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Ministry of Transportation



Construction Supervision Survey Guide

Traffic, Electrical, Highway Safety and Geometric Standards
Engineering Branch
April 2008

Preface

The **Construction Supervision Survey Guide (CSSG)** has been developed in response to a need for standardized procedures and deliverables for construction supervision survey services for the Ministry of Transportation in British Columbia.

The intended audience for this survey guide includes ministry supervision staff and ministry supervision consultants. This document covers a variety of topics and is designed to be used as a contract terms of reference and as a minimum standards reference guide.

The specifications in this guide shall be considered a minimum requirement for all construction project surveys undertaken by or for the Ministry of Transportation.

Contract terms of reference for supervision survey services will include references to this guide as in the following example:

This survey shall provide deliverables as defined in the Ministry of Transportation Construction Supervision Survey Guide as applicable.

The Construction Supervision Survey Guide has been developed by the Ministry of Transportation, Field Survey Emerging Technologies Committee and its members.

Field Survey Emerging Technologies Committee			
Name	**Position**	**Branch or Company**	**Location**
Dale Francis	Manager Business Analysis	Information Management	MoT Victoria
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The construction consultant community was asked to provide feedback on this guide and their comments have been considered during the finalization of the guide.

Technical Advice

Questions on interpretation and application of standards and guidelines should be directed to:

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100 Introduction

100.01 Standards and Requirements

This document outlines required minimum standards for Ministry of Transportation construction projects.

Ministry staff and ministry representative consultant surveyors will be required to use the TDS Survey Pro data collector software, Foresight DXM workstation software or *approved alternate software* (e.g. Survey Controller software, see section 700.03 of this guide) on ministry projects.

Survey equipment used in conjunction with TDS Survey Pro software shall be current Total Station Theodolites and/or GPS-RTK or GNSS-RTK capable equipment that meet or exceed survey tolerances as per the ministry standard specifications. Alternate survey software must be reviewed and approved by ministry survey software experts, in conjunction with the ministry representative prior to the awarding of a survey contract.

2006 Standard Specifications for Highway Construction (adopted in 2005)
http://www.th.gov.bc.ca/Publications/const_maint/contract_serv/standardspecs.htm

Construction contractor surveyors are encouraged to use TDS Survey Pro or compatible data collector software (current ministry standard version) on ministry projects. This will allow contractors to take advantage of electronic design information when available (i.e. RD5, TP5, LandXML, Templates, Design Surface DTMs, 3D Machine Control Grading DTMs, etc).

The ministry or ministry representative expects that:

- Survey instruments are well maintained and all stored error corrections are current
- Approved and technically acceptable procedures are applied
- All field and office processes have been checked for completeness and are correct
- Work will be performed by suitably skilled personnel

The ministry surveyors or ministry representative surveyors must have the ability to substantiate and supply on request:

- Accuracies and survey closures achieved
- Methodologies used for all field and office tasks
- Equipment capabilities
- Qualifications of personnel

Access to electronic design information is subject to the limitations stated below.

100.02 Provision of Electronic Information

Standard Ministry of Transportation supervision contracts state:

At the construction contractor's request and at the ministry representative's option, the ministry or ministry representative may provide the construction contractor with electronic copies of the drawings, design digital terrain models, or other such information.

If the ministry does provide such information, it is provided "as is" and at the construction contractor's request, without warranty of any kind, whether express or implied. All implied warranties, including, without limitation, implied warranties of accuracy, completeness, merchantability, fitness for a particular purpose, and non-infringement, are hereby expressly disclaimed.

Under no circumstances will the ministry be liable to any person or business entity for any direct, indirect, special, incidental, consequential, or other damages based on any use of this information or any information referenced therein, including, without limitation, any lost profits, business interruption, or loss of programs or information, even if the ministry has been specifically advised of the possibility of such damages.

100.03 RISP Registration, Identification, Selection, and Performance Evaluation (Contracts, Consultant Procurement and Selection)

Requirements for engineering and technical services valued at less than $1,000,000 must be selected through the RISP system.

Refer to the ministry eRISP website for additional information on the selection process.
http://www.th.gov.bc.ca/erisp/home.htm

Requirements for services valued at or over $1,000,000 will be listed on the BC Bid website.
http://www.bcbid.gov.bc.ca

100.04 Safety, Traffic Control and Property or Right of Way Entry Policies

All ministry, WorkSafeBC, and prime construction contractor safety policies will apply to all surveys, including policies regarding safety equipment, signs, traffic control and procedures. Refer to the WorkSafeBC resources website for information.
http://www.worksafebc.com

Refer to the Ministry of Transportation Traffic Control Manual for relevant information.
http://www.th.gov.bc.ca/Publications/eng_publications/TCM/Traffic_Control_Manual.htm

Property owners must be contacted in writing, stating the intent and requesting permission to enter their property. Refer to the BCOnline resources website indicated below for information.
https://www.bconline.gov.bc.ca

Refer to section 1100.01 of the General Survey Guide for policies regarding private land entry.

The ministry representative shall be notified prior to contacting property owners for access to private property. Advise the ministry representative in the event entry is denied.

If entry onto railway right of way (R/W) will be required, contact the railway company for that area to request permission for entry onto their R/W and special instructions that relate to access to their R/W.

200 Office Processing

200.01 General PC and Data Collector Software

- CAiCE
- AutoCAD
- TDS Survey Pro
- Foresight DXM

200.02 Acceptable Volume (Quantities) Calculation Methods

- DTM surface to surface
- Cross section average end area
- Block re-measure (acceptable by mutual agreement between the ministry representative and the contractor)

200.03 Required CAiCE Procedures

- Perform spot checks on the CAiCE design project to ensure that it conforms to the requirements of the CAiCE Design Project Data Format Terms of Reference. Communicate with design staff as required.
- Overlay AutoCAD design drawings on the CAiCE project data to ensure that the AutoCAD and CAiCE coordinate systems and key geometries match (right of way lines, clearing and grubbing lines, etc.).
- Check CAiCE x-sections to ensure a match to AutoCAD design typical sections.
- Review CAiCE project data for compatibility with the TDS Survey Pro field survey software and complete any preparations required.

200.04 Required TDS Survey Pro Procedures

The project should be prepared for import to TDS Survey Pro as follows.

- Break horizontal alignment segmental spirals into 1 metre tangents where necessary. A segmental spiral is an intermediate spiral between two horizontal curves (arcs). TDS Survey Pro will currently not accept segmental spirals or arc-spiral-arc alignments
- Edit the vertical alignment to change asymmetrical vertical curves into 5 metre tangents. TDS Survey Pro currently does not currently accept asymmetrical vertical curves.
- Edit the vertical alignment to ensure it is the same length, or longer than the horizontal alignment. The vertical alignment must start at the same location as the horizontal alignment when producing TDS RD5 files.
- For slope staking and subgrade stakeout, create TDS Survey Pro RD5/TP5 files at all required stations in the design EAR file.
- Depending on the length and complexity of the project, the size of the design template files* should be managed to work best with the processing speed of the field survey computer/data collector being used.

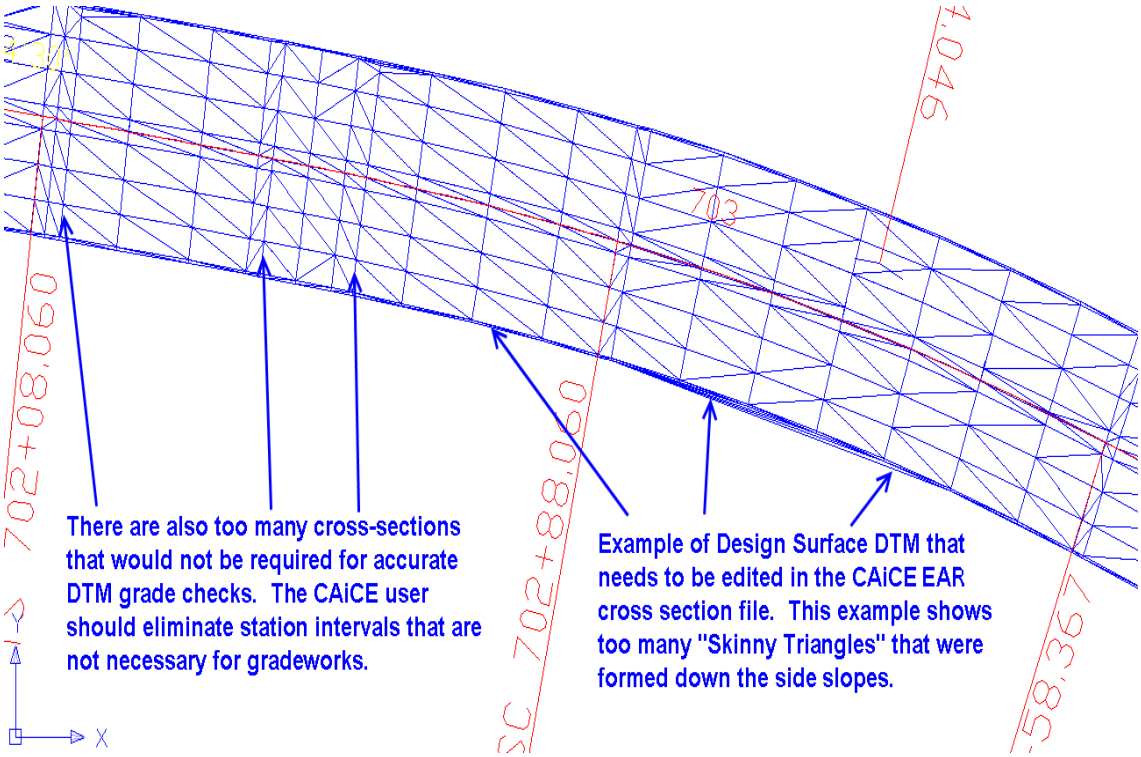
- Generate LandXML files from CAiCE EAR cross-section station templates for station grade staking using TDS Survey Pro.
- The DTM formation interval must match the staking interval – 20m for base grades, 10m for 25mm grades or 10m where the contract stipulates.
- Generate CAiCE design shoulder to shoulder DTMs for all roadbed gravel and asphalt surfaces. Maintain the correct spacing intervals as specified above.
- Export CAiCE design shoulder to shoulder DTMs to a 3D AutoCAD DXF file to enable further translation (via Foresight DXM) to a TDS Survey Pro compatible design DTM for grade checking.
- Using Foresight DXM, import the CAiCE design shoulder to shoulder DTM-DXF file and translate to a TDS Survey Pro DTM for grade checking using TDS Survey Pro.

* There are a number of ministry supplied macros and fragments designed for use within CAiCE to facilitate the generation of the design template files.

Design DTM Checking

Check for problems with the sizes of the design surface DTM files (e.g. too many x-section stations or too many skinny surface triangles) and, the LandXML surface files. Decide, whether these files need to be broken up into smaller pieces (similar to template files) if they are too large for the data collector being used.

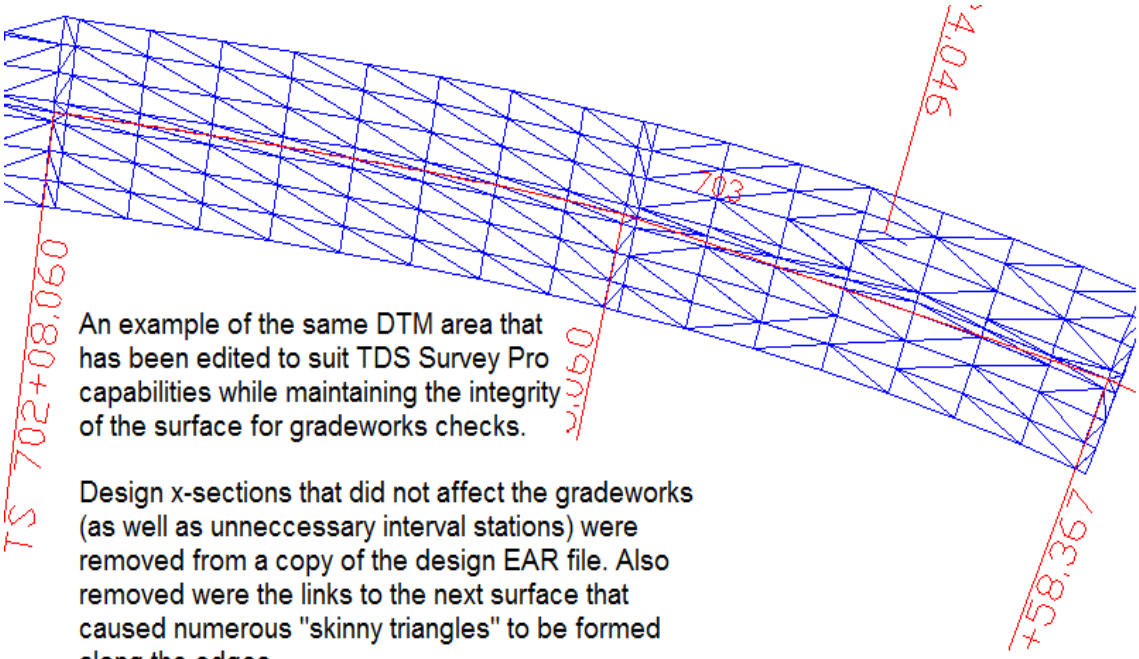
Example of a design DTM with too many triangles for efficient TDS Survey Pro functionality



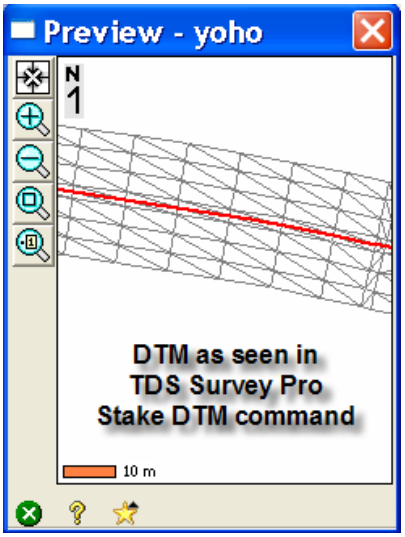
Example of a Re-edited Design DTM

DTM is in 10 meter minimum intervals, of the same area, that provides correct grading data, but eliminates too many stations that are unnecessary to perform accurate gradeworks checks via DTM methodologies. The edited Design DTM also eliminates numerous “skinny triangles” from the side slopes. Road Prism Gradeworks only require “shoulder to shoulder” 3D DTM modeling.

See the notes below the examples as to the required intervals.



Example of functional, edited, design grade DTM in TDS Survey Pro software on a Recon Survey Data Collector



Cross-section intervals (stationing) may not conform to the field staking interval requirements of a specific project. If field staking intervals are positioned at 20m stations (plus width changes) then users should be aware, when producing the design surface DTM, that the stations in the EAR file may not conform to the same intervals.

For example, the contract stipulations may require field staking at 20m intervals. If the CAiCE EAR x-section intervals are at 10m, the design DTM will be produced at 10m intervals. This scenario may result in out of tolerance cuts/fills on a specific surface at the 10m odd interval stations. This may occur where the vertical design profile has a substantial slope/radius. Further grade staking at 10m intervals may be required where this scenario occurs.

Note: DTM interval requirements at tight vertical radiuses for 3D grading design surface DTMs may have an even shorter interval specification (e.g. intervals of 5m).

200.05 Machine Controlled Grading

Design surface DTM data produced in CAiCE may also be translated into formats that work with machine controlled grading systems. As mentioned in section 200.04, DTM design surfaces generated for road prism gradeworks would require only “shoulder to shoulder” generation from a given road prism surface (e.g. subgrade, SGSB, 75mm, and 25mm surfaces).

When generating design surface DTMs for machine controlled grading, great care must be taken during the formation of the DTM from design x-section data to ensure that ministry standard specifications (vertical tolerances) for grading of a given surface will be adhered to.

Intervals between stations from x-section templates become a key component in the DTM design surface formation, particularly where there are tight curvatures in the vertical alignments or tight radiuses in the horizontal alignments. Generally, formation of design DTMs from x-section templates for grading may require 5-meter intervals (sometimes closer intervals) from the design stations to eliminate the possibility of exceeding grading specification vertical tolerances in areas with steep vertical or tight horizontal curvature. Conversely, design DTMs over areas with less curvature and longer tangential grades may be created with intervals up to 10 meters. This will ensure compliance with grading specification vertical tolerances.

300 Control Survey

300.01 Primary Control Points

- Primary control points must be re-established as per sections 300.01, 300.02, 300.03 (paragraph 1) and 300.04 of the General Survey Guide.
- Primary control points referenced by a stake must flagged pink and blue.
- Primary control points on pavement must be referenced by paint and an offset stake (flagged pink and blue) where possible.
- Primary control points are required to have a prefix of G for GPS established points and P for Total Station conventional points.

300.02 Secondary Control Points (Reference Points)

- Secondary control points must be re-established as per section 300.01, 300.02, 300.03 (paragraph 1) and 300.04 of the General Survey Guide.
    - Secondary control will be either a sight distance traverse or points set using RTK methods, closing to the primary control.
- Secondary control points must be referenced by a stake flagged pink and blue.
- Secondary control points must be intervisible
- Secondary control points on pavement must be referenced by paint and an offset stake (flagged pink and blue) where possible.
- Secondary control points must achieve accuracies as stated in:
    - Section 200.03 of the General Survey Guide (Topographic Survey Requirements) for OG survey
    - Section 500.01.D of this guide (Slope Staking)
    - Section 500.01.E of this guide (Grade Staking)
    - Section 201.47 of the ministry Standard Specifications (Finishing of Roadway)
    - Special Provisions (major) http://gww.th.gov.bc.ca/contractinfo/Content/Home/home.asp
- Secondary control vertical and horizontal accuracies re-established by GPS-RTK methods shall conform to Section 300.04 of the General Survey Guide and points must meet the accuracies stated in the previous bullet.
- The construction secondary control point horizontal accuracy requirement is 1:10,000 or defined as 1 part per ten thousand when using optical Total Station traverse methodologies.
- Vertical secondary control (Class II) accuracies will be determined as 0.008 times the square root of the distance in kilometres.
- Re-established secondary control points must include a unique two character prefix identifying the surveyor and records must be submitted to the ministry representative.
- Prefixes described below will be used on all documentation, drawings, control point labeling in the field and in the CAiCE survey database.
- Secondary control points set with a total station will have a prefix of N@@ where @@ represents the surveyor's prefix or initials (e.g. NJT18).
- Secondary control points established using RTK methods will have the prefix K@@ (e.g. KJT18).

300.03 Detail Hubs

- Detail hubs are not part of the primary and secondary control network, and will be considered as third order with accuracies as follows:
    - 1:6900 or 1 part per six thousand-nine hundred for horizontal accuracy
    - 0.024 times the square root of the distance in kilometres for vertical accuracy
- Hub descriptions must be identified with the prefix DH. This will indicate that the detail hub has not been part of a closed traverse.
- Detail hubs must satisfy the survey accuracies documented in:
    - Section 200.03 of the General Survey Guide for topographic original ground surveys
    - Sections 500.01.D and 500.01.E of this guide for slope and grade staking
    - Section 201.47 of the ministry Standard Specifications (Finishing of Roadway)
- If detail hubs are intended for continued use, care must be taken to tie these detail hubs back into the primary or secondary control network.

300.04 Hub Replacement (Maintenance on Active Projects)

- Will meet the requirements of secondary control points (reference points) detailed above.

300.05 Quality Control Methods, Records, Results and Reporting

- All previous survey information conforming to the "S-700 General Survey Guide" will be available on request through the design coordinator
- Control must be checked at beginning of a project. Random checks will be done by closed traverse or static GPS and will include a minimum of 4 secondary and/or primary control points. Additional checks may be required by the ministry representative (be aware of age of prior surveys when checking or re-establishing control points, prior to construction project commencement).
- Quality of control point elevations
- Minimum horizontal requirement for an optical instrument closed loop traverse is 1:10,000
- Minimum vertical requirement for a closed level loop is 0.008 times the square root of the distance leveled in kilometres.
- Records of control point check surveys will contain all electronic survey files, reports and other relevant survey data showing closures.

Example of a "Check Point" showing closures

DUNNSTAKE.JOB November 19, 2004

Raw Data Report

Line#	Record Type	
249	Occupy Pt:	Occ Pt: DUNN12 Northing: 680181.844m Easting: 699328.055m Elevation: 393.429m Desc: RP
250	HI/HR:	HI: 1.67m HR: 1.55m
252	Backsight:	Occ Pt: DUNN12 BS Pt: DUNN10A BS: 169.0043 BS Cir: 169.0043
254	Note:	BS Circle check : angular err= 0.0000
269	Note:	Check Point: RP22
270	Note:	delta= N:-0.005 E:-0.000436 Z:-0.001455
271	Note:	= HR:1.55 HA:180.0003 SD:30.005 ZA:90.0010

- If control point checks do not meet accuracy requirements, the ministry representative may consult the designer and seek a resolution to the control problem. The ministry representative must be aware that design and/or quantities review may be required based on changed control point locations.
- GPS co-ordinate transformation parameter (i.e. site calibrations, localizations, etc.) reports should be included in the design deliverable if GPS has been used (see example below).

Example from Section 700.02a. Of the General Survey Guide

Project:

Description:

Name of Employee:	**Cell Phone:**
Office (Branch):	**Project Manager:**
Local Extension:	**Other employees on project:**

Coordinate System Description (Horizontal & Vertical) :

Horizontal: (All UTM coordinates are NAD83 CSRS).
- Established using 6 GPS receivers including the Fort St John Active Site (BCACS)
- FORT ST JOHN ACP is held as: Lat: 56-15-17.79260 Lon: 120-50-54.86620.
- MON "900J" is held as: Lat: 56-16-04.74719 Lon: 120-56-16.30220.
- Weight constrained least-squares adjustment performed using the published standard deviations for control points. (See Appendix B for network results)

Vertical: (All elevations are CGVD28).
- Levels were run from BM 84C201 through all Primary and Secondary control points and closed back on 84C201. (See Appendix D for Loop results and closures)
- The elevation of 84C201 is held as 688.888m.
- The levelled elevations were compared with GPS observations to BM 80C010 and MON 900J.

Local (Project) Coordinate System:
- The average of all Primary and Secondary control points was used to calculate an average combined scale factor for the project. The calculated scale factor was found to be 0.99971864256. (See Appendix C for individual point scale factors)
- Primary control point "MOT4" was held as the central point of the survey. Its project coordinates are equal to the UTM values with the leading digit of the Northing truncated.
- To calculate project coordinates from NAD83 CSRS UTM values you divide the UTM coordinates by the project scale factor (Northing and Easting) and then subtract 6001754.6152 from the new northing and 178.2715 from the new easting. The oposite procedure will convert project coordinates to UTM.

Additional Information:

Appendices:
- Appendix A - Primary Control Survey Information Sheets
- Appendix B - Least Squares Adjustment. Network results & logfile.
- Appendix C - Detailed point information. (Convergences & Scale Factors)
- Appendix D - Vertical Results & electronic level notes.
- Appendix E - MASCOT Listings for Control Points.

Comments:

Signature	**Date:** **September 16, 2003**

- Provide reports for any control point replacement
- Ministry/ministry representative quality audit of primary control if secondary control audit results in problems
- Clarify methodology if required: GPS-Static, GPS- RTK, or conventional traverse

400 Field Survey

400.01 General Survey Requirements

400.01.A Filenaming Convention

Filenames for data provision to the ministry must adhere to the following convention:

Filename: Project Code – Date – Task – Surveyor
Extensions: JOB, RAW, TXT or MTS

- @@yymmdd@@@@.JOB WN060421OGJT.JOB
- @@yymmdd@@@@.RAW WN060421OGJT.RAW
- @@yymmdd@@@@.TXT WN060421OGJT.TXT
- @@yymmdd@@@@.MTS WN060421OGJT.MTS

- Project Code WN Whistler Nordic Centre Access Road
- Date 060421 2006-April-21
- Task OG Original Ground
- Surveyor JT Jim Turner

The task field can be up to 24 characters in length. An electronic note that describes the task must be provided with the JOB file.

400.01.B Points and Chains Survey requirements

All survey data must be compatible with the Ministry of Transportation's current version of CAiCE computer software.

When survey points define a linear feature, they must be surveyed using the chain survey method to facilitate the formation of breaklines.

All points/chains collected must have the minimum attributes described below.

400.01.C Points

- Unique point identifier (alpha or alpha-numeric)
- Northing
- Easting
- Elevation
- CAiCE feature code (TDS description code)
- DTM attribute - in/out DTM (may be established by default TDS feature/attributes table)
- Points collected may have the following optional attributes:
    - Point comment – surveyor's on-site specific comment
    - CAiCE point descriptions (TDS Survey Pro point attributes) - specific point information such as culvert size, type of headwall, etc.

400.01.D Chains

- Unique chain identifier (containing CAiCE feature code [TDS Survey Pro description code] and chain number)
- CAiCE feature code (TDS Survey Pro description code)
- DTM attribute - in/out DTM (may use default feature table, user may override)
- Survey chains cannot cross unless both chains have a common point.
- The TDS description codes (CAiCE feature codes) are provided at the following location: http://www.th.gov.bc.ca/caice/tds_pro.htm

400.01.E Topographic Survey Point Accuracy Original Ground

Horizontal and vertical accuracy specifications for topographical detail pickup are as follows:

• Pavement	2cm	± 1cm
• Urban detail	2cm	± 1cm
• Open terrain	5cm	± 2cm
• Heavy ground cover	10cm	± 5cm
• Undulating terrain	10cm	± 5cm
• Steep terrain	20cm	±10cm
• Inaccessible terrain	50cm	±20cm

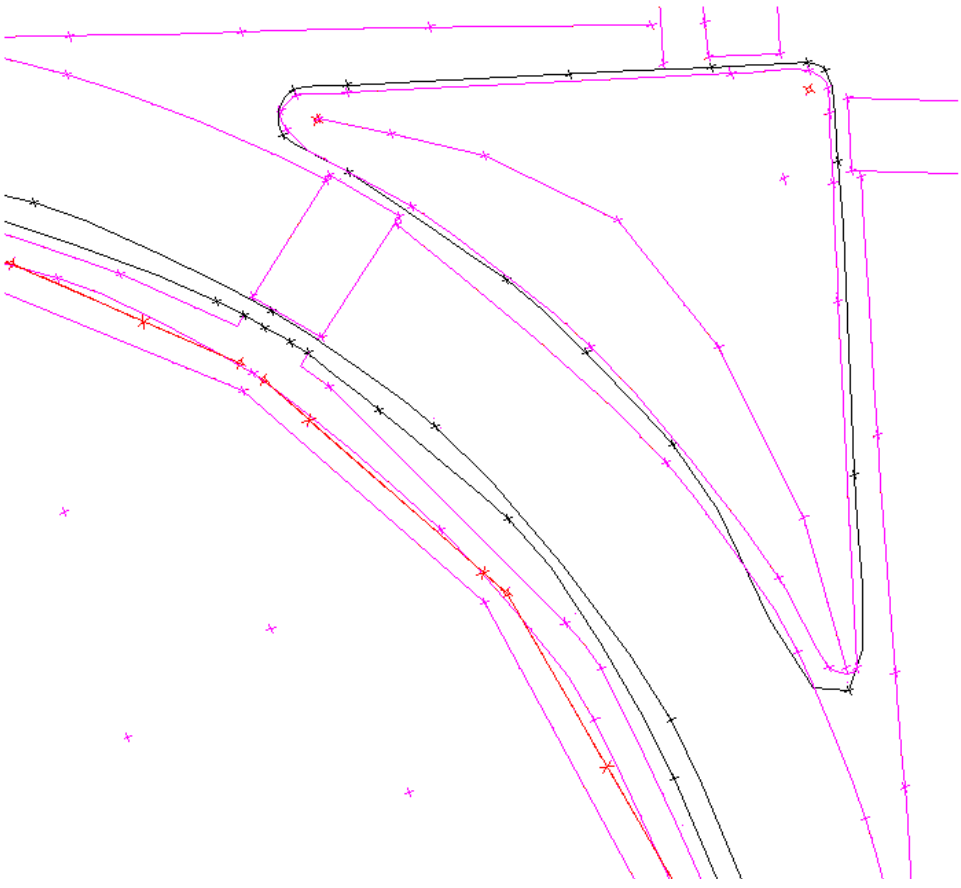
Deliberate care must be taken when surveying existing gutter and pavement milling ensuring a vertical accuracy of 1cm ± ½cm.

400.01.F Survey Point Density

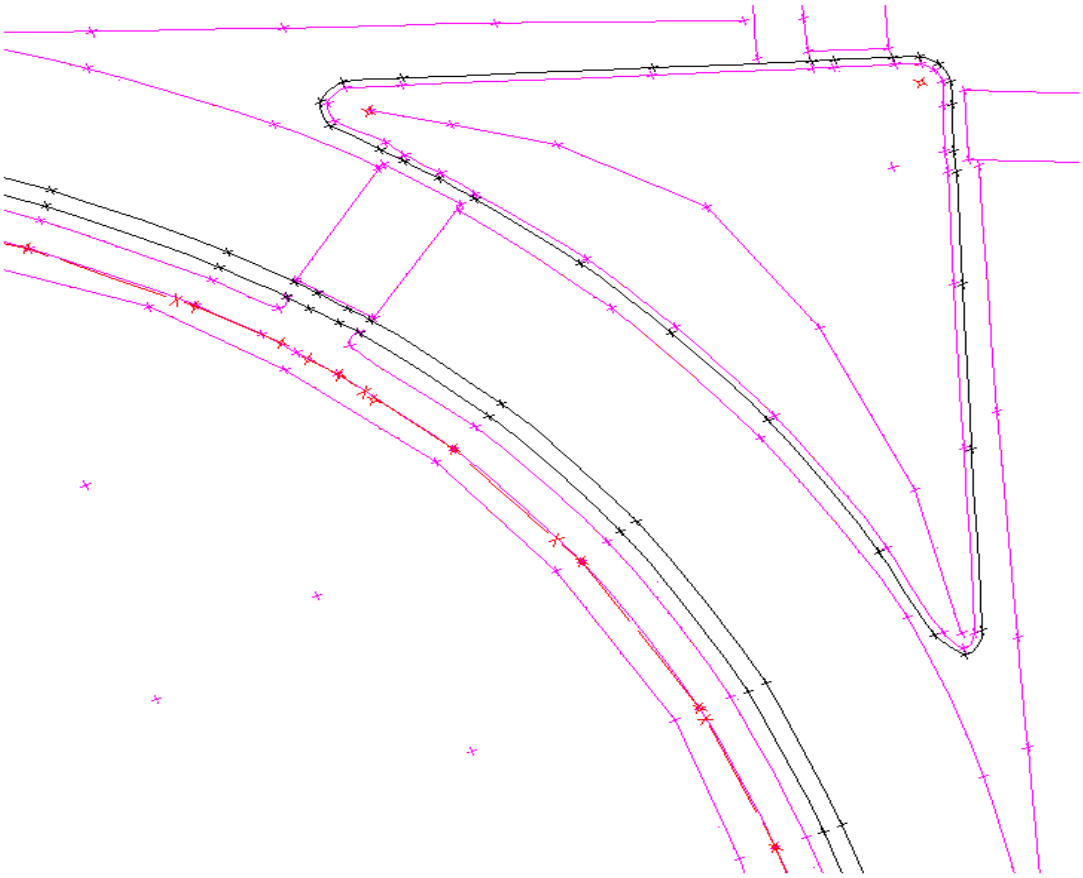
The point densities discussed here must be used as a minimum standard, unless specific contract requirements, special provisions or a mutual agreement between the ministry representative and the consultant/contractor state otherwise.

- The horizontal and vertical nature of the terrain dictates the point spacing and chain requirements to produce a good ground model (see minimum standards this section).
- Chains are the preferred method of survey pickup on all surfaces. Non-chain points (i.e. SE spot elevations, etc.) should be kept to a minimum.
- Point density will be established by the ministry representative or within the “Terms of Reference” for the project to accurately represent the features involved.
- Point spacing shall not exceed 20m along chains and 20m spacing for non-chain points. (10m point spacing is recommended for OG replacement survey and remeasures to produce cross-section quantities).
- To ensure drainage issues and quantity concerns are satisfied, there are many circumstances where point densities will have to be significantly higher. Complexity of terrain, material types and drainage patterns, may require point spacing of less than 5 meters, or as specified within the Survey Contract Terms of Reference.
- Point spacing of 1 to 5 meters within intersections, around access/intersection curves (curb returns) and traffic islands, must be used to adequately represent these features.
- Point spacing of 5 to 10 meters for curb and gutter surveys, rock areas, small radius curvature, ditches and watercourses to adequately represent drainage patterns and calculate quantities.

Incorrect point density example



Correct point density example



400.02 Original Ground Survey

The contractor, and ministry representative, must agree on the validity of the design original ground. The following items should be considered:

- Date and source of OG (OG produced from topographic survey, older x-section survey, LiDAR, mapping etc.)
- Extent of disturbed areas on the project (e.g. clearing & grubbing, etc.)

Methods available to validate the design original ground are as follows:

- Field survey spot checks on the project, using the design original ground DTM, via the STAKEOUT-Stake DTM command within the TDS Survey Pro software that will produce cut-sheet comparisons between the field shots and the OG DTM for validation or comparison errors of the design original ground.
- Complete survey of agreed upon portion(s) of the project area to generate a new CAiCE OG DTM to facilitate comparison against the existing CAiCE design OG DTM. Cross-sections generated from the new OG DTM and the existing OG DTM may be used to determine discrepancies.
- The ministry representative may decide that the design original ground or a portion of it is unacceptable. A resurvey of the original ground or portion of it is required.
- The decision to base quantities on design OG or to resurvey all, or a portion of the OG, must be reached by mutual agreement between the ministry representative and the contractor.

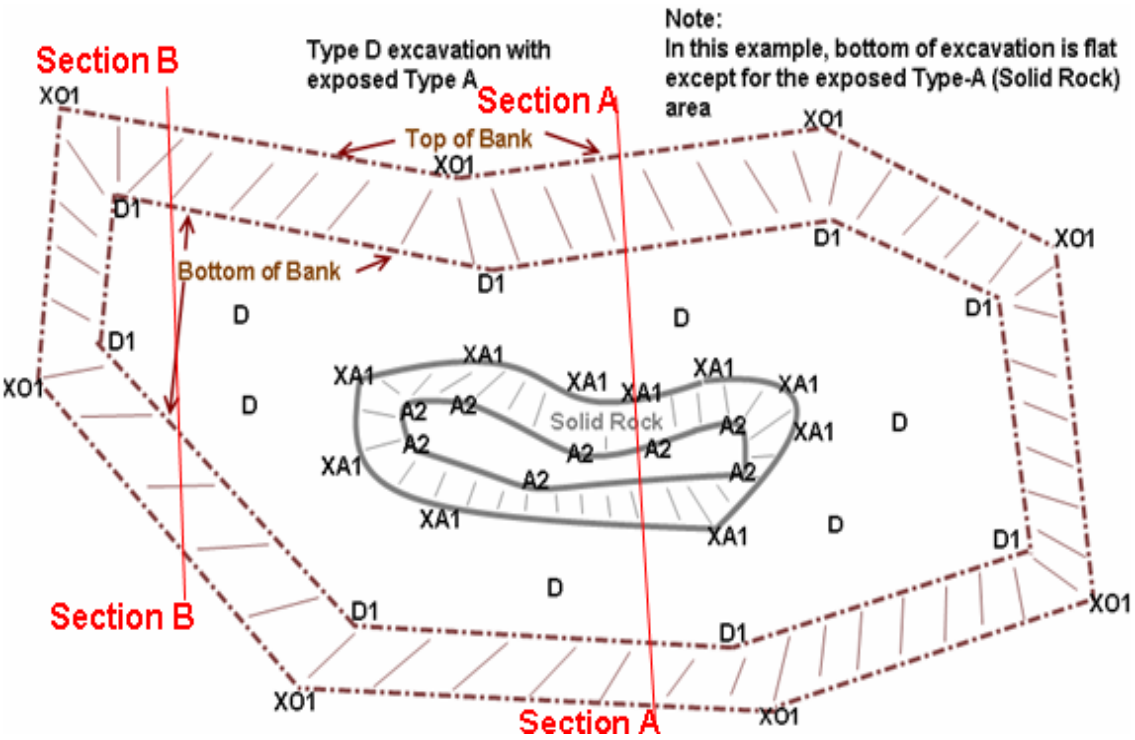
400.03 Earthworks Survey

400.03.A Excavation

Excavation remeasure surveys are used in the calculation of material volumes.

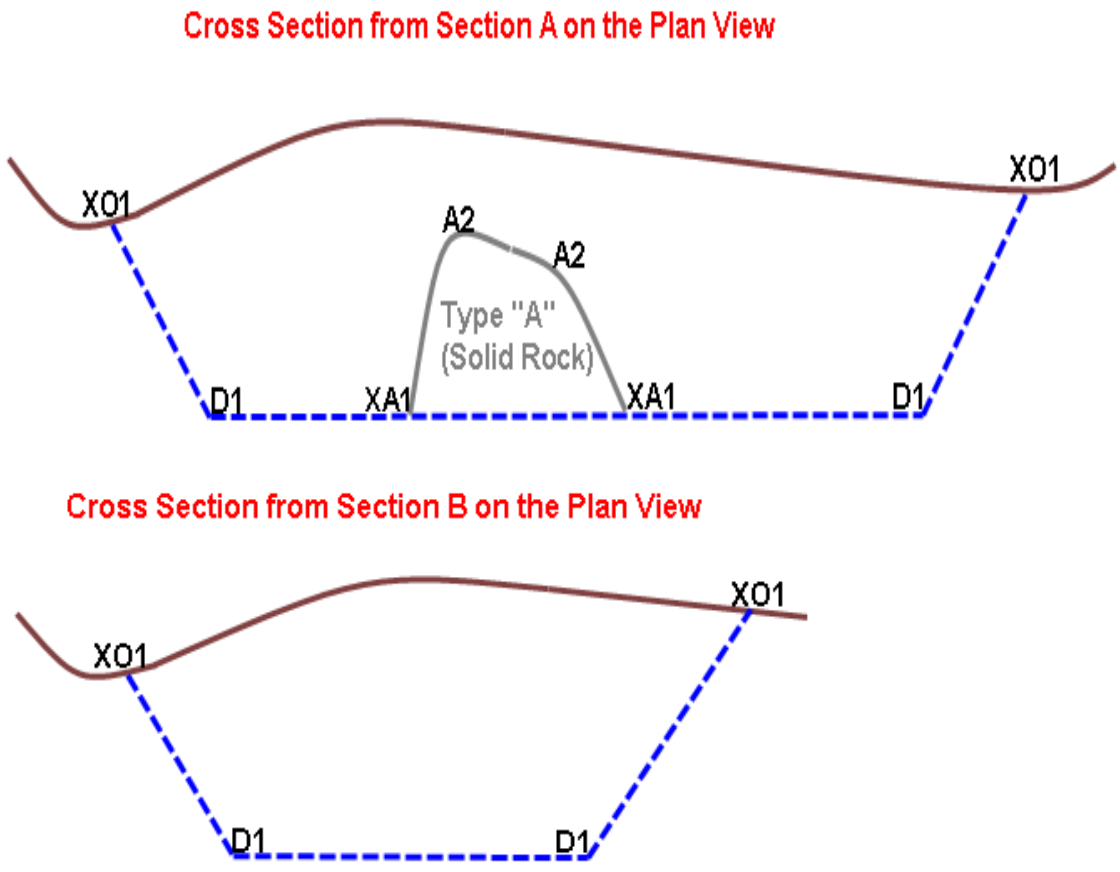
Acceptable description codes to this type of survey must reflect the **material** type at the location of the shot. Description coding must be a **material** type such as: **A**, **D**, **XA**, **XB**, **XO** or **A1**, **D1**, etc. where chains are required.

Example: Plan or overhead view of point coding for a Type-D excavation that has exposed Type-A (solid rock)



- **XO1** - perimeter chain at the top of excavation that ties to OG or to the previous material
- **D1** - inner toe of bank chain
- **D** - Type-D spot elevations in the bottom of excavation
- **XA1** - chain representing the bottom perimeter of Type A indicating Solid Rock
- **A2** - top of rock chain

Example: Cross-section view of point coding for a Type-D excavation that has also exposed Type-A (solid rock) from Section A on the plan view.



- Remeasures must have enough information to provide a tie to previous surveys (i.e. XO chain required)
- Exposure of new material type horizons (e.g. Type-A solid rock exposed during stripping process) may require new slope stakes and quantity volume surveys.

400.03.B Stripping

Minimum required shot density – 15m or less between shots along chain to ensure appropriate pickup of all breaks (contours).

400.03.C Type-A

Minimum required shot density – 5m between shots along chain to ensure appropriate pickup of all breaks (contours).

400.03.D Types B, C, D

Minimum required shot density – 10m between shots along chain to ensure appropriate pickup of all breaks (contours).

400.04 Other Surveys

Monitoring (Slope Stability / Settlement / Structures)

Monitoring surveys require a sensible approach to collecting the information required to derive the differences between one set of monitoring data and the next. A thorough understanding of survey methodology is required to ensure reliable results.

Careful attention must be given to (but not limited to) the following:

- Stability of control
- Accuracy of control
- Types of instruments used (e.g. Total Station, GPS, Terrestrial Scanner)
- Calibration of instruments
- Methods used
- Timing of measurements
- Number of redundant measurements
- Careful analysis of results
- Sources of error

400.05 Gravel Pits and Gravel Piles

400.05.A Gravel Pits – General

- Identify legal and excavation boundaries where applicable
- Required surveys may include: original ground, right of way, borrow boundaries, stockpile remeasures, final remeasures
- Additional flagging and staking may be required to identify potential conflicts with utilities, gas, overhead wires, etc.

400.05.B Gravel Pits – Control

- For pits that were not identified during highway location survey, UTM based ground coordinates are preferred, but local coordinate systems are acceptable.
- Sufficient control should be established and documented to provide for future reference. If possible, survey should be tied to legal plans and/or permanent monumentation. Ties to federal/provincial GPS network and geodetic elevations are recommended.

400.05.C Gravel Pits – Survey Requirements

- Survey detail as defined in section 400.01.F
- Sufficient detail to define the gravel pit for volume analysis and pit development. This may include a survey of geotechnical data such as test holes, test pits, instrumentation, etc.

400.05.D Gravel Pile Quantity Survey Requirements

- Survey of pit base prior to crushing and placing of gravel piles if possible
- Sufficient detail of gravel pit base or floor to ensure that piles will not fall outside the survey pit floor perimeter if possible
- Closed base of pile survey chain
- Closed offset base of pile survey chain (survey information is required beyond the base of pile)
- Sufficient detail to define pile via chains and points surveyed

500 Layout Survey Requirements

500.01 Layout Survey Requirements

To facilitate visual recognition and standardize color representations, all survey lines, layout lines, stakes, offset stakes and points must be marked with flagging of a colour or colour combination that is unique to the feature being identified. A legend of the colour scheme being used will be made available to the ministry representative at the beginning of the project.

Ministry and ministry representative surveyors will conform to the following standard. It is strongly recommended that contractor surveyors follow this as well (see table in section 800.01).

All electronic and hardcopy printouts, field notes, sketches and calculations for layout and/or pickup must be retained by the ministry representative and/or contractor for quality management purposes.

500.01.A Right of Way

- Must be flagged with **blue and white** survey ribbon
- Line of sight (or 20m maximum intervals) continuously visible flagging, stake optional and/or at ministry representative's request
- Stake to identify corners and each point of deflection (R/W corner written on stake) complete with flagging

500.01.B Clearing & Grubbing

- Must be flagged with **red and white** survey ribbon
- Line of sight (or 20m maximum intervals) continuously visible flagging, stake optional and/or at ministry representative's request
- Stake to identify corners (C/G corner written on stake) with station/offset
- If clearing and grubbing takes place to R/W, station/offset and R/W and C/G shall be written on corner stake. Stake shall be flagged blue, white **and red**.

500.01.C Working Easements or License to Construct (LTC)

- Must be staked and flagged with **pink** survey ribbon
- Line of sight (20m maximum intervals) with stake
- "Working Easement" or "License to Construct" must be written on stake

500.01.D Slope Staking

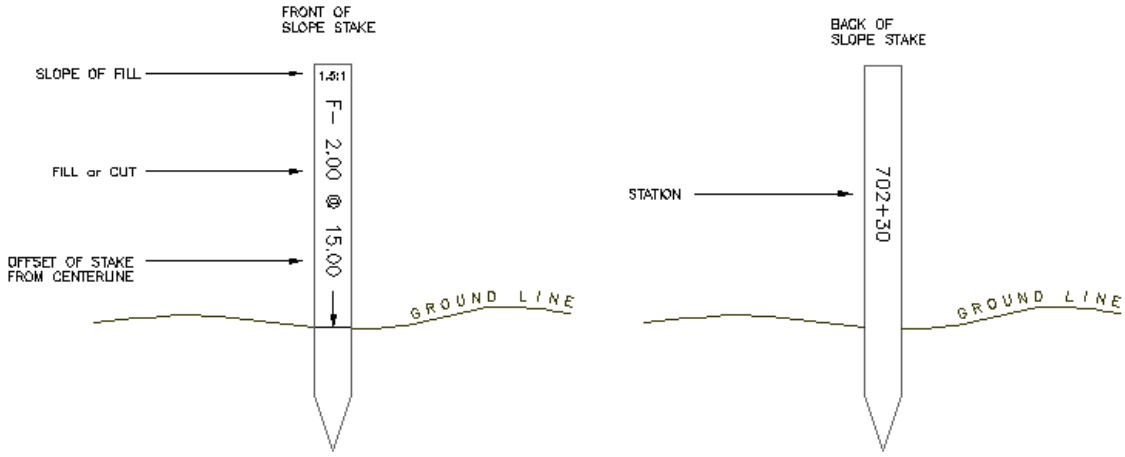
- **Orange** survey ribbon on **fills**
- **Yellow** survey ribbon on **cuts**
- 20m intervals maximum, 10m intervals in rock (refer to the survey contract Special Provisions appendix to confirm interval requirements)
- Additional slope stakes at obvious required locations: major grade and/or field elevation changes such as gullies, start/end of material type changes (type A to D) ditching changes and road widenings (see following examples)
- Non-standard ditches will be staked separately
- Placement of slope stake accuracies required ±0.30m – up or down chainage or revise station location to get around an obstruction
- Offset from CL accuracy required ±0.030m
- Vertical accuracy required ±0.015m – exception rock cut fills tolerance of ±50mm as per Standard Specifications section 201.47 (Finishing of Roadway)
- Offset/guard Stakes (in addition to slope stakes) are an acceptable practice (must be placed vertically and slope stake and offset and offset information from slope stake location clearly marked on the stake) **(slope stakes with corresponding data, must be placed – offset stakes alone are not acceptable)**
- On cuts/fills greater than 10m (i.e rock benching scenarios) the ministry representative may require placement of another set of slope stakes during the fill/excavation process

Example of a Fill Slope Stake Facing Toward Centreline

- The slope of 1½ to 1 is indicated on the top.
- The fill to subgrade at the **PSS (proposed subgrade shoulder)** and the offset to centerline is indicated on the front face of the stake. An arrow symbol is drawn at the ground line, indicating that the fill of 2.00 @ 15.00 from centerline is measured at the ground line point.

Front of slope stake with fill information and offset facing toward centerline

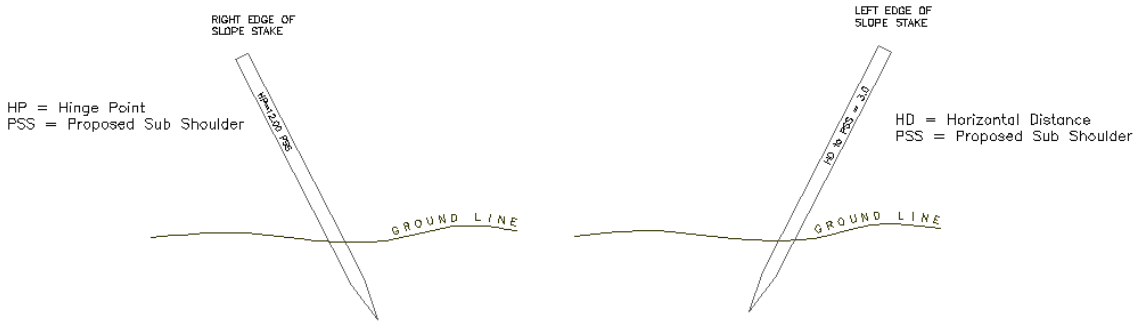
Back of slope stake with station



Side Views of a Slope Stake

The right edge of slope stake example below, indicates the PSS (proposed subgrade shoulder) and the HP (hinge point) distance (12.00m from centerline in this case).

The left edge of slope stake example (the other side), indicates the horizontal distance from the slope stake location toward centerline, from the stake to the PSS hinge point. In other words, this information is what a grade person would need to know to properly determine a fill/cut, slope and distance. Since this information is readily available via the TDS Survey Pro slope stakes screen, it has been added to the information on the stake to reduce manual calculation errors in the field.



The stake is set at a ±30° to ±40° degree angle with the front face of the stake facing centerline, and the station indicated on the back.

In the left edge of slope stake example, **HD (horizontal distance to PSS)** is written on the side of the stake. There should be an **HD** to the required points, either **PSS** or **PCZ**, etc. (this would

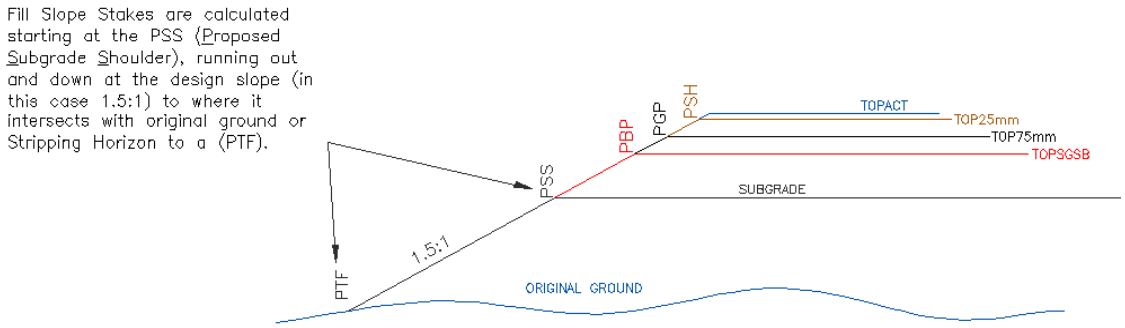
depend on the point used to calculate the slope stake). This allows a grade person to easily discern where the end of the cut or fill slope is from the stake, toward centerline.
Hinge point examples for slope staking calculations are:

- PSS Proposed Sub Shoulder
- PCZ Proposed Clear Zone*
- PBE Proposed BEnch (Bench)
- PBC Proposed Back of Cut
- PTF Proposed Toe of Fill
- PTC Proposed Top of Cut
- PBF Proposed Back of Fill (new feature code)

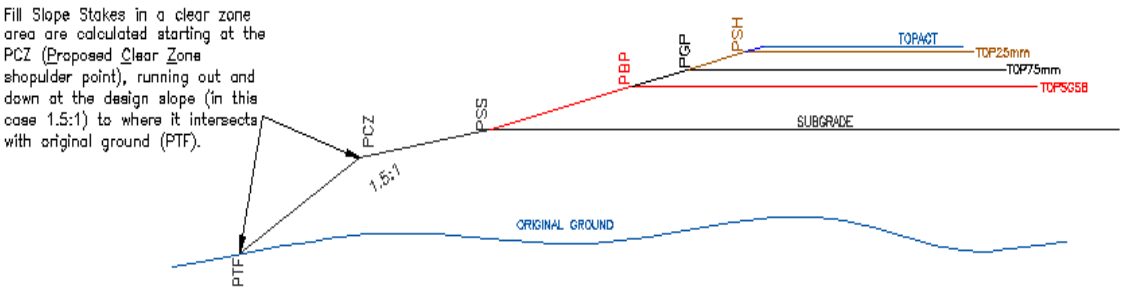
* additional slope stake required after fill placement to PCZ is completed

The following CAiCE cross-section examples will indicate various slope staking scenarios required and to which Proposed Hinge Point the calculation is based

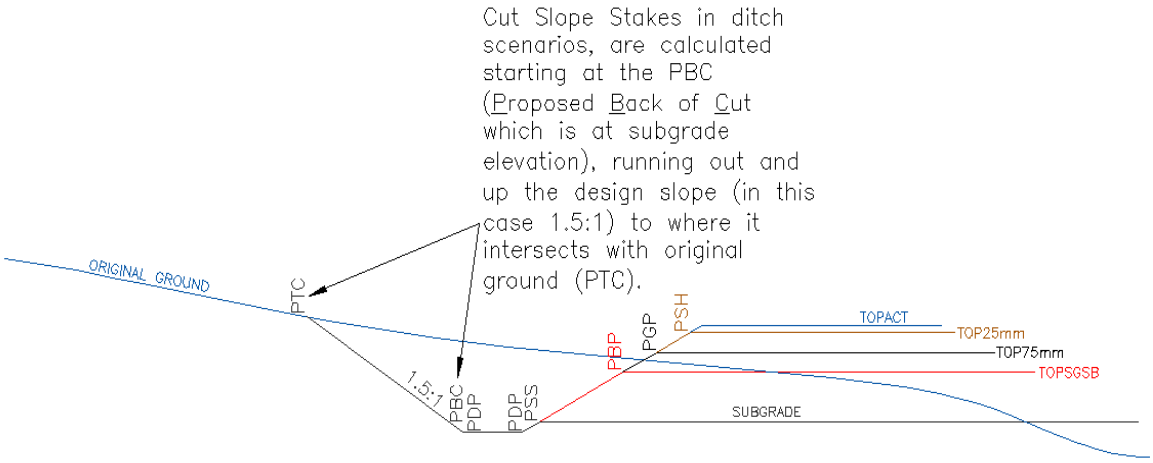
Example 1: Proposed Sub Shoulder (PSS) and probable fill slope stake location scenario from a CAiCE Cross section template EAR file



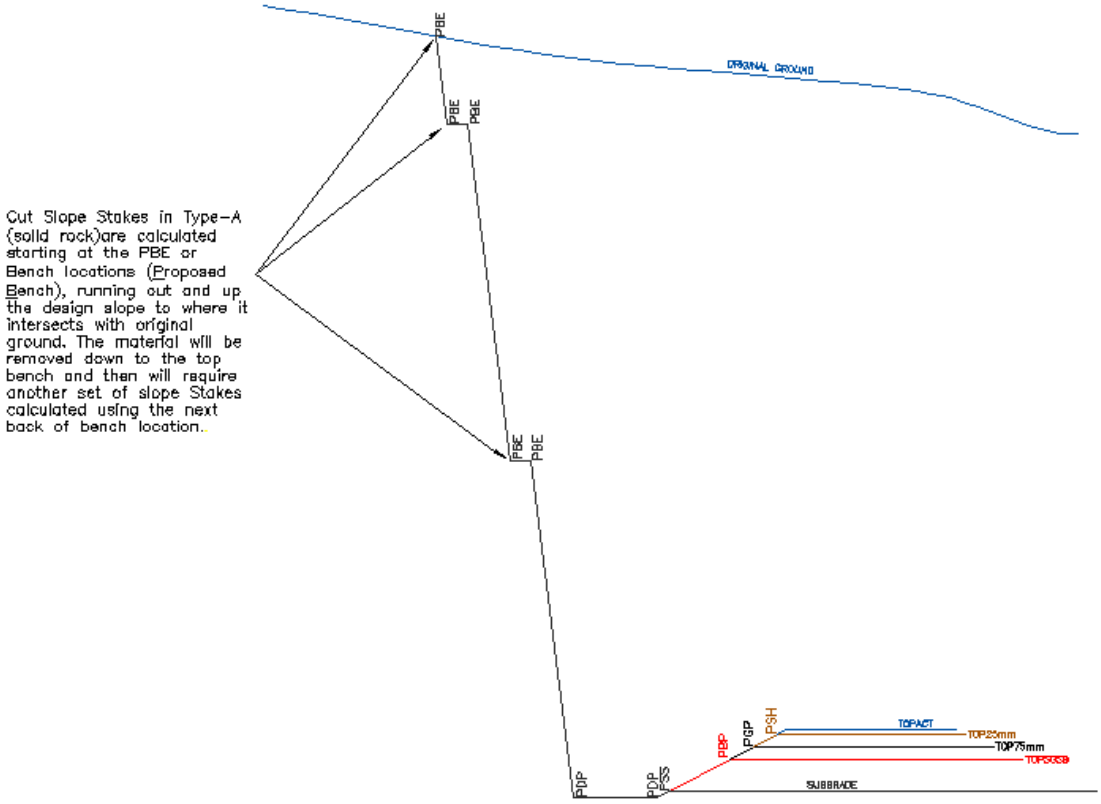
Example 2: Proposed Clear Zone (PCZ) and probable slope stake location scenario from a CAiCE cross-section template EAR file (once the fill has reached the PCZ hinge point, another slope stake calculated from the PSS on differing slopes may be required)



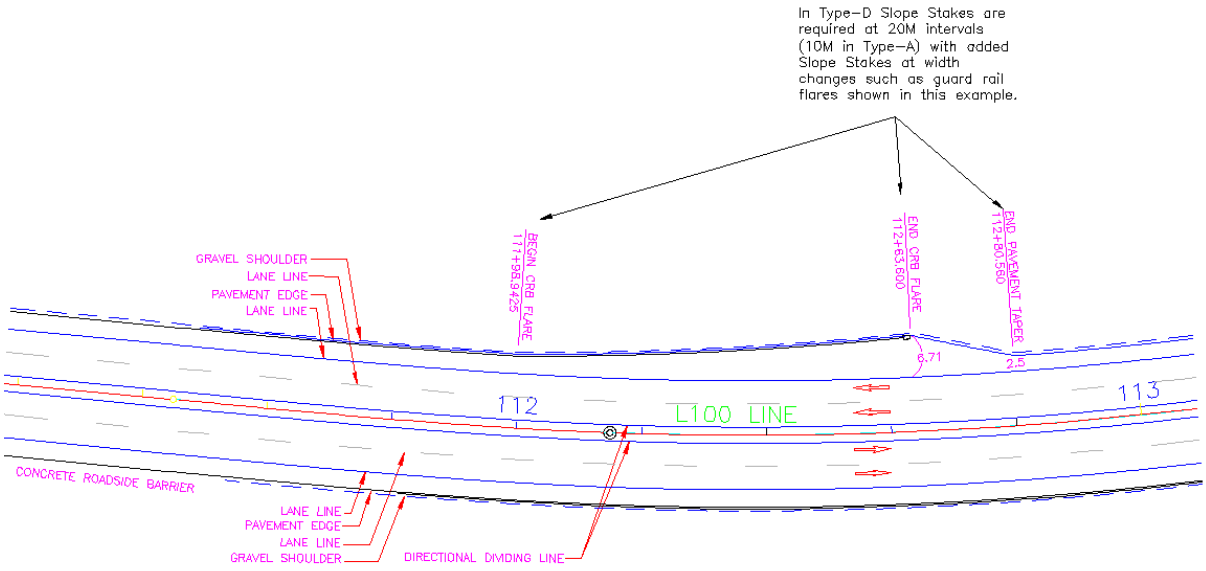
Example 3: Proposed Top of Cut (PTC) and probable slope stake location scenario from a CAiCE cross-section template EAR file in a Type-D excavation.



Example 4: Proposed Back of Bench (PBE) scenario, from a CAiCE cross-section template EAR file in a Type-A (rock) excavation. As each portion of blasting occurs, a further slope stake set may be required from the next lower back of bench (new PBE) hinge point.



Example 5: Slope Stake Required Locations at Widening Points Along the Chainage

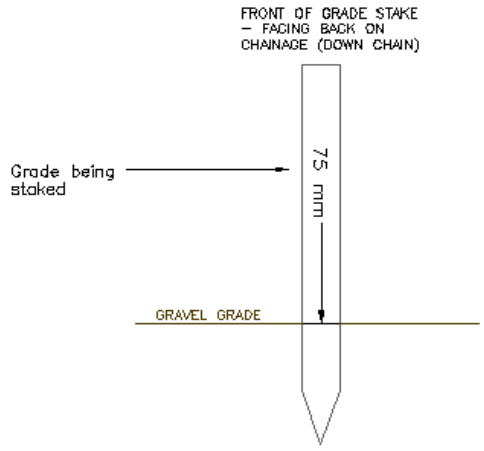


500.01.E Grade Staking

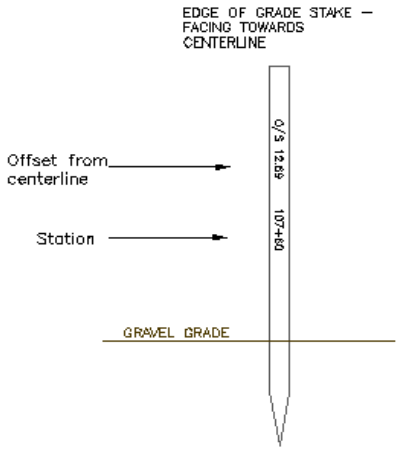
- At 20m station intervals, 10m for the final base course (refer to the contract Special provisions appendix) – there may be shorter intervals specified in the project contract
- At all roadway template change stations – gravel, slopes, widths, etc.
- At all intersection stations – access/intersection curves, etc (refer to 500.01.F)
- At grade breaks (often identified by spot elevations)
- All stations will have grade stakes at both shoulder and centerline. Stakes are also required at grade break points. Additional stakes may be required by the ministry representative.
- Placement of grade stake accuracies required: ±0.050m – up or down chainage
- Offset from CL accuracy required: ±0.030m
- Vertical loop closure accuracies require minimum vertical requirement for a closed level loop is **0.008 times the square root of the distance in kilometres**
- Grading tolerances:
    - Subgrade ±0.015m
    - SGSB ±0.015m
    - 75mm ±0.015m
    - 25mm ±0.010m
- Tie flagging around the grade stake at the grade line using following colours:
    - Subgrade Orange
    - SGSB Pink
    - 75mm Red
    - 25mm Blue

Grade Stakes

Front (facing back on chainage)



Side (facing toward centerline)

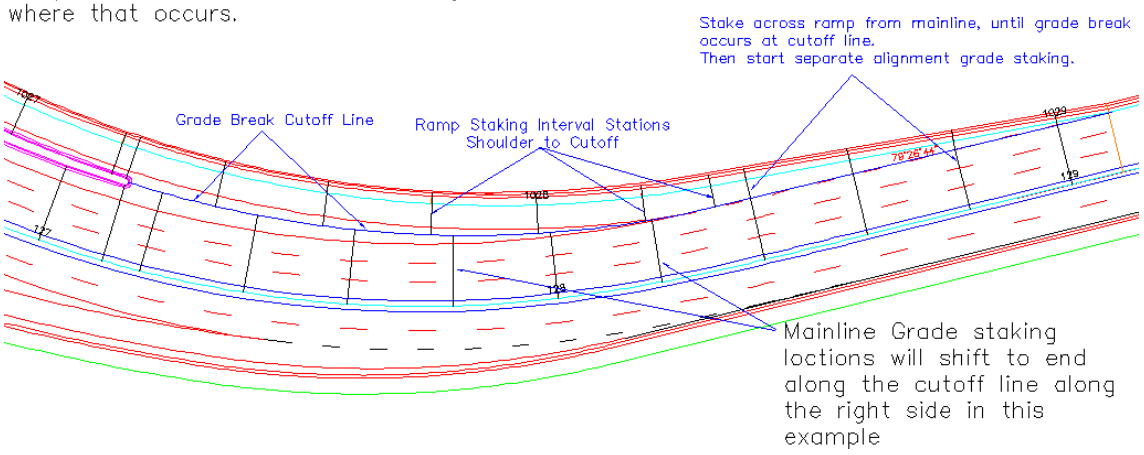


500.01.F Intersections

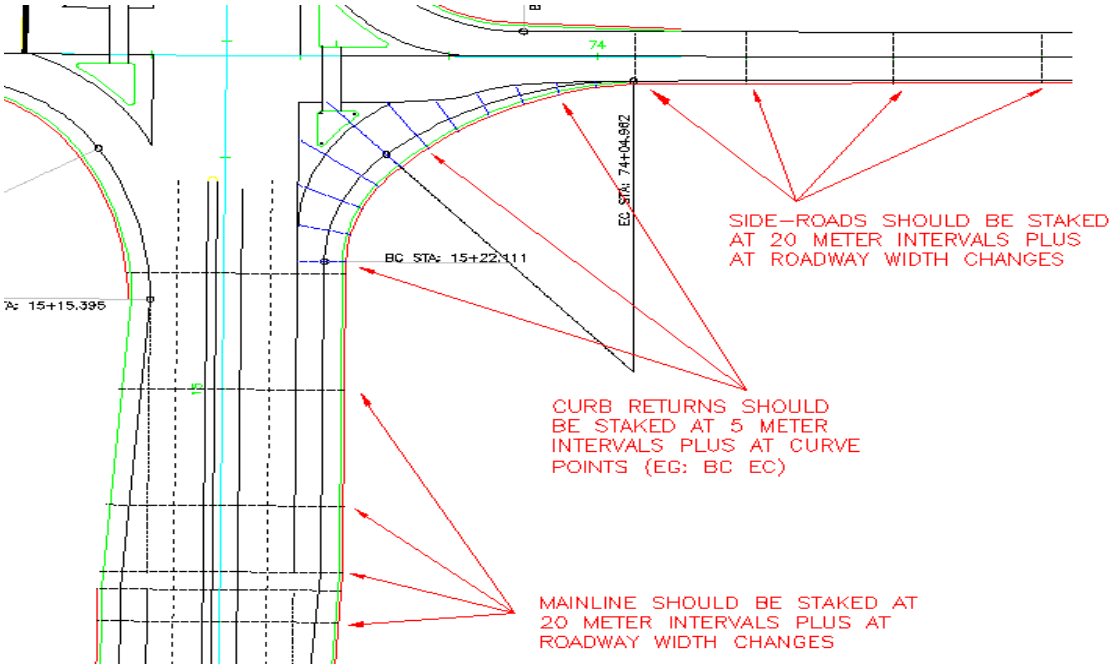
Intersection layout often requires an awareness of various grade break locations between converging/diverging mainline and ramp alignments, intersections, intersection islands, roundabouts, acceleration/deceleration laning, gravel structure variations between different alignments, and gore area grade break locations. Layout procedure for grade staking these areas must ensure that the laning grade cutoff locations match 3D DTM location cutoffs. The following examples are a guide to appropriate staking during some grade break cutoff scenarios.

Example 1: Gore Area Cutoff Line and Grade Staking Locations

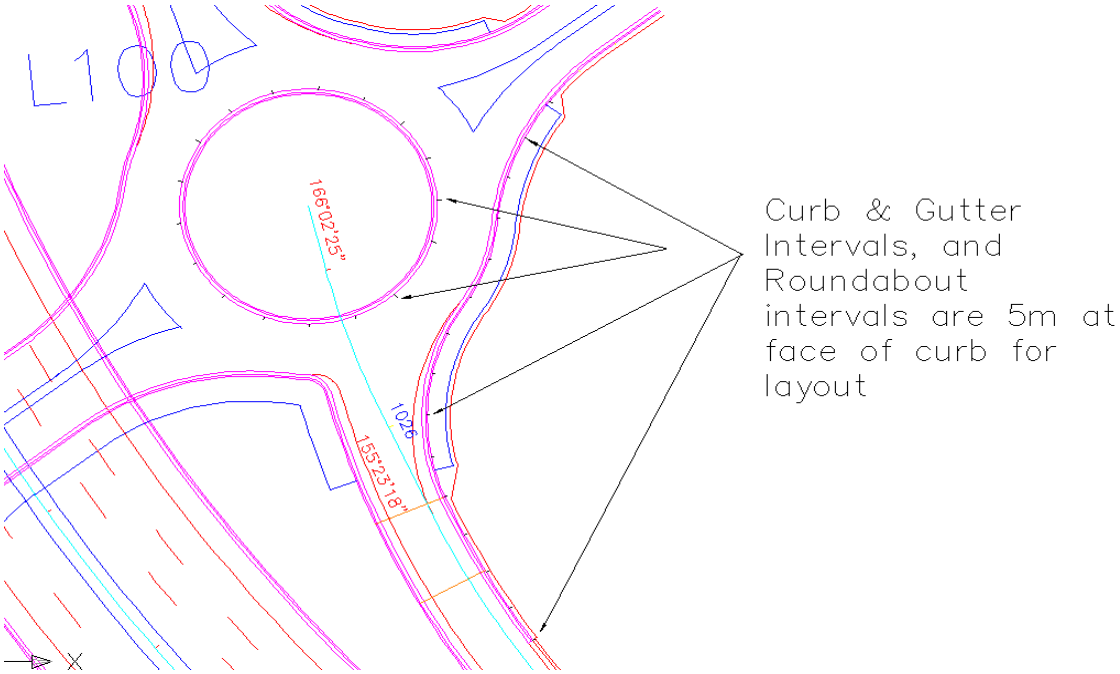
Gore area Grade Break Staking Intervals will also indicate where the "Grade Break" will diverge from the mainline, almost always in the Gore area. Where this occurs, Grade Staking stationing layout will also begin on the ramp alignment, with the stakes positioned on the appropriate ramp shoulder, and on the cutoff line. Generally, the Grade break cutoff line, indicating the divergence of grades, is near the starting point of the painted gore area. This may include the requirement of differing depths of gravel grades. Where different gravel depths occur between a mainline and a ramp it must be indicated on the grade stakes at the station where that occurs.



Example 2: Intersection Approach and Off/On Ramps



Example 3: Roundabout and Curb & Gutter



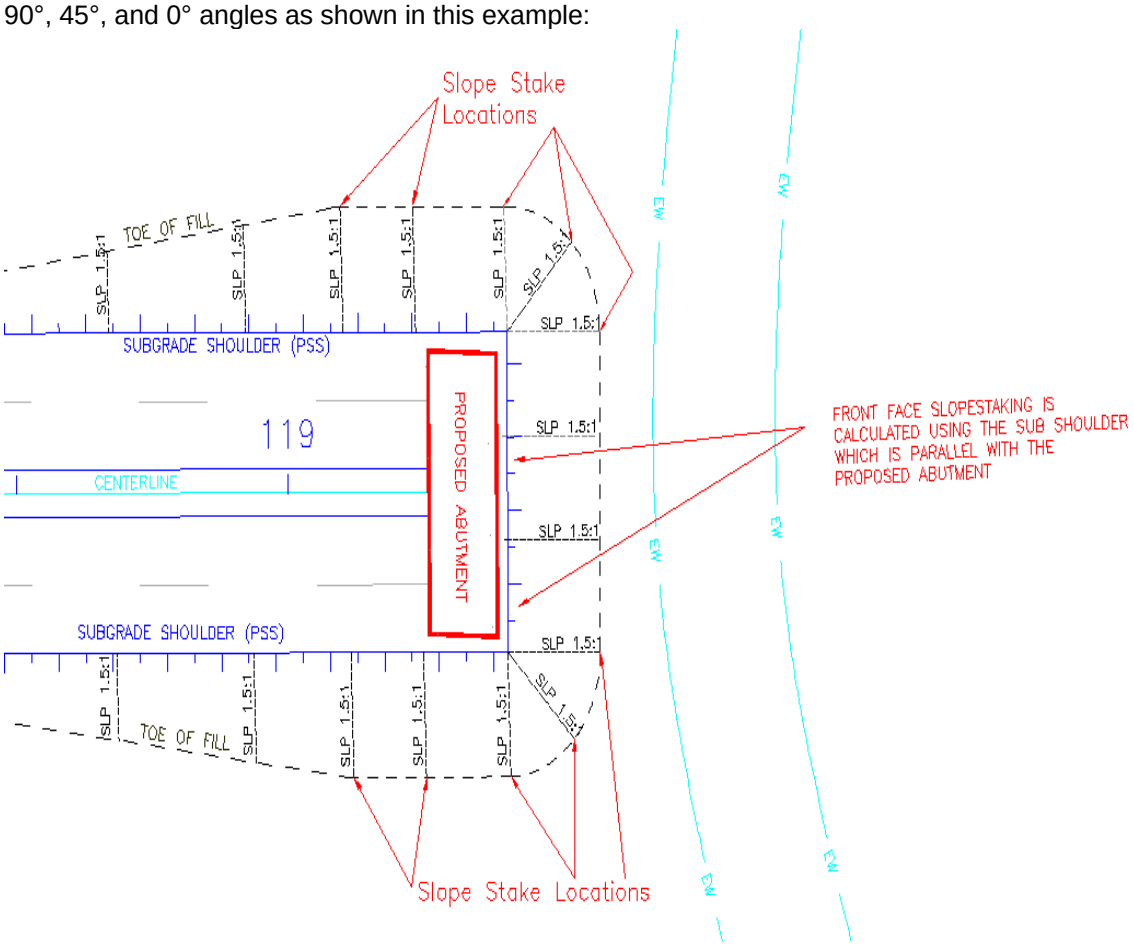
500.01.G Bridge End Fills

- Close attention is required, especially on higher fills, by setting alignment stakes to ensure the subgrade shoulder points are constructed accurately and at the correct perpendicular or other angle of skew required (see examples following).
- On cuts/fills greater than 10m the ministry representative may require placement of another set of slope stakes during the fill process.
- Bridge plans must be consulted to secure staking control/alignment information for bridge end fill layout. Particular care must be taken to ensure that the front skew alignment/elevations are accurate.

Example 1: Slope Staking Bridge End Fills – 90-degree Abutment Skews

This is a plan view example of a **90-degree skew** (perpendicular to centerline) for slope staking a bridge endfill.

This scenario provides a 1½ to 1 (1½:1) slope on both side slopes and the front face slope toward the creek. To establish the toe of the front face and corner curves locations, stakes are calculated from the corner abutments, offset to **subgrade shoulder** locations, and placed at 90°, 45°, and 0° angles as shown in this example:



Example 2: Slope Staking Bridge End Fills – Angular Abutment Skew

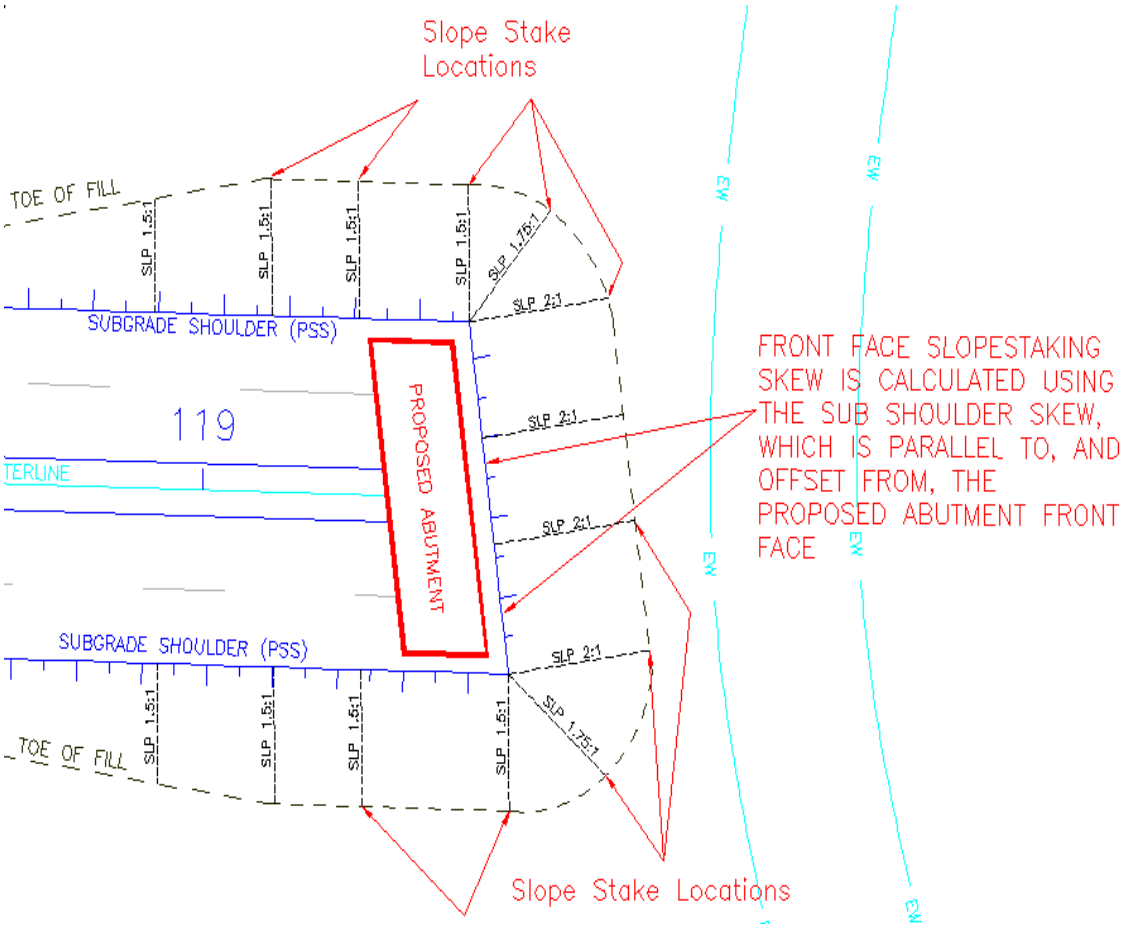
This is a plan view example of an abutment with **non-90 degree skew alignment** (not perpendicular to centerline) for slope staking a bridge endfill.

This scenario provides a 1½ to 1 (1½:1) slope on both side slopes and a 2:1 front face slope, along the skew, toward the creek.

To establish the toe of the side slope and corner curves locations, stakes are calculated from the corner abutments subgrade locations, and placed at **90°** (perpendicular to the **centerline-road horizontal alignment**).

The **45°** and **0°** slopes are calculated from the **skew alignment** along the **face of abutment**. If the front slope is **2:1** the 45° point becomes **1.75:1** to enable matching to the side slopes at **1.5:1**.

This will establish a front face toe that allows proper skew to match the proposed abutment skew at subgrade shoulder. The front face distance from the abutment to the Sub Shoulder along the face or skew alignment, will usually be determined by the Bridge drawings to ensure sufficient room for the abutment.

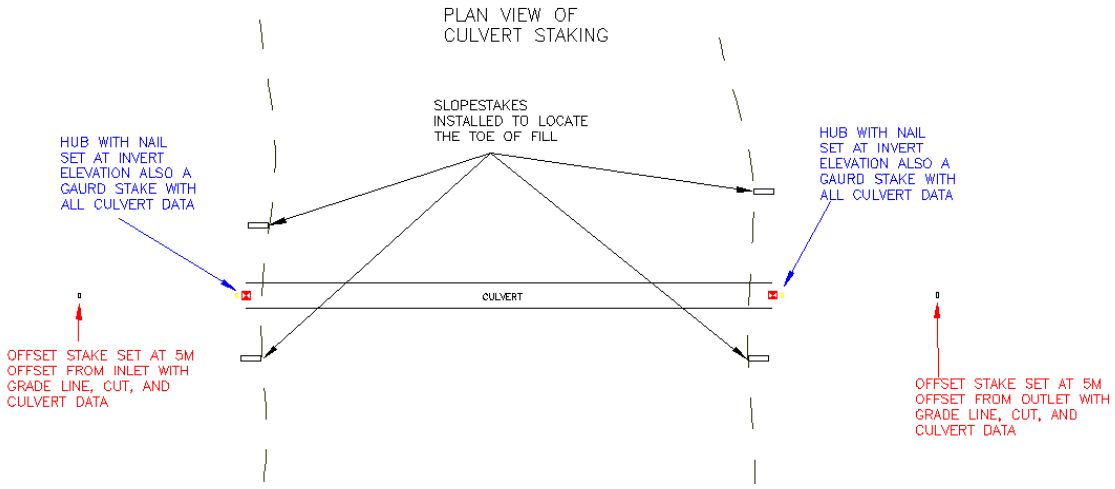


500.02 Drainage

Blue flagging is required for all drainage layout.

500.02.A Culverts

- Station/offset (i.e. culvert length) and/or elevations for culvert layout may require deviation from the design to suit field conditions (field fit)
- Offset hubs with guard stake for inlets and outlets (guard stake indicates cut/fill and offset to culvert inverts from nail in hub). Hubs are placed along the skew of pipe at each end.
- Guard stake should include pipe size, type, length information and percent grade along pipe.
- Place a stake or painted pavement marking at each pipe bend/elbow, indicating the degree of bend
- Slope stakes may be required at culvert inlet and outlet locations



500.02.B Ditching

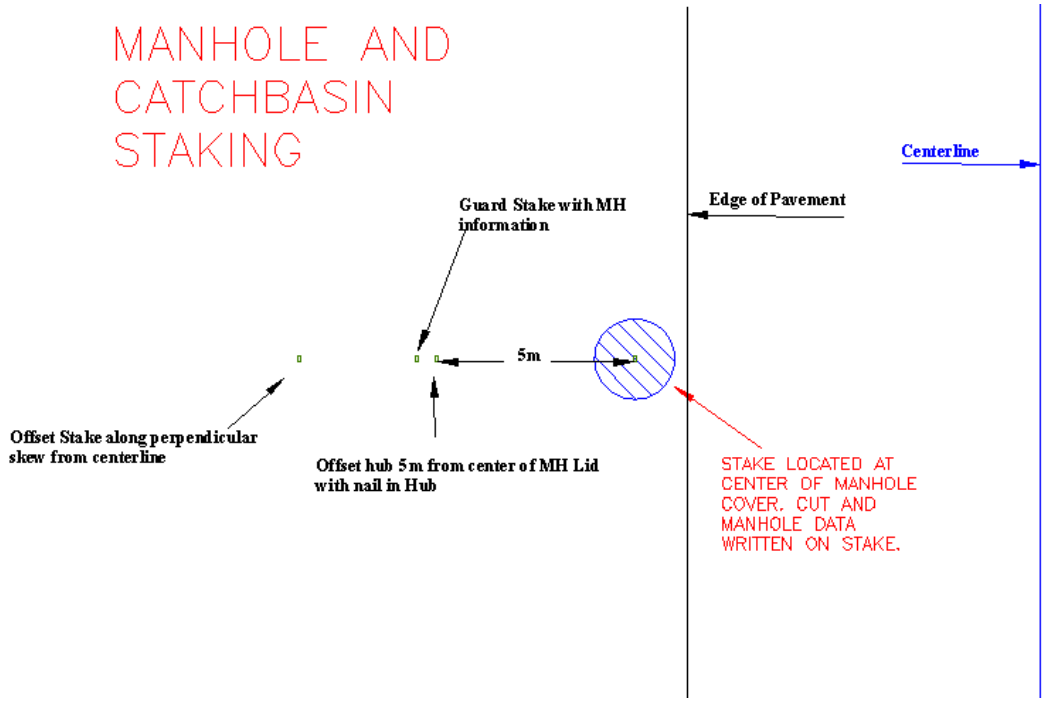
- Staking for special ditching situations (e.g. false grading) may require ditch specific slope and grade staking
- Check that the CAiCE design deliverable includes special ditching as part of the design

500.02.C Headwalls, Inlet/Outlet Structures

- Minimum requirement – refer to design drawings or Standard Specifications section 303.31.04
- Layout methods to be determined by mutual agreement between client and contractor

500.02.D Catch Basins / Manholes

- Communication between ministry representative, site foreman/superintendent and surveyor regarding flexibility/methods of preferred layout
- Refer to Standard Specifications section 582.32/33 and Standard Specification drawings (CBs SP582-02.02) and (MHs SP582-03.02) to ensure proper placement of barrel and lid (**be aware of offset lids on certain types of manholes and catch basins**)
- Minimum requirement: place a stake at the center of the catch basin, place offset hub with nail at 5m, place guard stake with required information 0.10m behind hub and add one offset stake perpendicular to the alignment approximately 3m further.



500.02.E Curb & Gutter

- Minimum 10m interval on tangents
- Minimum 5m interval or quarter points on intersection/access curve alignments (see example 2 diagram in 500.01.F)
- Offset requirements: nail in hub or spike in ground offset 1m back of gutter with guard stake indicating cut/fill and offset to gutter grade
- Stakes required at each end of letdown and at each end of transition for driveways, sidewalks, wheelchair ramps, etc.
- Stakes required at reverse gutter areas (e.g. Traffic Circles), clearly defining start and end of reverse gutter, ensuring the hub elevations reflect the actual revised gutter.
- Mountable curb may require hubs offset at more than one metre from gutter (offset as necessary to allow construction)

500.02.F Extruded Curb

- Layout with paint and/or nails along face/edge of curb
- Guideline marks at 20m intervals maximum
- Guideline marks at 5m intervals maximum along curves for traffic islands
- Continuous paint line (via roping method) must connect guideline marks

500.02.G Intersections & Roundabouts

- Minimum 5m interval or quarter points on intersection/access curve alignments
- See examples in grading section 500.01.F

500.02.H Sidewalks

- Stakes should indicate type of sidewalk (paver stones, concrete, asphalt, etc.)
- Start and end locations
- Letdowns (commercial / residential / wheel chair ramps)
- Widths of sidewalk

500.02.I Islands

- Grade staking of road widened so gravel widths will accommodate paving 0.5m behind curb face, or as per design
- Intervals determined by curb returns (provide minimums)
- Curb types are found in Standard Specifications drawing SP582-01.04 and SP582-01.02
- Letdowns (commercial / residential / wheel chair ramps)

500.02.J Structures/Steel Multi-plates

- Verify structure workpoints are accurate

500.03 Utilities

500.03.A Underground

Potential conflicts arising from existing and design utilities must be resolved (usually via communication with the design coordinator and/or project manager).

Prior to commencing works, procedures require notification of **BC One Call – Call Before You Dig**. http://www.bconecall.bc.ca

- Notification of ministry representative, and site superintendent/foreman prior to commencing works is also required
- Ensure communication between ministry representative, site foreman/superintendent, and surveyor regarding flexibility/methods of preferred layout

500.03.B Electrical

- White and yellow survey ribbon required
- Ensure communication between ministry representative, site foreman/superintendent, and surveyor regarding flexibility/methods of preferred layout. Minimum standards must be met as follows:
    - Layout center of pedestal and 2 offset hubs with nails at 2m and 4m (or further depending on pedestal size) with guard stakes aligned perpendicularily to the relevant alignment (i.e. usually the road EP, back of curb, back of sidewalk). Cut/fill elevation information and type of pedestal written on guard stake is required. Junction boxes near pedestals: layout with distance/offset/elevation as per Standard Specifications. Junction box types and sizes written on guard stake are required.
    - Stand alone junction boxes: center of junction box and one offset stake (perpendicular to relevant alignment on rectangular JBs). Junction box types and sizes written on offset stake are required.
    - When staking layout for pedestals and JBs, finished grade/back of sidewalk elevations should be crosschecked with CAiCE design data to avoid conflicts.

500.03.C Asphalt

- Method of grade break identification determined by mutual agreement between client and contractor (paint line, staking)
- Identify centerline, lane lines, EP at 100m on tangents and 20m on curves
- Identify islands with extra width paving required for completion of curbing
- Layout of asphalt curb areas – mark start/end locations
- Identify spillways etc.

**** DO NOT LAYOUT ASPHALT LIMITS FROM GRADE OR SLOPE STAKES ****

500.03.D Barrier

- Layout with paint and/or nails along the face/edge of barrier
- Guideline marks at 20m intervals along curves (maximum)
- Guideline marks at 100m intervals along tangents (maximum)
- Stake or paint to identify start/end and transition locations
- Continuous paint line (via roping method) must connect guideline marks

500.03.E Paint Lines

- Mark start and end of tangents 100m (minimum 50m intervals may be required at the direction of the ministry representative)
- 100m minimum distance along tangents (or as directed by the ministry representative)
- 20m minimum distance on curves/spirals (or as directed by the ministry representative)
- Marking required at:
    - Taper points
    - Gore areas
    - Crosswalks
    - Stop bars

500.03.F Milling/Overlay

- Layout records (cut sheets) must be produced
- Paint cuts/fills directly on pavement at 5m grid interval
- Survey of proposed milling area may be required

500.03.G Signing

- Stake at sign location complete with sign number (e.g. R1 = Stop Sign)
- Website: www.th.gov.bc.ca/publications/eng_publications/electrical/most_pm.pdf

500.03.H Fencing

- 10 meter intervals on tangent
- Layout as per design
- 0.300m inside of right of way when no design is available
- A stake is required at all corners and kinks
- A stake is required at all gate locations

500.03.I Landscaping

- Identify all landscaping areas as per design, or by mutual agreement between the ministry representative and the contractor.

600 Quality Management for Construction Supervision

600.01 Quality Assurance

- Quality assurance is defined as proving the quality of the product
- QA checks should be 10% to start, and may be increased or decreased as warranted
- Some quality assurance checks on layout are detailed in all construction contracts
- Other quality assurance examples that may be required throughout the project:
- Evidence of QA on all surfaces (each surface must tie accurately to previous surface)
- All electronic and hardcopy files, field notes, sketches and calculations for layout and/or pickup must be retained by ministry representative and/or contractor for quality management purposes

Examples of quality assurance plans can be found on the internal MoT Field Services website (select Quality Management Plan link).

http://gww.th.gov.bc.ca/gwwr2/Content/FieldServices3/qm.asp

600.02 Quality Control

Examples of quality assurance plans can be found on the internal MoT Field Services website referenced above.

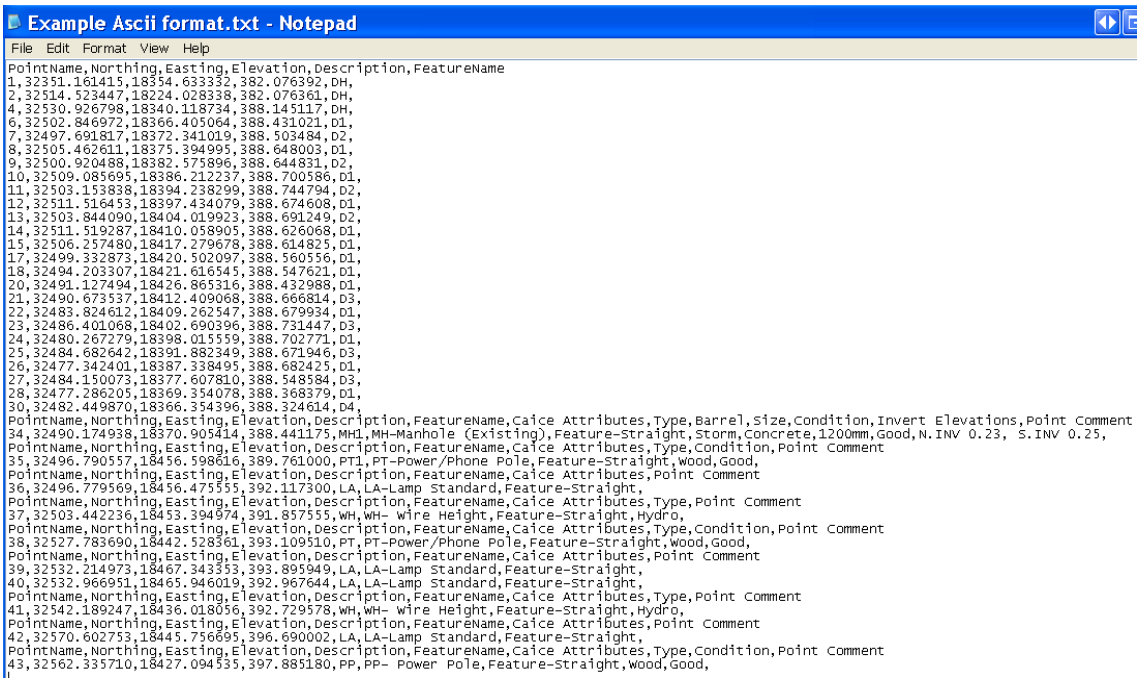
600.03 Survey Files

- Survey data must be provided to the ministry representative in raw (un-edited) and reduced formats (e.g. TDS Survey Pro RAW and JOB file formats).
- If the contract terms of reference requires the processed survey in the BCMoT Standard Survey File Format (MTS), refer to section 1000 of the General Survey Guide.

600.04 Topographic Survey File Structure

Refer to the General Survey Guide, section 700, Quality Control Methods, Records, Results, and Reporting.

Example: Reduced Survey File Showing Points and Points with Attributes (ASCII format)



Example Ascii format.txt - Notepad

File Edit Format View Help

```
PointName,Northing,Easting,Elevation,Description,FeatureName
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2,32514.523447,18224.028338,382.076361,DH,
4,32530.926798,18340.118734,388.145117,DH,
6,32502.846972,18366.405064,388.431021,D1,
7,32497.691817,18372.341019,388.503484,D2,
8,32505.462611,18375.394995,388.648003,D1,
9,32500.920488,18382.575896,388.644831,D2,
10,32509.085695,18386.212237,388.700586,D1,
11,32503.153838,18394.238299,388.744794,D2,
12,32511.516453,18397.434079,388.674608,D1,
13,32503.844090,18404.019923,388.691249,D2,
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15,32506.257480,18417.279678,388.614825,D1,
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20,32491.127494,18426.865316,388.432988,D1,
21,32490.673537,18412.409068,388.666814,D3,
22,32483.824612,18409.262547,388.679934,D1,
23,32486.401068,18402.690396,388.731447,D3,
24,32480.267279,18398.015559,388.702771,D1,
25,32484.682642,18391.882349,388.671946,D3,
26,32477.342401,18387.338495,388.682425,D1,
27,32484.150073,18377.607810,388.548584,D3,
28,32477.286205,18369.354078,388.368379,D1,
30,32482.449870,18366.354396,388.324614,D4,
PointName,Northing,Easting,Elevation,Description,FeatureName,Caice Attributes,Type,Barrel,Size,Condition,Invert Elevations,Point Comment
34,32490.174938,18370.905414,388.441175,MH1,MH-Manhole (Existing),Feature-Straight,Storm,Concrete,1200mm,Good,N.INV 0.23, S.INV 0.25,
PointName,Northing,Easting,Elevation,Description,FeatureName,Caice Attributes,Type,Condition,Point Comment
35,32496.790557,18456.598616,389.761000,PT1,PT-Power/Phone Pole,Feature-Straight,Wood,Good,
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36,32496.779569,18456.475555,392.117300,LA,LA-Lamp Standard,Feature-Straight,
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37,32503.442236,18453.394974,391.857555,WH,WH- Wire Height,Feature-Straight,Hydro,
PointName,Northing,Easting,Elevation,Description,FeatureName,Caice Attributes,Type,Condition,Point Comment
38,32527.783690,18442.528361,393.109510,PT,PT-Power/Phone Pole,Feature-Straight,Wood,Good,
PointName,Northing,Easting,Elevation,Description,FeatureName,Caice Attributes,Point Comment
39,32532.214973,18467.343353,393.895949,LA,LA-Lamp Standard,Feature-Straight,
40,32532.966951,18465.946019,392.967644,LA,LA-Lamp Standard,Feature-Straight,
PointName,Northing,Easting,Elevation,Description,FeatureName,Caice Attributes,Type,Point Comment
41,32542.189247,18436.018056,392.729578,WH,WH- Wire Height,Feature-Straight,Hydro,
PointName,Northing,Easting,Elevation,Description,FeatureName,Caice Attributes,Point Comment
42,32570.602753,18445.756695,396.690002,LA,LA-Lamp Standard,Feature-Straight,
PointName,Northing,Easting,Elevation,Description,FeatureName,Caice Attributes,Type,Condition,Point Comment
43,32562.335710,18427.094535,397.885180,PP,PP- Power Pole,Feature-Straight,Wood,Good,
```

600.05 Layout Report

A station/offset, cut/fill report as required for grade staking and/or DTM design grade checks.

Example: Offset Stake Cut Sheet Report

Station	Offset	Offset Length	Cut(-)/Fill(+)	As-Built El	Design El
102+20.000	Left	8.150	-4.713	388.489	383.775
102+30.000	Left	8.241	-5.401	388.666	383.265
102+40.000	Left	8.155	-6.023	388.736	382.713
102+50.000	Left	8.517	-6.643	388.744	382.101
102+60.000	Left	8.725	-7.255	388.701	381.446

600.06 Clearing & Grubbing, Right of Way, Working Easements

A station offset report for checking against design contract drawings.

Example: Point and Offset Stake Cut Sheet Report

Station	Offset Dir.	Offset Len.
102+20.000	Left	8.150
102+30.000	Left	8.241
102+40.000	Left	8.155
102+50.000	Left	8.517
102+60.000	Left	8.725

600.07 Slope Staking

A report that includes station/offset, cut/fill, design slope, observed slope, design elevation, actual elevation, ahead on station, horizontal distance to CL and horizontal distance to HP. Observation of field slope stake may be recorded in the point comment.

Example: Slope Stake Cut Sheet Report

Station	Offset Dir.	Cut/Fill	Design Slope (H/V)	Actual El	Design El	Ahead On Station	HD to Hinge Pt	VD to Hinge Pt	HD to Center Line	Observed Slope (H/V)
101+60.000	Left	Fill	1.500	378.342	370.363	-0.067	23.227	-15.406	30.592	1.508
101+70.000	Left	Fill	1.500	378.412	370.507	-0.020	22.667	-15.107	30.114	1.500
101+80.000	Left	Fill	1.500	378.427	370.511	0.005	22.249	-14.816	29.783	1.502
101+90.000	Left	Fill	1.500	378.303	370.403	-0.006	21.933	-14.622	29.757	1.500
102+00.000	Left	Fill	1.500	378.171	370.262	-0.039	21.588	-14.382	29.312	1.501
102+10.000	Left	Fill	1.500	378.578	370.712	0.427	20.290	-13.560	28.312	1.496

600.08 Grade Staking

A station/offset cut/fill report.

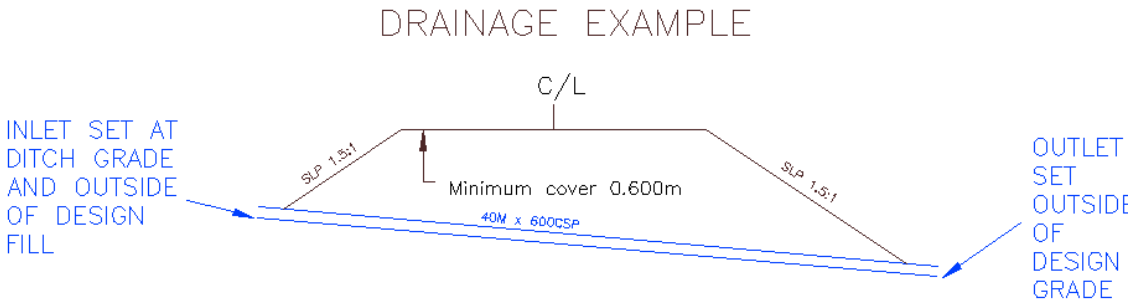
Example: Offset Stake Cut Sheet Report

Station	Offset	Offset Length	Cut(-)/Fill(+)	As-Built El	Design El
102+20.000	Left	8.150	-4.713	388.489	383.775
102+30.000	Left	8.241	-5.401	388.666	383.265
102+40.000	Left	8.155	-6.023	388.736	382.713
102+50.000	Left	8.517	-6.643	388.744	382.101
102+60.000	Left	8.725	-7.255	388.701	381.446

600.09 Drainage

600.09.A Culverts/Multi-Plates/Etc…

Inlet, outlet and size of pipe must ensure adequate cover and length to fit design slopes. A "field fit" by surveyor may be different from design locations. Field fit elevations to suit may be required. Ministry representative must be informed.



600.09.B Ditching

See slope staking. Care should be taken for special ditching or false grading scenarios.

600.09.C Curb & Gutter

Station/offset, cut/fill, design elevation, actual elevation, ahead on station, horizontal distance to CL report. Checks on actual offset hubs. Curb and gutter layout notes and documentation.

600.10 Intersections

Station/offset and cut/fill reports (see example in section 600.08)

600.11 Utilities

Station offset elevation report

600.12 Sidewalks

Station/offset and elevation report with point comments defining the start and end of letdowns

600.13 Islands

Station/offset and elevation report with point comments defining the start and end of letdowns

600.14 Asphalt

Station/offset and elevation report

600.15 Paint Lines

Station/offset report with point comments defining stop bar and crosswalk locations

600.16 Milling/Overlay

CAiCE area report and/or station/offset report:

```
>>>> Chain Areas <<<< [Thu Apr 03 16:43:46 2008]
********************************************************************************
CHAIN MILL1
List          07EP177,04EP382,385-386,390-391,393-394,397-398,402-403,427,429-430
List          ,433,437,440-442,07EP177
Layer         225
Feature       PDS
********************************************************************************
CHAIN AREA 1416.27 sq. m. 0.14 hectares
********************************************************************************
```

600.17 Signing

Station/offset and attributes report (i.e. sign number)

600.18 Fencing

Station/offset, fence type report

600.19 Landscaping

CAiCE area report and/or station offset (see example in section 600.16)

600.20 Surcharge & Settlement Monitoring

Ensure monitoring is performed and documented as per geotechnical engineering plan. The geotechnical engineer is responsible for providing recommendations for data tracking.

600.21 As-Builts

Refer to section 1270.2 of the BC Supplement to TAC Geometric Design Guide (CAiCE Design Project Data Format Terms of Reference – Policy Exceptions).
http://www.th.gov.bc.ca/publications/eng_publications/geomet/TAC/TAC.htm

600.22 Surveyor Knowledge and Experience Requirements

RISP-Registration, Identification, Selection, and Performance Evaluation System

RISP Category Glossary section 06-11 “Construction Survey”:
http://www.th.gov.bc.ca/erisp/documents/RISP_Category_Glossary.pdf

RISP Adjudication Criteria link section 06-11:
http://www.th.gov.bc.ca/erisp/documents/RISP_Adjudication_Criteria.pdf

- Under the Construction Surveying Category, a company wishing to submit a proposal must propose surveyors having sufficient TDS Survey Pro and Foresight DXM software knowledge and experience. Proposals must detail relevant knowledge and experience.
- Surveyor responsibilities include, but may not be limited to: knowledge of payment methods for units on current contract - i.e. cubic/square metres, lineal quantities etc, OG & as-built surveys, construction progress surveys (remeasures), daily diary, photo logs and reports.
- Surveyors will be familiar with the “Construction Supervision Survey Guide” minimum standards (this guide).

600.23 Electronic Survey Data Requirements

The ministry requires field data collection and layout procedures to be performed using TDS Survey Pro or an approved alternate software.

Generated data files are required in the following formats:

- CAiCE generated hardcopy grade sheets created via CAiCE BC MoT macro
- CAiCE design surface DTMs which are translated (via the Foresight DXM translation utility tool) to a TDS-DTM that is functional within TDS Survey Pro. These DTMs are primarily used, in conjunction with an alignment, for grade checking of any surface that produces station/offset and cut/fill information. See examples in section 200.04.
- LandXML 2D alignments translated via CAiCE BC MoT macro
- LandXML 3D cross-section design surface files translated via CAiCE BC MoT macro (see example below)
- TDS Survey Pro RD5 and TP5 files produced by a CAiCE BC MoT macro. These files are primarily used in the calculation and setting out or checking of slope stakes.

600.23.A CAiCE Generated Grade Sheets

Station 702+08.058 Surface FINISH
685146.8262639 N 511880.6515371 E Azimuth = 97°34'29.0"

FC							PTF	PSS	PBP	PGP	PSH
Elev							911.767	913.199	913.495	913.643	913.791
Off							-15.136	-12.989	-12.545	-12.322	-12.1
Slope							-1.50:1	-1.50:1	-1.50:1	-1.50:1	horz

FC	PSH	PEP	PLE	PLE	PLE	PCL	PLE	PLE	PLE	PEP	PSH
Elev	913.791	913.889	913.864	913.834	913.805	**913.794**	913.784	913.754	913.724	913.699	913.597
Off	-12.1	-11.8	-8.7	-5.0	-1.3	**0.0**	1.3	5.0	8.7	11.8	12.1
Slope	-3.07:1	0.81%	0.81%	0.81%	0.81%		-0.81%	-0.81%	-0.81%	-0.81%	-2.93:1

FC	PGP	PBP	PSS	PDP	PDC	PBC	PTC				
Elev	913.444	913.292	912.988	912.838	912.788	912.988	916.827				
Off	12.405	12.71	13.165	13.39	14.39	14.69	20.448				
Slope	-2.00:1	-2.00:1	-1.50:1	-1.50:1	-20.0:1	1.50:1	1.50:1				

Station 702+08.058 Surface SUBGRDE
685146.8262639 N 511880.6515371 E Azimuth = 97°34'29.0"

FC											PTF
Elev											911.767
Off											-15.136
Slope											-1.50:1

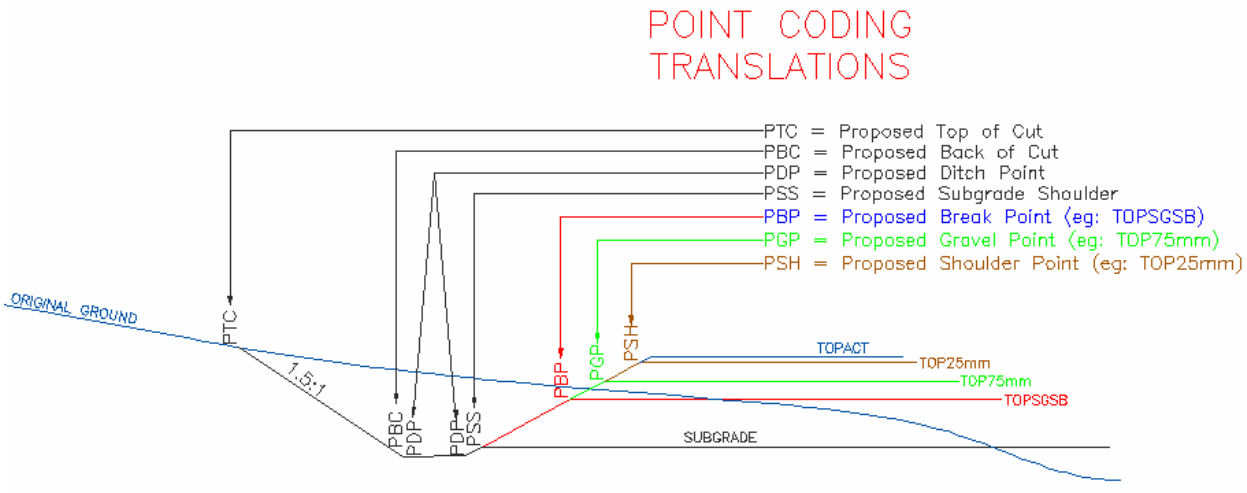
FC	PSS										PSS
Elev	913.199	913.191	913.164	913.134	913.105	**913.094**	913.084	913.054	913.024	912.997	912.988
Off	-12.989	-12.1	-8.7	-5.0	-1.3	**0.0**	1.3	5.0	8.7	12.1	13.165
Slope	0.81%	0.81%	0.81%	0.81%	0.81%		-0.81%	-0.81%	-0.81%	-0.81%	-0.81%

FC	PDP	PDC	PBC	PTC							
Elev	912.838	912.788	912.988	916.827							
Off	13.39	14.39	14.69	20.448							
Slope	-1.50:1	-20.0:1	1.50:1	1.50:1							

600.23.B Ministry Codes for Cross Section Design Break Points

Some examples of point coding generated in/from a CAiCE x-section EAR file:

- **PTC** = Proposed Top of Cut
- **PTF** = Proposed Toe of Fill
- **PBC** = Proposed Back of Cut
- **PDP** = Proposed Ditch Point
- **PDC** = Proposed Ditch Center
- **PSS** = Proposed Subgrade Shoulder
- **PBP** = Proposed Break Point (i.e TopSGSB)
- **PGP** = Proposed Gravel Point (i.e Top75mm)
- **PSH** = Proposed Shoulder Point (i.e. Top25mm)
- **PCZ** = Proposed Clear Zone (see the diagram example 2 in section 500.01.D)



600.23.C Design surface DTMs

Design surface DTMs (Digital Terrain Models), used in conjunction with an alignment, are required for the purpose of project grade checks. Design DTMs are produced from the “shoulder to shoulder” points of the selected design cross-section template surface (25mm, 75mm, SGSG, SubGrade, etc.) from a CAiCE design cross-section EAR file. Interval selection in the EAR file, for the formation of a particular design surface DTM, should match the required staking layout intervals of a particular project, while including staking requirements at all surface widening points.

Note the example diagrams showing incorrect/correct DTM formation in section 200.04. If the design DTM is to be used in conjunction with 3D Machine Control Grading, please refer to section 200.05.

600.23.D LandXML format alignments (2D alignments)

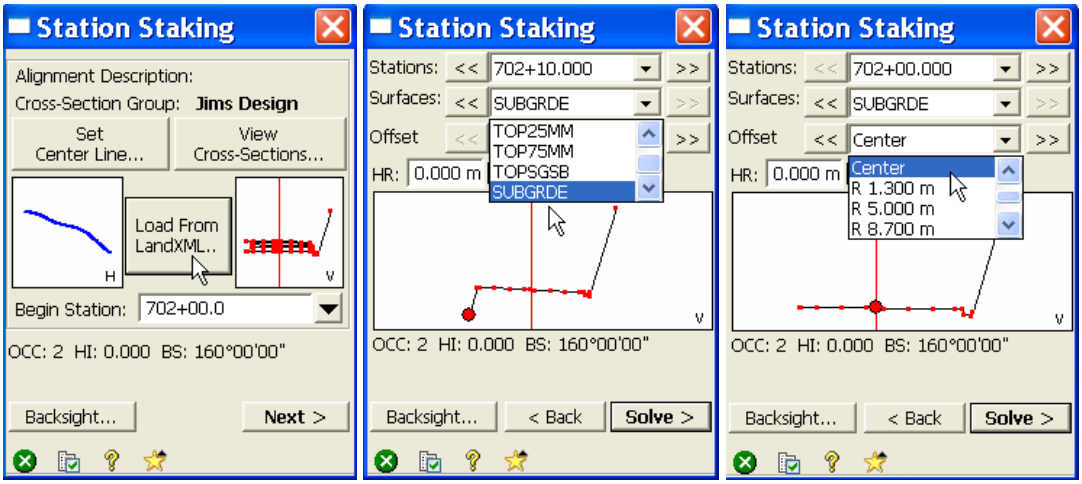
LandXML 2D alignments are primarily used to obtain station/offset data with no elevations. They can be used alone, for 2D survey requirements, or in conjunction with station/offset and cut/fill information obtained from a design surface DTM.

600.23.E TDS Survey Pro RD5 and TP5 files

RD5 files are 3D alignments (both horizontal and vertical information). TP5 files are x-section template arms, used in conjunction with an RD5 file. These files are used primarily for slope staking functionality.

600.23.F LandXML Template Design Surfaces

LandXML x-section surface files, that are functional within TDS Survey Pro software, are generated from CAiCE EAR files via a Ministry of Transportation designed macro. Functionality includes user selection of station, surface, and offset for grade stake layout or existing grade stake checks.



600.23.G BC MoT (Construction & Survey) Standard Feature Code Files

These files are used for assigning point codes, and point attributes for a given survey shoe. The files are available on the ministry website at: http://www.th.gov.bc.ca/caice

600.23.H Foresight DXM Reports

Various reports required will include the following, produced from Foresight DXM Version 3.2.1 Software. Files transferred from TDS Survey Pro.

- DTM Grade check reports example in section 600.05
- Station/Offset report example in section 600.06
- Slope Stake reports example in section 600.07
- Grade Stake reports example in section 600.08

700 Documentation

700.01 Introduction

Surveyor's quality management documentation should be complete with the following items:

- Check sheets
- Field drawings
- Sketches and Diaries
- Project photos
- Equipment reports
- All report files generated from survey files
- All plan marked up contract drawings in current Ministry AutoCAD DWG format
- JOB/RAW and any edited survey files

The two electronic data formats that could be specified are either the TDS Foresight DXM edited and reduced file format (TXT) including attributes, or, if reduction and editing has been completed in CAiCE or some other software package, the BCMoT survey file format (MTS).

700.02 As-Builts

Refer to section 1270.2 of the BC Supplement to TAC Geometric Design Guide (CAiCE Design Project Data Format Terms of Reference – Policy Exceptions).
http://www.th.gov.bc.ca/publications/eng_publications/geomet/TAC/TAC.htm

700.03 Surveyor Knowledge and Experience Requirements

Surveyor knowledge and experience should be detailed in the BC MoT RISP system.

RISP Registration, Identification, Selection, and Performance Evaluation System:

RISP Category Glossary section 06-11 "Construction Survey"
http://www.th.gov.bc.ca/erisp/documents/RISP_Category_Glossary.pdf

RISP Adjudication Criteria section 06-11
http://www.th.gov.bc.ca/erisp/documents/RISP_Adjudication_Criteria.pdf

Under the construction surveying category, a company wishing to submit a proposal must propose surveyors having sufficient TDS Survey Pro and Foresight DXM software knowledge and experience. Proposals must detail relevant knowledge and experience.

Companies submitting alternate survey software and methods must be approved by ministry software experts and the ministry representative. Alternate methods may be required to employ ministry generated data files from the CAiCE software.

Surveyor responsibilities will include, but may not be limited to: knowledge of payment methods for units on current contract - i.e. cubic/square meters, lineal quantities, etc, OG surveys, as-built surveys, construction progress surveys (remeasures), daily diary, photo logs and reports.

800 Appendix

800.01 Flagging Color Table

Flag Type	Color(s)
Right of Way	Blue & White
Clearing & Grubbing	Red & White
Working Easements	Pink
Slope Staking-Fills	Orange
Slope Staking-Cuts	Yellow
SubGrade-Grade Stakes	Orange
SGSB-Grade Stakes	Pink
75mm-Grade Stakes	Red
25mm-Grade Stakes	Blue

Policies on Entry to Private Land

As per section 1100.1 of the General Survey Guide.

800.02 BC MoT 2007 Construction Description Codes

The feature/description codes listed below are a sub-set of the CAiCE BCMoT Global Feature Table to be used when completing ministry construction supervision surveys.

Two Listings are provided below for **description** codes:

800.02. A: is in alphabetical order by **"Codes"**

800.02. B: is in alphabetical order by **"Descriptions"**

800.02.A In Alphabetical Order by Codes

Code	Description	Code	Description
A	Type A Horizon	LA	Lamp Standard
AB	Edge of Asphalt Binder Course	LG	Lagoon
AC	Asphalt Curb	LP	Lead Plug
AE	Area of Exclusion	LR	Loose Rock
AF	Active Flood Plain	LS	Lt. Shoulder (existing)
AL	Asphalt Levelling	LT	Lt. Toe (existing)
AN	Anchor	MB	Mailbox
AS	Asphalt Spillway	MD	Manhole (proposed)
AW	Abutment Wooden	MH	Manhole (existing)
B	Break in Groundline	MN	Concrete Post Monument
BA	Railway Ballast	MP	Swimming Pool
BB	Bridge	MS	Marsh/Swamp
BC	Back of Cut Slope	OB	Overbreak
BCM	Standard Brass Cap Monument	OG	Original Ground
BD	Boundary Line	OL	Oil Line
BG	Building	OV	Overhang
BH	Bush Line	P	Pavement
BI	Bin Wall	PA	Patio
BL	Broken White Line	PB	Telephone Booth
BM	Benchmark	PC	Plastic Pipe
BN	Broken Rock	PD	Pedestal
BO	Boulder	PE	Pier
BP	Shoulder Break Point	PF	Flag Pole
BR	Base of Rock	PG	Piling
BS	Bottom of Slope	PH	Power/Phone with Transformer
BU	Abutment	PI	Traverse PI
BW	Base of Wall	PL	Pavement Lt. (existing)
C	Centerline (L-Line)	PN	Pipeline
C	Type C Horizon	PO	Guard Post
CA	Abutment Concrete	PP	Power Pole
CB	Catch Basin (existing)	PR	Pavement Rt. (existing)
CC	Concrete	PS	Power Pole with Transformer
CD	Concrete Driveway	PT	Power/Phone Pole
CE	Concrete Pad	RA	Rest Area
CF	Bottom of Curb	RB	Roadside Barrier
CG	Cattle Guard	RD	Road
CI	Culvert Inlet	RE	Retaining Wall
CK	Center of Creek (narrow waters)	RI	RipRap
CL	Centerline (existing)	RIP	Round Iron Pin
CM	Catch Basin/Manhole	RP	Reference Point

Code	Description	Code	Description
CN	Concrete Pillar	RPM	Rock Post Monument
CO	Culvert Outlet	RR	Railway
CR	Crown of Road	RS	Rt. Shoulder (existing)
CS	Corrugated Steel	RT	Rt. Toe (existing)
CT	Cast Iron	RW	Right of Way
CU	Concrete Curb	S	Stripping
CUL	Culvert	SA	Sand
CW	Crosswalk	SE	Spot Elevation
CZ	Clear Zone	SF	Sluff (Scarp)
D	Type D Horizon	SG	Seepage
DB	Decorative Boulder	SI	Road Sign
DC	Ditch Center	SM	Stream
DE	Ditch Edge	SN	Traffic Signal
DG	Drainage Grate	SR	Solid Rock
DH	Detail Hub/Traverse Hub	SS	Subgrade Shoulder Point
DIP	Dominion Iron Post	ST	Septic Tank
DL	Double Yellow Line	SU	Sanitary Sewer
DM	Deadman	SV	Service Meter
DO	Delineator Post	SW	Sidewalk/Walkway
DP	Ditch Point	SZ	Staircase/Steps
DR	Dirt Road	T	Talus
DS	Storm/Sewer Drain	TA	Traffic Counter
DT	Decorative Tree	TB	Top of Slope
DY	Daylighting Start Point	TC	Toe of Cut
EA	Easement Line	TE	Tree
EG	Edge of Gravel	TF	Toe of Fill
EH	Extreme High Water	TH	Test Hole
EO	Electrical Outlet	TI	Trail (Mapping Requirement)
EP	Edge of Pavement	TL	Tree Line
ET	Edge of Travelled Road	TO	Toe
EW	Edge of Water	TP	Telephone Pole
FC	Filler Cap	TR	Top of Rock
FE	Fence	TT	Test Pit
FH	Fire Hydrant	TU	Curb Top
FL	Flume	TW	Top of Wall
FN	Foundation	TX	Traffic Signal Control Box
FT	Fuel Tank	UE	Underground Power
FU	Fuel/Gas Pump	UG	Underground Miscellaneous
G	Garage	UM	Underground Marker
GA	Gate Post	UP	Utility Pole
GB	Gazette Boundary	US	Underground Gas Service Line
GC	Clearing & Grubbing	UT	Underground Telephone
GE	Power Guy Pole	V	Valve
GK	Ground Crack	VN	Vegetation
GL	Gravel	VP	Breather/Vent Pipe
GM	Gas Main	W	Well
GN	Garden	WE	Waste
GR	Gravel Road	WH	Wire Height
GS	Guard Rail with Posts	WL	White Line
GT	Telephone Guy Pole	WM	Water Meter
GU	Gutter	WN	Wooden Post
GV	Gas Valve	WP	Witness Post
GW	Guy Wire	WR	Water Main

Code	Description	Code	Description
GY	Power/Phone Guy Pole	WS	Weighscale
H	House	WT	Water Reservoir Tank
HD	Head Wall	WV	Water Valve
HF	Hog Fuel	WW	Wing Wall
HG	Hedge	XA	Change to Type A
HT	High Tension Tower	XB	Change to Type B
HV	High Tension Pole	XC	Change to Type C
HW	High Water Mark	XD	Change to Type D
I	Island	XG	Change to Gravel
IB	International Boundary	XO	Change to OG
IE	Indefinite Elevation	XR	Change to RipRap
IP	Standard Iron Pin	XS	Change to Stripping
JB	Junction Box	YL	Yellow Line
K	BC Tel Kiosk	ZB	Type B Horizon
KK	Culvert Kink	ZC	Type C Horizon
L	Lawn	ZZ	Miscellaneous

800.02.B In Alphabetical Order by Descriptions

Code	Description	Code	Description
BU	Abutment	JB	Junction Box
CA	Abutment Concrete	LG	Lagoon
AW	Abutment Wooden	LA	Lamp Standard
AF	Active Flood Plain	L	Lawn
AN	Anchor	LP	Lead Plug
AE	Area of Exclusion	LR	Loose Rock
AC	Asphalt Curb	LS	Lt. Shoulder (existing)
AL	Asphalt Levelling	LT	Lt. Toe (existing)
AS	Asphalt Spillway	MB	Mailbox
BC	Back of Cut Slope	MH	Manhole (existing)
BR	Base of Rock	MD	Manhole (proposed)
BW	Base of Wall	MS	Marsh/Swamp
K	BC Tel Kiosk	ZZ	Miscellaneous
BM	Benchmark	OL	Oil Line
BI	Bin Wall	OG	Original Ground
CF	Bottom of Curb	OB	Overbreak
BS	Bottom of Slope	OV	Overhang
BO	Boulder	PA	Patio
BD	Boundary Line	P	Pavement
B	Break in Groundline	PL	Pavement Lt. (existing)
VP	Breather/Vent Pipe	PR	Pavement Rt. (existing)
BB	Bridge	PD	Pedestal
BN	Broken Rock	PE	Pier
BL	Broken White Line	PG	Piling
BG	Building	PN	Pipeline
BH	Bush Line	PC	Plastic Pipe
CT	Cast Iron	GE	Power Guy Pole
CB	Catch Basin (existing)	PP	Power Pole
CM	Catch Basin/Manhole	PS	Power Pole with Transformer
CG	Cattle Guard	GY	Power/Phone Guy Pole
CK	Center of Creek (narrow waters)	PT	Power/Phone Pole
CL	Centerline (existing)	PH	Power/Phone with Transformer
C	Centerline (L-Line)	RR	Railway
XG	Change to Gravel	BA	Railway Ballast
XO	Change to OG	RP	Reference Point
XR	Change to RipRap	RA	Rest Area
XS	Change to Stripping	RE	Retaining Wall
XA	Change to Type A	RW	Right of Way
XB	Change to Type B	RI	RipRap
XC	Change to Type C	RD	Road
XD	Change to Type D	SI	Road Sign
CZ	Clear Zone	RB	Roadside Barrier
GC	Clearing & Grubbing	RPM	Rock Post Monument
CC	Concrete	RIP	Round Iron Pin
CU	Concrete Curb	RS	Rt. Shoulder (existing)
CD	Concrete Driveway	RT	Rt. Toe (existing)
CE	Concrete Pad	SA	Sand
CN	Concrete Pillar	SU	Sanitary Sewer
MN	Concrete Post Monument	SG	Seepage
CS	Corrugated Steel	ST	Septic Tank
CW	Crosswalk	SV	Service Meter

Code	Description	Code	Description
CR	Crown of Road	BP	Shoulder Break Point
CUL	Culvert	SW	Sidewalk/Walkway
CI	Culvert Inlet	SF	Sluff (Scarp)
KK	Culvert Kink	SR	Solid Rock
CO	Culvert Outlet	SE	Spot Elevation
TU	Curb Top	SZ	Staircase/Steps
DY	Daylighting Start Point	BCM	Standard Brass Cap Monument
DM	Deadman	IP	Standard Iron Pin
DB	Decorative Boulder	DS	Storm/Sewer Drain
DT	Decorative Tree	SM	Stream
DO	Delineator Post	S	Stripping
DH	Detail Hub/Traverse Hub	SS	Subgrade Shoulder Point
DR	Dirt Road	MP	Swimming Pool
DC	Ditch Center	T	Talus
DE	Ditch Edge	PB	Telephone Booth
DP	Ditch Point	GT	Telephone Guy Pole
DIP	Dominion Iron Post	TP	Telephone Pole
DL	Double Yellow Line	TH	Test Hole
DG	Drainage Grate	TT	Test Pit
EA	Easement Line	TO	Toe
AB	Edge of Asphalt Binder Course	TC	Toe of Cut
EG	Edge of Gravel	TF	Toe of Fill
EP	Edge of Pavement	TR	Top of Rock
ET	Edge of Travelled Road	TB	Top of Slope
EW	Edge of Water	TW	Top of Wall
EO	Electrical Outlet	TA	Traffic Counter
EH	Extreme High Water	SN	Traffic Signal
FE	Fence	TX	Traffic Signal Control Box
FC	Filler Cap	TI	Trail (Mapping Requirement)
FH	Fire Hydrant	PI	Traverse PI
PF	Flag Pole	TE	Tree
FL	Flume	TL	Tree Line
FN	Foundation	A	Type A Horizon
FT	Fuel Tank	ZB	Type B Horizon
FU	Fuel/Gas Pump	C	Type C Horizon
G	Garage	ZC	Type C Horizon
GN	Garden	D	Type D Horizon
GM	Gas Main	US	Underground Gas Service Line
GV	Gas Valve	UM	Underground Marker
GA	Gate Post	UG	Underground Miscellaneous
GB	Gazette Boundary	UE	Underground Power
GL	Gravel	UT	Underground Telephone
GR	Gravel Road	UP	Utility Pole
GK	Ground Crack	V	Valve
PO	Guard Post	VN	Vegetation
GS	Guard Rail with Posts	WE	Waste
GU	Gutter	WR	Water Main
GW	Guy Wire	WM	Water Meter
HD	Head Wall	WT	Water Reservoir Tank
HG	Hedge	WV	Water Valve
HV	High Tension Pole	WS	Weighscale
HT	High Tension Tower	W	Well
HW	High Water Mark	WL	White Line

Code	Description	Code	Description
HF	Hog Fuel	WW	Wing Wall
H	House	WH	Wire Height
IE	Indefinite Elevation	WP	Witness Post
IB	International Boundary	WN	Wooden Post
I	Island	YL	Yellow Line

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BC Bid

BC Government advertising site for procurement opportunities to suppliers via an electronic sourcing system.

http://www.bcbid.gov.bc.ca

BC One Call

Call before you dig notification center. Call prior to commencing excavations.

http://www.bconecall.bc.ca

CAiCE

Computer Aided Civil engineering software produced by Autodesk. CAiCE is the current Ministry of Transportation design and construction application software. Also known as CAiCE Visual Transportation.

CAiCE EAR File Format

A cross-section file format used by the CAiCE engineering software.

Conventional Total Station Survey

A ground survey conducted using Total Station Theodolites or Transits. These instruments may also be robotic, and/or robotic/direct reflex capable instruments.

Direct Reflex

A methodology for collecting survey data without the use of mirror prisms. A survey shot from a Total Station that is capable of “direct reflex” will produce a horizontal angle, vertical angle, and slope distance reading via the reflectivity of the point desired.

DTM or Design DTM

A digital terrain model (triangulated) or a design surface digital terrain model. An example of a design DTM surface would be a DTM representing a design grading surface such as the top of 25mm surface model.

Electronic Design Information

Data such as CAiCE design data (DTMs, templates, etc.), AutoCAD drawings and other applicable files that are transferable to and from user’s computer workstations, field data collectors, etc.

Foresight DXM

Tripod Data Systems PC software Foresight DXM is a standard data transfer and editing of survey data software currently used by the Ministry of Transportation Field Services and Ground Modelling sections. Engineering data coming to/from CAiCE and other engineering software and to/from field survey data collectors may be viewed and edited with this software.

General Survey Guide

Traffic, electrical, highway safety and geometric standards for the Engineering Branch of the Ministry of Transportation.

An MoT minimum standards guide for location survey and procedures:

http://www.th.gov.bc.ca/publications/eng_publications/eng_pubs.htm#survey

LiDAR

Light Detection and Ranging. LiDAR is a multiple survey point data collection method using multiple laser shots, usually from a fixed wing or helicopter aircraft.

Ministry Representative

A Ministry of Transportation project field crew or ministry appointed consultant project field crew that acts on behalf of the ministry as the client for contracted construction projects.

RISP – Registration, Identification, Selection, and Performance Evaluation

The Ministry of Transportation's RISP program is designed to ensure open and equitable selection of consultants for Ministry contracts of less than $1 million, with priority given to local delivery of services when applicable.

http://www.th.gov.bc.ca/erisp/home.htm

Robotic Total Station

A Total Station that is driven by gears or magnetic rotation systems that will automatically track a prism. Robotic systems allow survey tasks to be completed by a single user in many instances.

TDS (Tripod Data Systems) Survey Pro

TDS Survey Pro Version 4.5.2 is the current standard data collector software for Ministry of Transportation Field Services survey staff.

WorkSafeBC

Formerly the Workers Compensation Board of British Columbia

http://www.worksafebc.com

3D Machine Control Grading

Fully automatic, machine controlled grade control systems. An automated control system on excavators, dozers, or graders that works in conjunction with GPS-RTK, GNSS-GPS RTK or conventional location systems that function with design electronic engineering data storage interpretation and implementation systems. These systems may preclude the need for standard staking operations.