Select green check mark to return to Traverse-Direct screen.

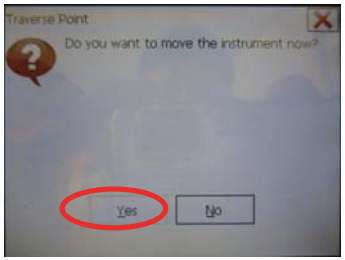
9. Aim TS near the Prism at the next CP (cp402), select search button circled below. TS will perform a search and locate the prism. When TS stops moving it has located the prism. Look through the telescope to verify the TS crosshairs are very near the center of the Prism. The crosshairs may not be positioned perfectly to the center of the Prism. This is normal as the Magnet software has the ability to calculate the exact center of the prism and incorporate the calculation into the coordinate measurement (X pointing technology). When verified, select the Precise EDM button shown below.



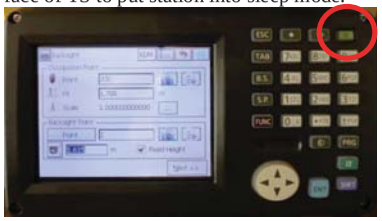
10. Once TS has obtained the coordinate of new point it will ask if you want to store the point. Select Save button.



11. The Traverse Point window will open asking if you want to move now. Select Yes:

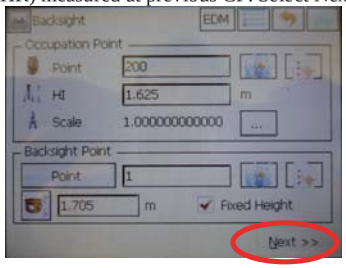


12. Press power button (shown below) on face of TS to put station into sleep mode.



13. Disconnect TS from tribrach and place it in carrying case. Transport TS to new CP. Exchange TS with the prism at the new CP. Once TS and prism have been swapped, turn on TS by pressing the power button. When TS is turned on, the digital level screen should open. Level TS using thumbscrews and make sure TS is centered on new CP with the optical plummet. Exit level screen and return to "Backsight" screen by tapping X in upper right corner. Do the same fine leveling process with Tribrach and prism that is now setup over original CP (the one you just came from). Measure and record heights of both TS and prism.

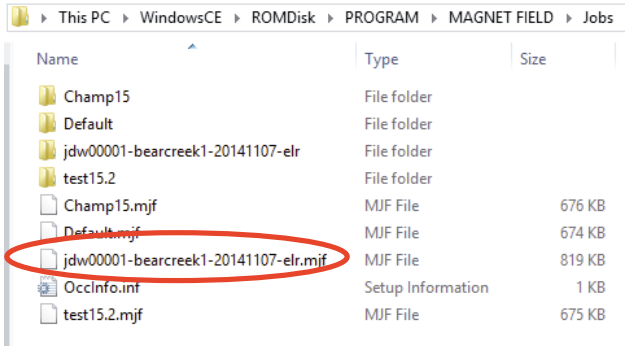
14. In the "Backsight" window, fill in accurate Occupation Point information. Enter the height of instrument (HI). Confirm that backsight point matches previous CP. Input new height of prism (HR) measured at previous CP. Select Next



The mjf is not a Magnet export, it is the Magnet file. Similar to what a docx is to Word. Word = docx, Magnet = mjf

The mjf file must be copied from its memory location on the total station and pasted to the memory of the Champ laptop.

18. Using Windows Mobile browse to the memory location on the total station. See example below: right click on the mjf file and select copy:

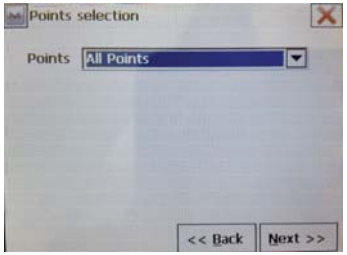


19. Browse to the memory location on the laptop, right click and select paste.

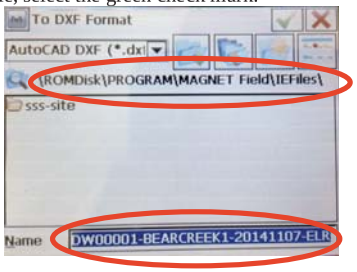
20. This same process (copy and paste) will need to be completed for the raw and dxf files.

This completes transferring the data to the CHaMP laptop that is required for GIS processing.

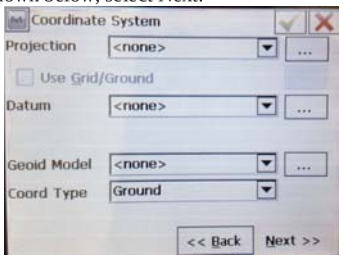
13. Select All Points and then select Next:



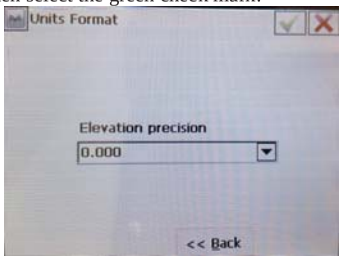
14. If necessary change the file location to the IEFiles folder. Enter the name for the file, select the green check mark:



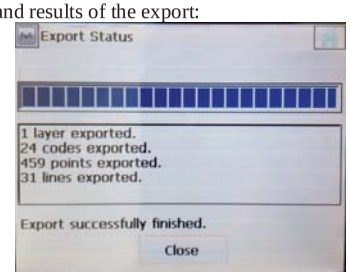
15. Use the coordinate system selections shown below, select Next:



16. Select the precision (0.000) as below and then select the green check mark:

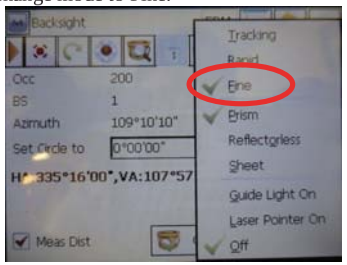


17. A window will appear showing progress and results of the export:

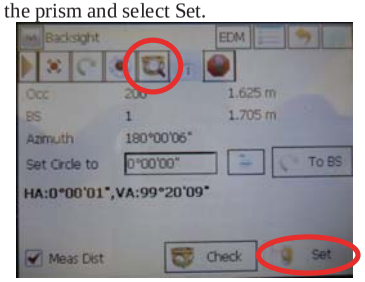


Exporting of the raw file and dxf file are complete! Go to next page to Export the mjf.

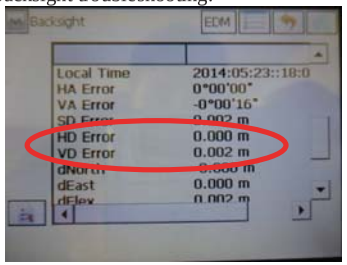
15. The next screen displays the Backsight and Occupation Point information input in the previous screen. Before Setting the backsight, select the EDM button and change mode to Fine.



16. Be sure the Set Circle to field is 0°00'00". Point TS near Prism and select Search button. Once TS locates prism, use telescope to confirm that it is centered on the prism and select Set.



17. Review the BS report error values and record in field notebook. If error is within acceptable tolerances (HD < 0.030 and VD < 0.015) select home button. If error is above acceptable tolerance, re-measure both TS and prism and confirm that correct points were selected. If error persists see section 5.4 of the protocol regarding backsight troubleshooting.



The traverse is now complete. If there are any BMs or other CPs visible from the current location, conduct "Stake Point" procedure outlined in Section 2.3. Or return to "Sideshot-Direct" screen by selecting Survey, Topo from home menu and continue surveying site.

Be sure to change EDM setting from Fine to Rapid before collecting topographic points.

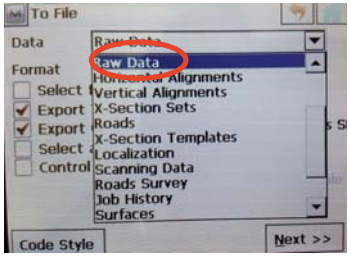
2.6 Export Data

The exports from the TS which allow processing the data in GIS are:

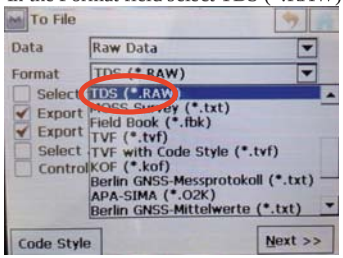
1) *.raw
2) *.dxf
3) *.mjf

1. Raw Data Export. Select Export:

2. In the Data field use the dropdown arrow to select Raw Data:

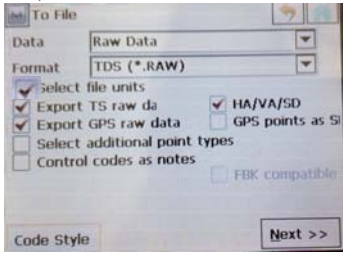


3. In the Format field select TDS (*.RAW):

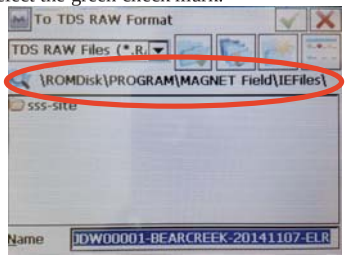


4. The Code Style selections should be as indicated below:

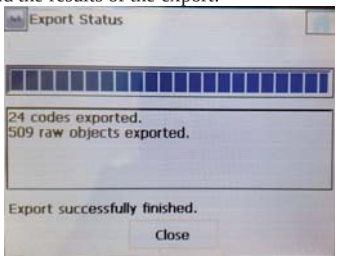
5. When the fields and check boxes are as below, select Next:



6. If necessary change the file location to the IEFiles folder. Enter the name for the file, select the green check mark:

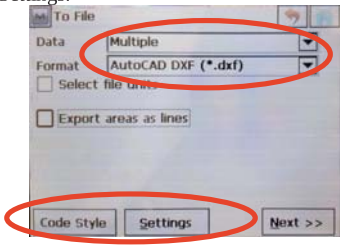


7. A window will appear showing progress and the results of the export:

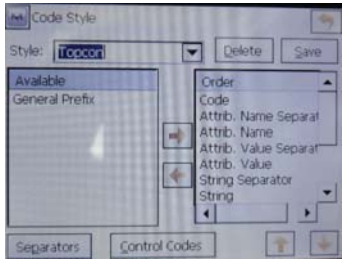


8. dxf Export. The lines must be exported in the dxf format. Select Export:

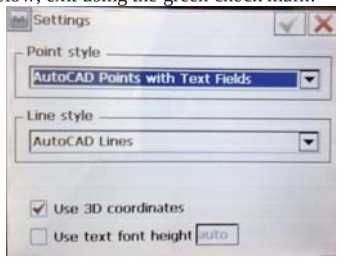
9. Populate the Data and Format fields as below then check the Code Style and Settings:



10. The Code Style selections should be as indicated below:



11. In the Settings populate the fields as below, exit using the green check mark:



12. In the Data Selection window, select points, codes and lines, then select Next: