

BC Ministry of Transportation and Infrastructure

Construction Supervision Survey Guide

Workflow and Project Data Requirements

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Contents

100 Overview.....	1
100.01 Overview.....	1
100.02 Requirements For Use of Workflows and Standards	1
100.03 Construction Surveyor Duties and Responsibilities.....	2
100.04 Geomatics General Survey Guide	2
100.05 Standard Specification for Highway Construction.....	2
100.06 Survey Equipment and Software	3
100.07 Civil 3D Survey and Design Terms of Reference	3
100.08 Safety, Traffic Control and Property / ROW Entry Policies.....	4
100.09 Provision of Electronic Information to Contractor	4
100.10 Survey Instruments.....	5
100.11 Construction Tender Data Package CTD.....	5
100.12 Construction Survey Data Package (CSDP)	5
200 Construction Surveyor Standardized Components	7
200.01 Construction Survey Folders and Data Organization	7
2.01.01 Construction Survey Data Package.....	10
2.01.02 Records and Correspondence	10
2.01.03 Survey Control	11
2.01.04 Downloaded Field Data	11
2.01.05 Geomatics Design	11
2.01.06 Horizon and Remeasure	11
2.01.07 Spot, Linear and Area Surveyed Quantities.....	12
2.01.08 Layout Data	12
200.02 Construction Survey Codes.....	13
200.03 Survey Linework Creation.....	13
200.04 Data Collector Downloads	14
200.05 Naming Standards	15
200.06 TBC Standards for Construction Survey Workflows	17
2.06.01 Feature Definition FXL File	17
2.06.02 TBC Project Templates	19
2.06.02.01 TBC Project Coordinate Zones	19
2.06.03 Drafting Templates	22

2.06.04 Text Styles and Alignment Labels	22
200.07 TBC Project Management.....	22
2.07.01 Project Graphics and Reference surfaces.....	23
2.07.01.01 Project Graphic Reference	23
2.07.01.02 Reference surfaces.....	24
2.07.02 TBC Project Folders	24
300 General Survey Requirements.....	26
300.01 Spot and Linear Feature Codes.....	26
300.02 Survey Point Accuracy	26
300.03 Point and Linestring Point Density / Spacing.....	26
3.03.01 Linestrings and Surfaces	27
3.03.02 Point Spacing / Density.....	28
300.04 Working with Ground Modeler	30
400 Geomatics and Design Data Consumption.....	31
400.01 TBC Project Creation – Design Data Consumption.....	31
500 Survey Control	33
500.01 Primary Control Points	33
500.02 Secondary Control	34
500.03 Primary and Secondary Survey Control Tolerances	34
500.04 Secondary Survey Control Point Names and Feature Codes.....	35
5.04.01 Secondary Control Point Names.....	35
5.04.02 Secondary Control Point Codes.....	35
500.05 Detail Hubs	35
500.06 Quality Control	36
600 Construction Original Ground (COG).....	37
600.01 Construction Original Ground with Features	37
600.02 Construction Original Ground Without Features	38
600.03 Construction Original Ground TBC Project Setup.....	38
600.04 Construction Original Ground COG Surface Model.....	40
600.05 COG Data Transfer to Ground Modeler	42
700 Horizon and Remeasure Surveys, Surface Modeling and Volumes	44
700.01 Horizon Surfaces.....	44
7.01.01 Stripping	44
700.02 Remeasure Surfaces	45

700.03 Horizon and Remeasure Feature Codes	45
700.04 TBC Horizon and Remeasure Project Setup	47
700.05 Horizon and Remeasure Surface Modeling	49
700.06 Volume Calculations	49
7.06.01 Stripping Volumes	50
7.06.02 TYPED Volumes.....	50
7.06.03 TYPEA Volumes.....	50
7.06.04 Volume Calculation in Trimble Business Center.....	51
7.06.05 TBC Selection Sets, View Filters and Construction Data Management.....	52
7.06.05.01 TBC Selection Sets.....	52
7.06.05.02 TBC View Filters	53
800 Spot, Linear and Area Survey Quantity Calculations	57
800.01 Survey Codes	57
800.02 TBC Project Creation.....	57
900 Other Types of Surveys.....	59
900.01 Monitoring.....	59
900.02 Pits and Piles.....	59
1000 Survey Data Tracking and Quantity Reports	60
1000.01 Survey Data File Tracking	60
10.01.01 Survey Controller Data File Tracking	60
10.01.02 Survey Task Data File Tracking	60
1000.02 Survey Quantity Tracking	61
1100 Layout Quality Assurance Surveys.....	63
1100.01 Right of Way	63
1100.02 Clearing and Grubbing.....	63
1100.03 Working Easements / License to Construct.....	64
1100.04 Slope Staking	64
11.04.01 Slope Staking Requirements.....	65
11.04.02 Slope Stake Inscriptions – Front and Back Views	65
11.04.03 Slope Stake Inscriptions – Side View	66
11.04.04 Cross Section Codes.....	67
1100.05 Grade Staking	71
11.05.01 Intersection Layout.....	72
11.05.02 Bridge End Fills	74

1100.06 Drainage	76
11.06.01 Culverts.....	76
11.06.02 Ditches.....	78
11.06.03 Headwalls, Inlet and Outlet Structures	78
11.06.04 Manholes and Catch Basins.....	78
11.06.05 Curb & Gutter	79
11.06.06 Extruded Asphalt Curb.....	79
11.06.07 Sidewalks	80
11.06.08 Islands.....	80
11.06.09 Asphalt.....	80
11.06.10 Roadside and Median Barriers	80
11.06.11 Paint Lines	80
11.06.12 Pavement Milling and Overlay	81
11.06.13 Signage	81
11.06.14 Fencing	81
1100.07 Private Utilities	81
11.07.01 Electrical Utilities.....	82
1200 Quality Management for Construction Supervision.....	83
1200.01 Project Folders.....	83
1200.02 Survey Data Files – Location and Naming	83
1200.03 Survey Data Files – Content.....	84
1200.04 TBC Projects and Templates	84
1200.05 Reports	84
1200.06 Survey Data Tracking	85
1200.07 Quantity Data Tracking.....	85
1200.08 Cross Section Codes.....	85
1300 As-Built Data Collection and Recording.....	86
1400 Appendix A – Construction Survey Codes	87
1500 Appendix B – Horizon and Remeasure Coding and Surfaces	88
1600 Appendix C – Flagging Colour Table	89
1700 Appendix D – Glossary of Terms	90

100 Overview

The Construction Supervision Survey Guide has been developed to bring consistency to the workflows undertaken by Ministry Field Services construction surveyors, and outlines the procedures and standards required to fulfill their duties.

The intended audience for this guide includes Ministry and consultant surveyors engaged with construction supervision activities. This document covers a range of topics and is designed to be used as a contract terms of reference, and as a minimum standards reference guide.

The Construction Supervision Survey Guide has been developed by the BC Ministry of Transportation Field Services Workflow and Technology Working Group.

100.01 Overview

The BC Ministry of Transportation Field Services Division administers construction supervision activity for road and highway construction projects in British Columbia. Standardized construction supervision workflows are required for the following:

1. Provide Quality Assurance checks for work completed by construction contractors.
2. Support monthly payments to contractor based on field measurement and calculations.
3. Ensure all survey records and calculations are completely auditable by a third party.
4. Provide consistent framework for training and continued development of workflows.

The 2 predominantly technical roles and associated major tasks on the construction supervision team are as follows:

- **Ground Modeler** – Civil 3D (C3D) expert responsible for 90% detailed design complete data compliance check to ensure data follows the Civil 3D Geomatics and Design Terms of Reference, preparation of the construction survey data package for construction surveyors, processing design corridor models against measured construction horizons and “actual” volume calculations, and support to construction surveyors on an as needed basis.
- **Construction Surveyor** – Trimble Business Center (TBC) expert responsible for construction original ground survey and surface, horizon and remeasure surveys and surfaces, construction quantity (removals and new) calculations and QA on contractor layout.

Standardized components used to fulfill the needs of the construction supervision workflow are provided for both Civil 3D and Trimble Business Center and are addressed in this manual.

The primary data deliverable to the construction supervision team is a standardized Civil 3D construction archive consisting of design model and production drawings, which was prepared by a geomatics and design team.

100.02 Requirements For Use of Workflows and Standards

The workflows and standards outlined in this document are required to be used in the following circumstances:

- Construction supervision teams consisting of Ministry staff only.
- Construction supervision teams consisting of Ministry staff and consultants.

It is recommended that construction supervision teams formed exclusively by consultants follow the workflows and standards outlined in this document, but it is not required. If consultants are not using workflows and standards outlined in this document, then they must ensure that their processes and data will stand up to a detailed audit in the event of a dispute, or litigation.

100.03 Construction Surveyor Duties and Responsibilities

This section describes the duties and responsibilities of the construction surveyor. Please note that the construction surveyor may have technical interactions with the project ground modeler on the construction supervision team. For details on workflows and standards applicable to the ground modeler role, refer to the Ministry's Ground Modeling manual.

The primary duty of the construction surveyor is to provide QA (quality assurance) on the work completed by the contractor. Quality assurance has many components however, the following bullets represent the major tasks to be completed by the construction surveyor on road and highway construction projects to support the quality assurance mandate:

1. **Survey Control** – establish secondary survey control on the site for instrument setup for subsequent observations and measurements.
2. **COG Feature and Surface Model** - conduct construction original ground surveys to create existing conditions feature and surface models with the former being used as the basis for calculating removal quantities, and the latter as a basis for earthworks calculations.
3. **Horizon and Remeasure Surveys, Surfaces and Volumes** – conduct horizon and remeasure surveys and surface to calculate monthly excavation quantities for the various materials encountered on site.
4. **Spot, Linear and Area Quantity Surveys** – survey and record newly constructed point, linear and area features for the purpose of quantification.
5. **Quality Assurance on Construction Layout** – work with layout data files provided by GMG to validate the correctness of contractor layout stakes before grading occurs.

All aspects of these major tasks must incorporate Ministry quality management mandates to ensure all calculations are supported by measurements and models that can be sourced back to the original survey observations.

A suite of standardized tools for Trimble Business Center and Microsoft Excel is available to help the construction surveyor accomplish these tasks.

100.04 Geomatics General Survey Guide

Construction surveyors are expected to apply best practices when conducting field surveys. The BC [Ministry of Transportation Geomatics web page](#) contains the General Survey Guide and other information relating to conducting field surveys. Construction surveyors should become familiar with the contents of the Geomatics web page, to ensure best practices for conducting field surveys are being followed.

100.05 Standard Specification for Highway Construction

All Ministry construction projects must follow the minimum requirements for highway construction as specified in the [Standard Specification for Highway Construction](#).

100.06 Survey Equipment and Software

Ministry surveyors and consultants working with Ministry staff on construction supervision teams are required to use Trimble Access data collection software, or an approved alternate software, provided that Ministry survey codes are used. Survey equipment used in conjunction with Trimble Access or equivalent controller software shall be current total stations and/or GPS-RTK or GNSS-RTK capable equipment that meets or exceeds required survey tolerances as per the Ministry standard specifications. Consultant approval for the use of survey controller software other than Trimble Access is required from the Ministry Representative.

It is expected that:

- Survey instruments are properly maintained and that stored error corrections are current.
- Data collection and reduction procedures are discussed with and approved by the Ministry Representative.
- All field and office procedures are in line with those outlined in this document.
- All work will be performed by suitably skilled personnel.

All construction supervision surveyors must have the ability to substantiate and supply the following upon request:

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

Ministry surveyors and consultant surveyors working with Ministry staff on construction supervision teams are required to use Trimble Business Center release 5.6 or later for survey data processing and record keeping. TBC version 5.6 introduced project and surface data sharing functionality, which are both central to Ministry workflows.

The Ground Modeler on the construction supervision team will create and provide the construction survey data package (CSDP) to the construction surveyors. The CSDP is a collection of application neutral data files (XML, DWG, PDF) created from the Civil 3D archive (from designers) that can be efficiently consumed using a customized project template in TBC. None of the major tasks (previous section) completed by the construction surveyor are to be completed using Civil 3D.

100.07 Civil 3D Survey and Design Terms of Reference

The BC Ministry of Transportation Civil 3D Terms of Reference (ToR) document outlines standards and data submission and assembly requirements for the preparation of both geomatics and detailed design data. The C3D ToR is a required document for survey and design consultants providing services to the Ministry, and was created to:

1. Ensure standardized data deliverables to construction supervision teams.
2. Provide consistency in the appearance of production drawings.
3. Form a reference point for continued development and improvements.

The Civil 3D construction archive represents a standardized data handoff to construction supervision teams. For more information on the C3D ToR refer to the BC Ministry of Transportation [Civil 3D Resources web page](#).

100.08 Safety, Traffic Control and Property / ROW Entry Policies

Safety

The Ministry is a safety-oriented organization with provincial, regional, and district level occupational health and safety committees. All employees are expected to perform their duties in a safe manner, adhering to all laws, regulations, and rules affecting their work. Copies of safety assessments are to be kept on file and readily available upon request.

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 Health and Safety](#) website for information.

Traffic Control

Traffic control requirements are required to be adhered to, and are clearly outlined in the [BC Ministry of Transportation Traffic Management Manual for Work on Roadways](#).

Right of Way Entrance

Property owners must be contacted in writing, stating the intent, and requesting permission to enter their property if required. Refer to section 1.05 Entry onto Private Properties of the General Survey Guide on the [Ministry's Geomatics Resources web page](#) for private property entrance requirements.

The Ministry representative shall be notified prior to contacting property owners for access to private property, and notified immediately if private property access is denied. If entry onto a railway right of way is required, the Ministry Representative will contact the railway company to seek permission prior to accessing the railway right of way. Special instructions regarding railway right of way access are to be followed.

100.09 Provision of Electronic Information to Contractor

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.

100.10 Survey Instruments

Construction surveyors are provided with survey instruments for total station, robotic and GNSS surveying. Survey instrument are to be cleaned and maintained as follows:

- **Cleaning** - all survey equipment is cleaned regularly and peripheral equipment such as tribrachs, level bubbles, cables, etc. are checked regularly and adjusted or replaced, if necessary.
- **Regular Maintenance** - survey equipment is regularly field inspected and calibrated including horizontal and vertical collimation, tilt axis correction, and tracker calibration.
- **Yearly Maintenance** - survey equipment is sent in once a year to a service center for maintenance, factory calibration, and certification.

100.11 Construction Tender Data Package CTDp

Design consultants are required to submit a construction tender data package (CTDP) with the Civil 3D construction archive, to complete the project design phase. This requirement is outlined in the [BC Ministry of Transportation Supplement to TAC](#) Section 100.5.5.12 Deliverables. CTDp specifications can be found in the Ministry's Civil 3D Terms of Reference document in Section 1280.11.02.02 (2300 Tender Data) available on the [Ministry's Civil 3D Resources](#) page.

The CTDp is a collection of data files (no Civil 3D) that represents the design elements of the project and are provided to construction contractors during tendering as part of Schedule T3, Contract Specific Reference Documents. Contractors use this data to help prepare their tender responses, which prevents the expensive and time-consuming recreation of design data in various contract estimating software packages and allows for more emphasis on construction execution.

A summary of the standardized contents in the CTDp is as follows:

- Vectorized PDF plan set tender / production drawings
- Vectorized PDF design model data from 100 series plan drawings
- AutoCAD 2D DWG design model data from 100 series plan drawings
- Survey control in XML
- Existing (pre-design) surfaces in XML
- Control alignment and profile in XML
- Proposed surfaces in XML
- Proposed underground culverts and utilities in XML
- Earthworks reports in XLSX (Excel)

Data is provided in a standardized folder structure and delivered within the Civil 3D project folder structure containing the Civil 3D construction archive. The CTDp also forms the basis for the construction survey data package (CSDP), which is prepared by the ground modeler for the construction supervision team, and discussed in the next section.

Details of the Construction Tender Data Package can be found in the Ministry's Civil 3D Terms of Reference document.

100.12 Construction Survey Data Package (CSDP)

The Construction Survey Data Package, prepared for each project by the ground modeler for the construction surveyor, represents a data extraction from the Civil 3D construction archive that is

exclusively for consumption by Trimble Business Center. The intent with the development of the CSDP is to eliminate construction surveyor dependency on Civil 3D.

The CSDP is created by duplicating the Construction Tender Data Package and adding layout RXL data created directly from the Civil 3D corridor models.

The CSDP folder structure, upon reception by the construction surveyor, is copied to the projects standardized construction survey folder structure (see Section 200.01).

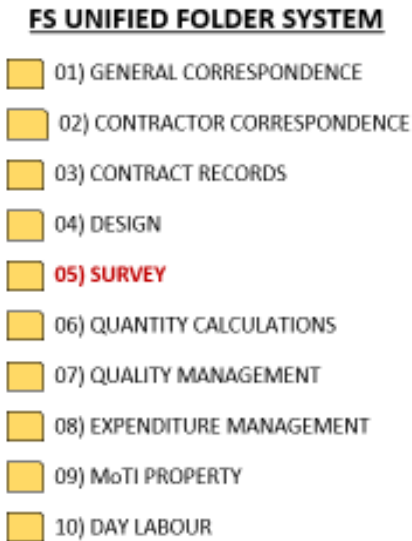
If there are design changes between IFC and IFT, or any subsequent design amendments, the Ground Modeler will communicate these changes with the construction surveyor and update the CSDP, if required.

200 Construction Surveyor Standardized Components

This following sections address the standardized components of the tools applicable to the construction surveyor. Specific folders are assigned to the various tasks undertaken by the construction surveyor.

200.01 Construction Survey Folders and Data Organization

Construction supervision survey data is in the *05) Survey* folder of the Field Services Unified Folder System.



Quality assurance protocols warrant a standardized folder structure that is used to store the following types of information:

- **Construction Survey Data Package** – extracts from Civil 3D IFT/IFC archive, created by Ground Modeler, for use in TBC
- **Records and Correspondences** – survey records and data tracking, correspondences, and requests, final quantity reports and data transfer with project ground modeler
- **Survey Control** – survey control details for project
- **Downloaded Field Data** – CSV and JXL (legal record) files downloaded from survey controller. CSV files are used to create task specific files for transfer to task specific TBC projects and folders
- **Geomatics Design** – TBC project for consumption of AutoCAD drawings residing in Construction Survey Data Package
- **Horizon and Remeasure** – Folders for data, TBC projects and quantity calculations for COG, STRP, TYPED, TYPEA and SUBEX horizon and remeasure tasks
- **Surveyed Quantities** – Folders for data, TBC projects and spot/linear/area quantity calculations for surveyed constructed features
- **Layout** – TBC Project for managing and creating construction layout data

One of the most challenging aspects of construction supervision surveyor workflows is data organization, especially given the number of tasks the construction surveyor is responsible for. Trimble Business Center version 5.6 introduced the following functionality, which is a cornerstone of Ministry construction supervision survey workflows:

- **Dynamic Project Graphic References** – a TBC project (COG, for example) can reference another TBC Project (SURVBASE, SURVUTIL, DESIGN etc.) as a graphics overlay, without loading the data and associated standardized components (layers, block etc.) into the current project.
- **Dynamic Reference surface** – a TBC project (TYPEDSTRP, for example) can reference a surface from another TBC Project (COG) for volume calculations.

Given the ability to create data references, the TBC folder structure allows for the creation of multiple TBC projects that can be inter-referenced. This is discussed in more detail in Section 200.07 Project Management.

The complete folder structure is shown in the following diagram:

Construction Surveyor Folder Structure

05) Survey



Details of these folders are discussed in the following sections.

2.01.01 Construction Survey Data Package

The *01) ConstructionSurveyDataPackage* folder contains the construction tender data package, which is a collection of geomatics and design data for TBC project consumption. The Ground Modeler performs QA on the construction tender data package and then creates layout RXL data files from Civil 3D models for construction surveyor on construction supervision team.

The Construction Survey Data Package consists of the following folders:

01) TenderDrawingsPDF

Vector PDF of drawings in production drawing set.

02) 100SeriesPlanPDFDWG

AutoCAD drawing files (no Civil 3D) showing complete drawing production models of geomatics and design data complete with all engineering annotations.

03) SurveyControlXML

LandXML file containing survey control data created by Geomatics surveyors.

04) ExistingSurfaceXML

LandXML files containing surface models for pre-engineering Geomatics surfaces.

05) AlignmentProfileXML

LandXML files containing control centreline alignment and profile data.

06) ProposedSurfacesXML

LandXML files containing proposed surfaces including datum, subgrade, granular surfaces and top.

07) ProposedGravityNetworksXML

Proposed gravity networks representative of underground utilities and culverts are provided in XML format and can be imported into Trimble Business Center.

08) EarthworksReportsXLSX

Earthworks reports for each control alignment in MS Excel format.

09) LayoutDataRXL

Layout RXL files created from Civil 3D corridors.

If required, the construction survey data package is required to be updated by the designer with IFC and design addendum changes. The construction supervision ground modeler is then notified of these changes.

2.01.02 Records and Correspondence

The *02) RecordsandCorrespondence* folder contains files reflecting all records and correspondences relating to construction survey activity. The following are the subfolders:

01) Correspondence

Outlook MSG (dragged from Outlook) and other documents supporting correspondences between construction surveyor, Ministry Representative, contractor, and other parties.

02) Records and Tracking

MS Excel XLSX workbooks and other documents used to track survey and other construction supervision data.

03) Final Quantity Reports

Final reports for removal, excavation and spot, linear and area quantities.

04) GMD Data Transfer

01) Sent and 02) Received folders for data transfer to and from the project ground modeler.

2.01.03 Survey Control

The 03) *SurveyControl* folder contains TBC project, data and other records relating to primary (and other) survey control, which has been established by Ministry Geomatics. The project survey control LandXML file is delivered as part of the construction survey data package.

2.01.04 Downloaded Field Data

The 04) *DownloadedFieldData* folder contains the 01) *CSVDownload* folder for the original, unedited CSV files downloaded from the controller, the 02) *JXLLegalDownload* folder contains the raw JXL file for each of the CSV files and the 03) *DataCollectorBackup* folder can be used to store backups for data on the controllers.

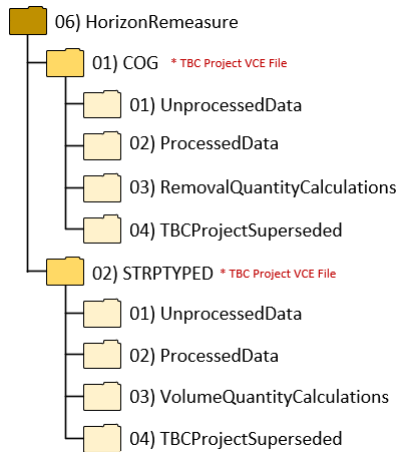
CSV files are used to export task-based CSV files for transfer and use with task-based folders in 06) *HorizonRemeasure*, 07) *QuantitiesSpotLinearArea* and 08) *LayoutData*.

2.01.05 Geomatics Design

The 05) *GeomaticsDesign* folder contains the TBC project used for modeling geomatics and design data. The DWG files provided in 01) *ConstructionSurveyDataPackage* \ 02) *100SeriesPlanPDF* DWG are imported to GeomaticsDesign TBC project. Specific geomatics and design data can be extracted from this project and used in various calculations.

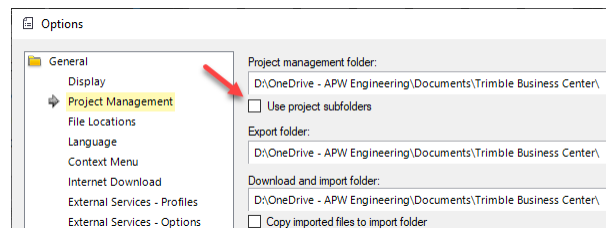
2.01.06 Horizon and Remeasure

The 06) *HorizonRemeasure* folder contains task specific subfolders for material horizon and remeasure surfaces and volume calculations. Subfolders are used for materials such as COG, STRPTYPED, TYPEA, and are where the TBC Project VCE file is saved.



Subfolders for each of the task folders are used to organize unprocessed data, processed data, quantity calculations and superseded TBC projects. Surveyors can create their own task subfolders for other horizon and remeasure tasks, provided the same subfolder structure is used. Folders under \06)HorizonRemeasure that are not required for the project can be removed.

By default, TBC creates a project subfolder which is used mostly for copying imported data files. The standard folder structure contains folders for both unprocessed and processed data, leaving it up to the construction surveyor to move imported data from the unprocessed data folder to the processed data folder. To ensure TBC does not create project subfolders, from TBC go to *File* → *Options* → *General* → *Project Management* and ensure *Use project subfolders* is toggled off, prior to creating your TBC project.



After the project has been created, you can specify the *Download and input folder* from the *Project Management* options.

Task based CSV files created from files in 04) Downloaded Field Data are copied to \06) HorizonRemeasure\01) Unprocessed Data\ folder. Once data has been imported to TBC the file is then moved to the \06) HorizonRemeasure\01) Processed Data\ folder.

2.01.07 Spot, Linear and Area Surveyed Quantities

The 07) QuantitiesSpotLinearArea folder contains task specific subfolders for various types of constructed quantities. Folder structure is similar to folders in 06) HorizonRemeasure and are used for items such as drainage, fences and barriers, or all surveyed quantities. The TBC project VCE file is stored in the task specific root folder.

2.01.08 Layout Data

The 08) LayoutData folder contains TBC project and subfolders for creating and organizing corridor layout data.

200.02 Construction Survey Codes

Consistency in the use of survey codes is of paramount importance for all construction survey related tasks. Survey codes are important as they are used for the following:

- Identify points as either spot or linework features
- Place point and line on specific layers, which are part of predefined layer groups
- Identify points and lines for surface inclusion

Available survey codes include those used by Ministry Geomatics surveyors, in addition to several codes specific to construction supervision tasks.

Construction survey codes are applicable to the following tasks:

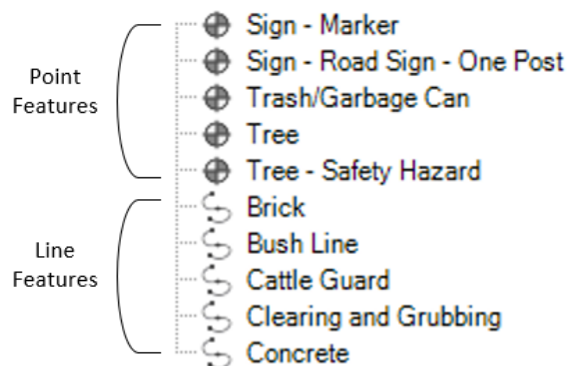
- Establishing secondary survey control
- Construction original ground surveys
- Horizon and remeasure surveys
- Spot, linear and area construction quantity surveys
- Quality assurance on construction layout activity

For the construction surveyor, the survey codes manifest themselves in the Trimble Business Center Feature Definition File (FXL). The FXL file is loaded to survey controllers in addition to all Trimble Business Center projects required to complete survey tasks.

The complete list of survey codes can be found in Appendix A of this document.

200.03 Survey Linework Creation

The Trimble Business Center Feature Definition (FXL) file, which is loaded into a TBC project, distinguishes between point feature and line feature definitions. This is most evident when you view survey point names and codes using the Feature Definition Manager.



Line feature parameters in the Feature Definition File are shown in the following illustration:

Note the survey Code, Feature (linestring) layer, Point layer and the DTM attribute for a line feature definition.

Line features are automatically connected based on alphanumeric point ID sort order encountered in the survey data file. Surveyors should strive to collect all linework consecutively along the line to properly create the linestring in TBC.

After importing a point file to TBC, use the Survey → Process Feature Codes command to process survey codes from that file against the Feature Definition (FXL) File. The Process Feature Codes command will generate the linestrings and place them on the layer specified in the Feature Definition File.

200.04 Data Collector Downloads

Data collector files downloaded from the controller, for consumption by TBC, are CSV (comma separated value) files consisting of Point ID (Name), Northing, Easting, Elevation and Code (Description) for each observation. It is important from both a quality control and auditing perspective to be able to revert back to the original, unedited file.

For this reason, all CSV files are to be downloaded to the...

\<ProjectName>\05) Survey\04) DownloadedFieldData\01) CSV Download

...task specific folder. The task specific folder is user defined. A few examples are as follows:

- COG (Construction Original Ground)
- TYPEDSTRP (TYPED and Stripping)
- TYPEA (TYPEA)
- Layout (Layout Data)
- Quantities

Construction surveyors are also required to download the corresponding JXL file, for each of the CSV files to the following folder

\<ProjectName>\05) Survey\04) DownloadedFieldData\02) JXL Legal Download

The raw data is original record of data that has not been processed for use and is required for the following reasons:

1. Serves as the legal record of what the instruments observed, whereas coordinates and elevations are derived from the raw data.
2. RAW data can be used to rederive the coordinates and elevations, in the event that total station and GPS setup parameters were entered incorrectly.

Survey best practices warrant backups using RAW data.

A Trimble JXL file is a “raw” data file that stores the actual instrument measurements. In the case of a total station information stored consists of height of instrument, height of rod, horizontal angle, vertical angles and slope distances. For GPS the raw data file is the JOB file.

200.05 Naming Standards

Consistency with naming standards is of the utmost importance for workflow audits and for data sharing and handoff. This section addresses naming standards for folders, data files, points, TBC projects, surfaces and XML files for data transfer. All naming conventions require some level of intuition, in order that others who may not have worked on the project, understand the nature of the object being described.

The date is a very important component for all naming standards and should generally be the prefix for the object name. This allows for sorting and facilitates the identification of chronological activities on a project.

Project Folders

Project folders are named using numeric prefixes to sort based on the chronology of construction supervision events. The naming standards for project folders has been established as part of the standardized folder structure. If new folders are required, use a numeric prefix for folder sorting, and assign a representative name to the folder.

Survey Point Files and DXF

Survey point and DXF files are to be named using the following convention:

- YYMMDD-PROJ-TASK-INIT.txt
- YYMMDD-PROJ-TASK-INIT.dxf

Using the date as a prefix enables chronological sorting in both Windows Explorer and TBC.

PROJ is an abbreviated description of the project, refer to the following examples:

- *HWY1Glover* - Highway 1 and Glover Road Interchange
- *HWY9932* - Highway 99 and 32nd Avenue Interchange
- *HWY1FordTapp* - Highway 1, Ford to Tappen
- *NSTP* - North Surrey Truck Parking Lot

TASK represents the predominant type of data in the survey data file, refer to the following examples:

- *COG* – Construction Original Ground
- *TYPEDH* – TYPED Horizon
- *TYPEDR* – TYPED Remeasure
- *TYPEAH* - TYPEA Horizon
- *L100STK* – L100 Stakeout

INIT represents the surveyor initials.

Surveyors can apply an additional suffix to the file name, after the *INIT* field, to further describe the contents of the file (location, for example).

Point ID's / Names

With the exception of survey control (refer to section 5.04.01), all point IDs are to use the following format:

- *YYMMDDINIT####*

represents an ascending 4-digit number (0001, 0010, 0100, 1000 etc.).

Feature Codes (Point Descriptions)

Point descriptions are based on the Ministry's FXL file and are summarized in the Appendices of this document.

Point feature definitions must match the code exactly (no alpha or numeric suffixes within the code unless they are separated from the feature code with a space). If additional information is required to describe the point, use the Description 1 or Description 2 fields to further describe the points. Point attributes, although enabled in the FXL, are currently not being supported.

Line feature definitions must incorporate a unique numeric suffix to distinguish between different lines for the same type of feature (ZD1 and ZD2, KA1 and KA2, for example). All line feature points with the same codes will be connected to create a linestring upon execution of the Process Feature Codes command.

Surface Names

Surfaces in TBC are to be named using the following format:

- *YYMMDD-TYPE*

Some examples for *TYPE* are as follows:

- *COG* – Construction Original Ground
- *TYPEDH* – TYPED Horizon
- *TYPEDR* – TYPED Remeasure
- *TYPEAH* – TYPEA Horizon
- *TYPEAH* – TYPEA Remeasure
- *SUBEXH* – SUBEX Horizon

The *YYMMDD* represents the date for the last operation on the surface. Since remeasure surfaces are generally calculated monthly the date represents the date that the remeasure surface was created. Horizon surface, on the other hand, may evolve throughout the course of a construction project. The date for the horizon surface, therefore, should reflect the date of the most recent operation (data addition) on the surface. This is especially important for horizon surface handoff to the project Ground Modeler.

XML Surface Transfer Files

XML files containing horizon surfaces transferred from the construction surveyor to the ground modeler shall have the same name as the surface name.

Isopach (Volume) Surfaces

To prevent overwriting, isopach surface are to be renamed using the following convention:

- *YYMM-V-Material-Desc*

The *DESC* field further describes the material being calculated, and would typically relate to a Schedule 7 pay item. An example is as follows:

- 2207-V-TYPED-Offsite (offsite disposal of TYPED)

TBC Projects

TBC Projects are to be named using the following convention:

- *PROJ-TASK*

PROJ is an abbreviated description of the project. Examples of *TASK* are Geomatics, Design, Control, COG, TYPED and QUANT (spot, linear and area quantities)

200.06 TBC Standards for Construction Survey Workflows

Standardized components for Trimble Business Center include the following:

- Feature Definition FXL Files
- TBC Project Templates
- Drafting Templates for Plan Production (Plan, Profile and Cross Section)

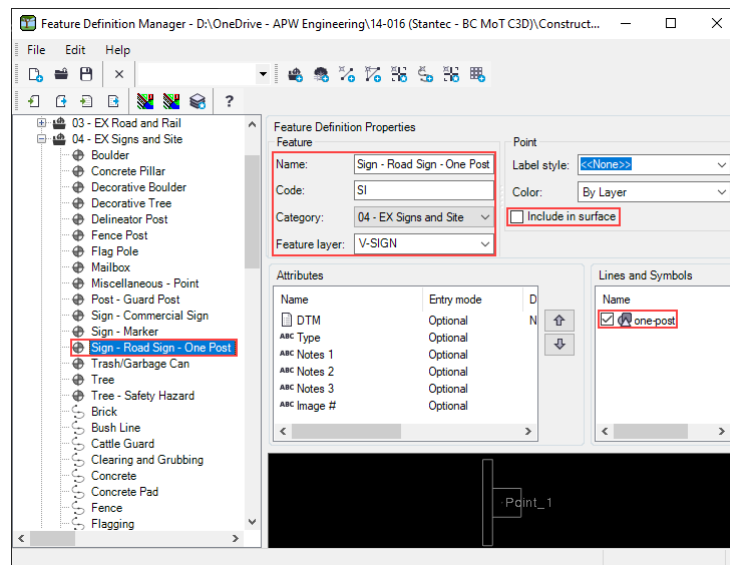
These standardized components are discussed in the following sections:

2.06.01 Feature Definition FXL File

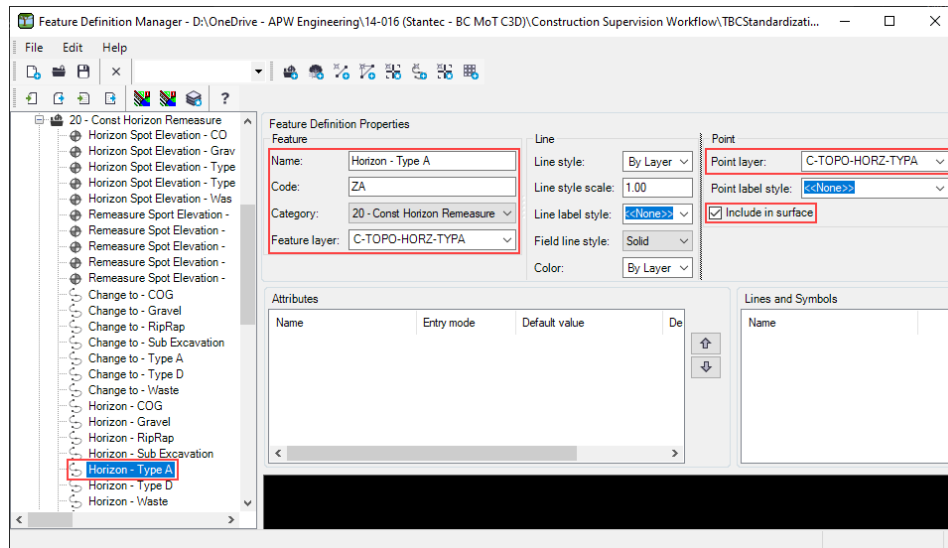
The feature definition file is an FXL file that is optionally loaded into a TBC project, and is used for the following:

- The master survey feature code list for all surveyed features
- Distinguish between point and line features
- Specifies a *name* for the feature (point and line)
- Assigns the point to a *layer*
- Assigns the linestring to a *layer* for line features
- Assigns the *Include in surface* property for points and linestrings
- Inserts a symbol for point features
- Allows for the use of attributes (not currently implemented)

The following image shows an example of a point feature in the Feature Definition Manager:



The following image shows an example of a line feature in the Feature Definition Manager:

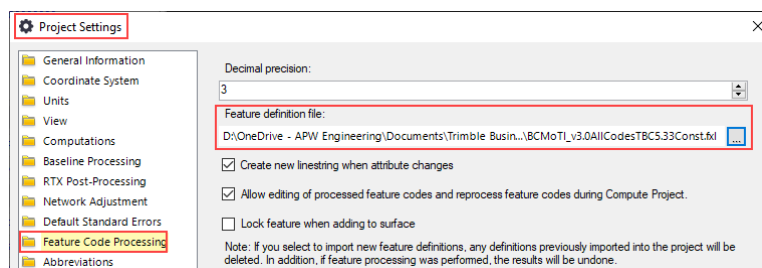


Features defined in the feature definition file are organized into the following categories:

- 00 – EX Control
- 01 – EX Geotech
- 02 – EX Property
- 03 – EX Road and Rail
- 04 – EX Signs and Site
- 05 – EX Structure
- 06 – EX Topography
- 07 – EX Utility Drainage
- 08 – EX Utility Gas and Oil
- 09 – EX Utility General
- 10 – EX Utility Power and Tel
- 11 – EX Utility Sanitary and Storm
- 12 – EX Water
- 20 – Const Horizon Remeasure
- 21 – Const General

Categories 00 through 12 are used by Ministry Geomatics Department for pre-engineering survey data collection activities and can be used by construction surveyors for COG (Construction Original Ground) and spot/linear/area quantification survey tasks only. Categories 20 and 21 are used exclusively for construction supervision.

To set the path for the Feature Definition File use Project Settings → Feature Code Processing → Feature definition file, as shown in the following diagram:



It is recommended that the Feature Definition FXL file is copied to the same folder as the TBC project templates (next section).

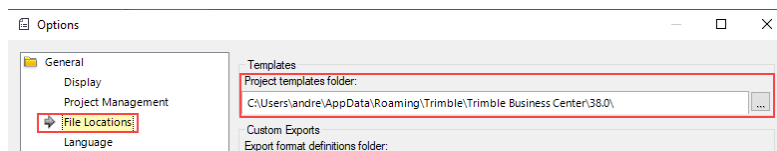
2.06.02 TBC Project Templates

The following task specific TBC project templates are available:

- *GeomaticsDesignV#* – Consumption of Geomatics and Design Data
- *COGV#* – Construction Original Ground Survey and Removal Quantities
- *HorizonRemeasureV#* – Horizon and Remeasure Surfaces and Volumes
- *SpotLinearAreaQuantitiesV#* – Surveyed Spot, Linear and Area Quantities

The “V#” in the template name suffix represents the template version.

In Trimble Business Center set the path for TBC Project Templates using File → Options → General → File Locations → Project templates folder, as shown in the following diagram:



The default path for TBC project templates is as follows:

C:\Users\UserName\AppData\Roaming\Trimble\Trimble Business Center\38.0

The last folder represents the TBC version, for example \38.0\ is the folder for TBC V5.81. For TBC V5.33 the folder is \33.0\.

The standardized components of these templates, along with workflow details are discussed starting in Section 600.

2.06.02.01 TBC Project Coordinate Zones

TBC Project Coordinates do not include coordinate zone settings. Provided that CSV files exported from controllers are reduced coordinates the assignment of a coordinate zone in TBC is not required. The assignment of a TBC coordinate zone is only required under the following circumstances:

1. When importing raw JXL (ascii) or JOB (binary) files to TBC containing instrument observation data
2. To enable Google Earth mapping in TBC using the Toggle Background Maps command on the task bar.

All construction supervision workflows, with the exception of primary control checks and secondary control development requires the use of reduced CSV for data imports. Control surveys require working with JXL or JOB raw data files from Trimble Access.

Ministry projects are using the following horizontal and vertical datums:

Horizontal: UTM NAD83 CSRS 2002.0 epoch (1997.0 for Vancouver Island)

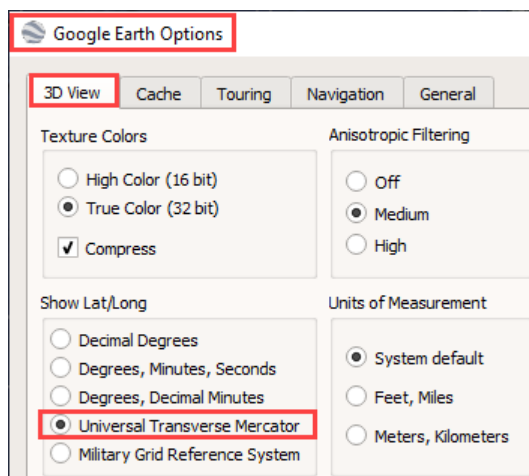
Vertical: CGVD28 using the HT2.0 Geoid (HTMVBC00 for Metro Vancouver, Abbotsford, and east to Hope)

The UTM zones in British Columbia are shown in the following illustration:



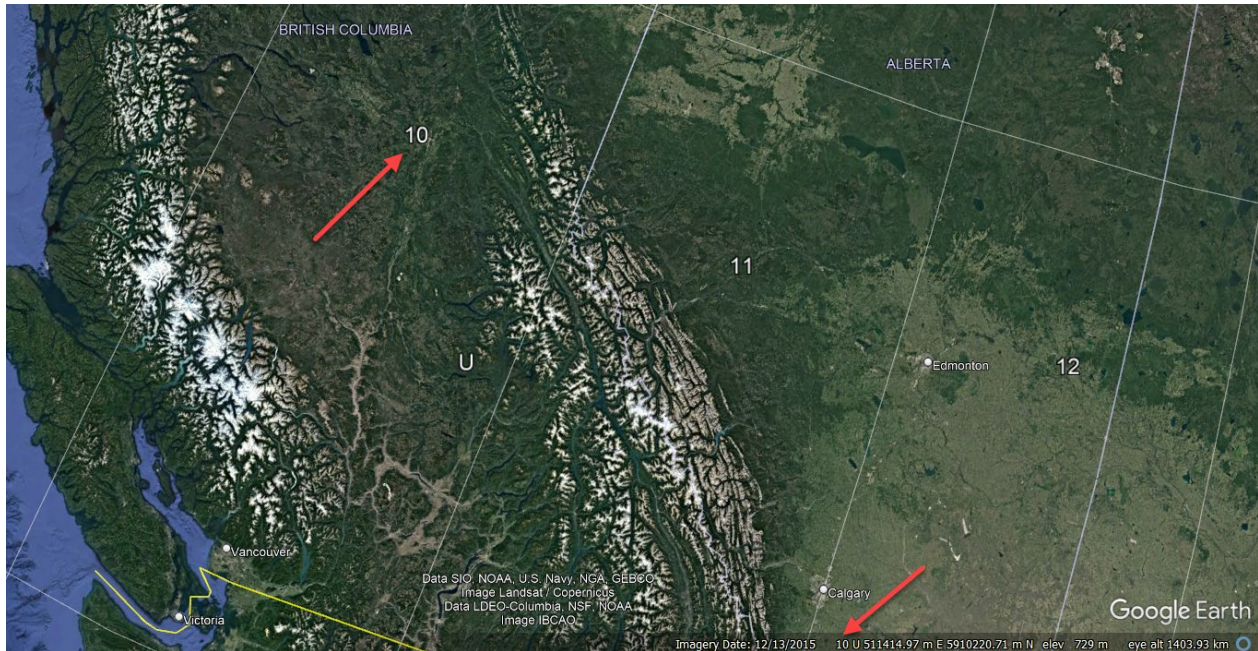
Alternatively, Google Earth can be used to identify the UTM zone for the project. From Google Earth:

1. Tools → Options → 3D View tab
2. For show Lat/Long, click Universal Transverse Mercator



3. Click OK

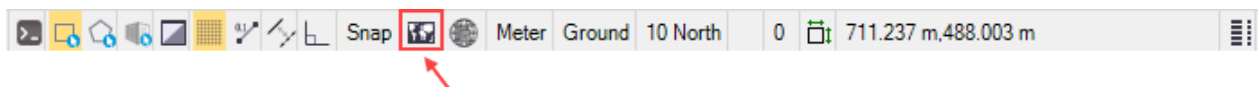
The UTM zone is displayed in the graphics area, and also on the Google Earth taskbar at the bottom of the screen, based on the position of the cursor.



To establish the coordinate zone for the TBC project, use Project Settings → Coordinate System → Change and then...

1. Select Coordinate System and Zone button, For Coordinate System Group choose World wide/UTM and for Zone, choose Zone # (North), click Next.
2. For Select Horizontal Datum, select NAD 1983 (Canada), click Next.
3. For Select Geoid Model, click Predefined geoid model, select Canada Geoid Model HT2_0 and for Geoid model quality, select Survey Quality and click Finish.
4. Click Coordinate System → Local Site, and click Local Site Settings button, and click Yes to save the project settings.
5. In the Local Site Settings palette:
 - a. For Coordinate type, select Grid.
 - b. For Easting and Northing, enter the Grid (UTM) Easting and Grid (UTM) Northing values of the tack point, indicated in the survey control table in the drawing set.
 - c. For Elevation, enter the elevation of the tack point.
 - d. Toggle Use ground coordinates on.
 - e. For Ground scale factor enter the inverse (ground to grid) ACSF (average combined scale factor) from the control table in the drawing set.
 - f. For False northing offset, enter 5000000 and click OK to finish coordinate zone setup.

To enable background maps, click the Toggle Background Map button on the TBC taskbar.



2.06.03 Drafting Templates

Drafting templates are external VCL files that can be imported to a TBC project for the purpose of plan, profile and cross section sheet production using Ministry of Transportation title blocks.

The default path for drafting templates is as follows:

C:\ProgramData\Trimble\DraftingTemplates

The Ministry Field Services drafting template for Trimble business center consists of the following files:

- BCPlanSetsV#.vcl (V# is the version number)
- BCMoTILogo.jpg

The plan set VCL file needs to be copied to the folder indicated above, and the JPG logo file is copied to the TBC project template folder.

2.06.04 Text Styles and Alignment Labels

Text styles and alignment label styles are preconfigured in the TBC project templates.

200.07 TBC Project Management

The creation and management of multiple Trimble Business Center projects for a construction project is extremely important, especially for larger projects. The creation, assembly and extent of Trimble Business Center projects is largely dictated by the number of tasks that will be undertaken by construction surveyors and the size of the project.

Trimble Business Center V5.6 introduced very useful functionality that allows for sharing of graphical and surface data among different TBC projects, which makes it easier to create separate task based projects that can share and leverage data from other projects.

Some examples of TBC projects include the following:

- 1) Geomatics survey data consumption, graphics only (from Construction Survey Data Package)
 - a) <ProjectName>SURVBASE (Geomatics base plan with linework and symbols)
 - b) <ProjectName>SURVUTIL (Geomatics survey utility drawing)
 - c) <ProjectName>SURVPROP (Geomatics property data)
- 2) Design data consumption, graphics only (from Construction Survey Data Package)
 - a) <ProjectName>DESIGN (100 series model space data, no sheets)
- 3) Construction original ground modeling
 - a) <ProjectName>COG (for surface modeling and removal item quantification)
- 4) TYPED horizon and remeasure
 - a) <ProjectName>TYPED (for TYPED horizon surface, TYPED remeasure surface, STRP stripping and TYPED excavation quantities)
- 5) TYPEA horizon and remeasure
 - a) <ProjectName>TYPEA (for TYPEA horizon surface, TYPEA remeasure surface and TYPEA excavation quantities)

The next section describes TBC functionality that enables data sharing among projects.

2.07.01 Project Graphics and Reference surfaces

This section discusses project data sharing functionality which became available in Trimble Business Center V5.6. Data sharing functionality among TBC projects exists for the following:

- Load graphics from another project (for example working in COG project the surveyor may wish to see graphics representing the proposed design.
- Load a surface from another project (for example working in TYPED project load the COG surface from COG project for STRP stripping volume calculation.

The benefit of working with references is as follows:

- Entities and associated layers are not loaded into current project as they are references
- Updates are dynamic. For example if COG surface changes this is reloaded in TYPED project and volume (isopach) surfaces automatically update

TBC references are discussed in the following sections:

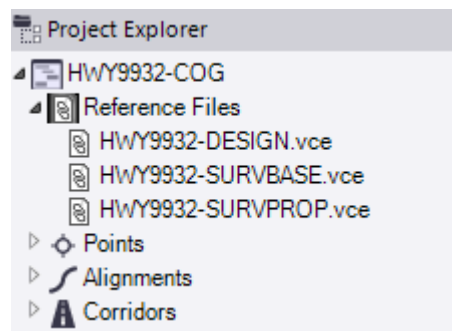
2.07.01.01 Project Graphic Reference

To create a project graphic reference...

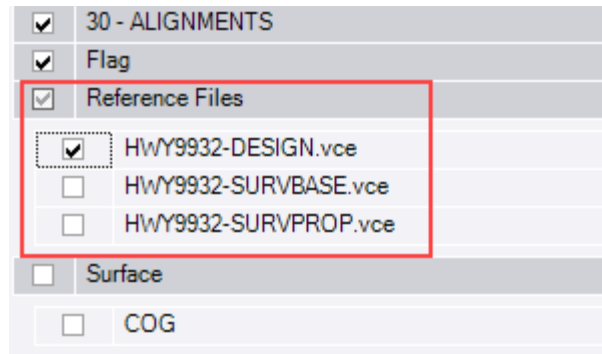
Home (ribbon tab) → Data Exchange (panel) → Reference File (command)

You are then prompted to browse to and choose a TBC project VCE file.

These references are displayed in a “Reference Files” collection in Project Explorer, as shown in the following image:



Modify the properties of the references to i) change the view filter, enable/disable, change transparency settings and iv) override the colours. Enabled referenced can be turned on/off in View Filter Manager under the Reference Files collection, as shown in the following image:



2.07.01.02 Reference surfaces

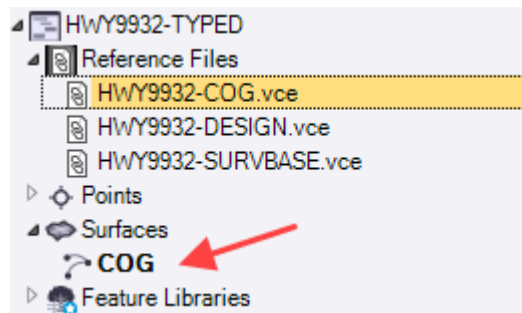
Reference surfaces should only be used to calculate earthworks volumes.

To create a reference surface...

Surfaces (ribbon tab) → Create (panel) → Reference Surface (command)

Browse to and select the VCE project first, select the surface from the drop down list and then assign a name to the reference surface. It is best to use the exact same name as the surface in the reference file.

The VCE file containing the reference surface is displayed in Project Explorer under the Reference Files collection, with the same settings as graphic references available in Properties. The VCE file containing the reference surface is also visible under the Reference Files collection in View Filter Manager. In addition to this, reference surfaces are displayed under the Surfaces collection in Project Explorer as follows:



Reference surfaces are also displayed under the Surface collection in View Filter Manager and are dynamic, meaning that if the source data changes, the reference can be updated.

2.07.02 TBC Project Folders

When a TBC project is created the default settings result in the creation of the following:

- The TBC project VCE file
- A folder with the same name as the TBC project

The project folder that TBC creates stores copies of imported files. For example, if a CSV point file is imported to TBC from a thumb drive, then that file is copied to the TBC project folder.

Ministry FS workflows are such that the construction surveyor is responsible for managing the location of data to be imported to TBC. A summary of these requirements as it relates to the standardized project folder structure, is as follows:

1. Unedited CSV survey data files copied to the following location:

\05) Survey\04) Downloaded Field Data\01) CSV Download\01) CSV Task

2. Unedited JXL raw data file, for each corresponding CSV file, copied to the following location:

\05) Survey\04) Downloaded Field Data\01) JXL Download\01) CSV Task

The JXL file represents the “legal” file which will stand up in a court of law, and from which coordinates can be rederived, if necessary.

3. CSV files, from item 1 above, are *copied* to the following location:

\05) Survey\06) Horizon Remeasure\01) COG\01) Unprocessed Data, and then moved to...

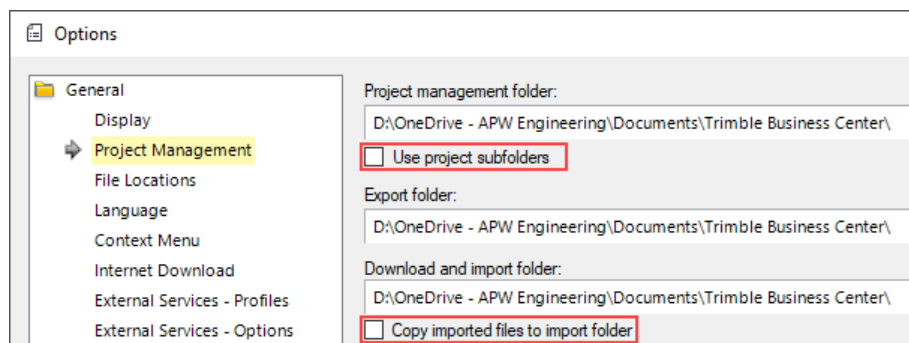
\05) Survey\06) Horizon Remeasure\01) COG\01) Processed Data, once imported to TBC

The *01) COG* folder above, could be the location of any TBC project.

For this reason, use...

File (ribbon tab) → Options → General → Project Management

...to disable *Project subfolders* and disable *Copy imported files to import folder*, as shown in the following illustration:



The *Use project subfolders* toggle can only be disabled when there is no active TBC project.

300 General Survey Requirements

This section discusses general survey requirements. These are expounded in the task specific sections of this document.

300.01 Spot and Linear Feature Codes

All survey codes must conform to the Ministry's Feature Definition (FXL) file, with no exceptions. The FXL file clearly distinguishes between spot feature and linework feature codes (Section 2.06.01). The use of standardized survey codes ensures the following:

- Generation of a spot or linear feature
- Insertion of a spot feature symbol
- Assignment of points and linestrings to the correct layer (and TBC layer group)
- Assignment of the Include in surface property (Yes or No) for both points and linestrings

Codes for spot features must not include any suffixes or prefixes to further describe the feature. Surveyors can use the *Description 1* and / or *Description 2* point properties to record additional information relating to the point (diameter and material, for example).

Linework codes must incorporate a unique numeric suffix (no space between the code and the number) to ensure that unique linestrings are generated in Trimble Business Center. For example left pavement and right pavement edges are coded as EP1 and EP2 respectively so that linestrings that connect the left and right sides are not generated.

300.02 Survey Point Accuracy

The following topographic point accuracies have been reproduced from the BC Ministry of Transportation Geomatics Survey Guide.

Construction Survey (Relative to Secondary Control)	Horizontal (m)	Vertical (m)
Steep Terrain	0.500	0.300
Undulating / Natural Terrain	0.300	0.150
Rock	0.020	0.025
Ditches and Watercourses	0.100	0.050
Granular Prisms	0.100	0.050
Pavement	0.020	0.025
Pavement Overlay	0.020	0.015
Curb & Gutter	0.020	0.015
Curb Returns	0.020	0.015
Traffic Islands	0.020	0.025
Urban Detail	0.020	0.025
Intersections	0.020	0.025

300.03 Point and Linestring Point Density / Spacing

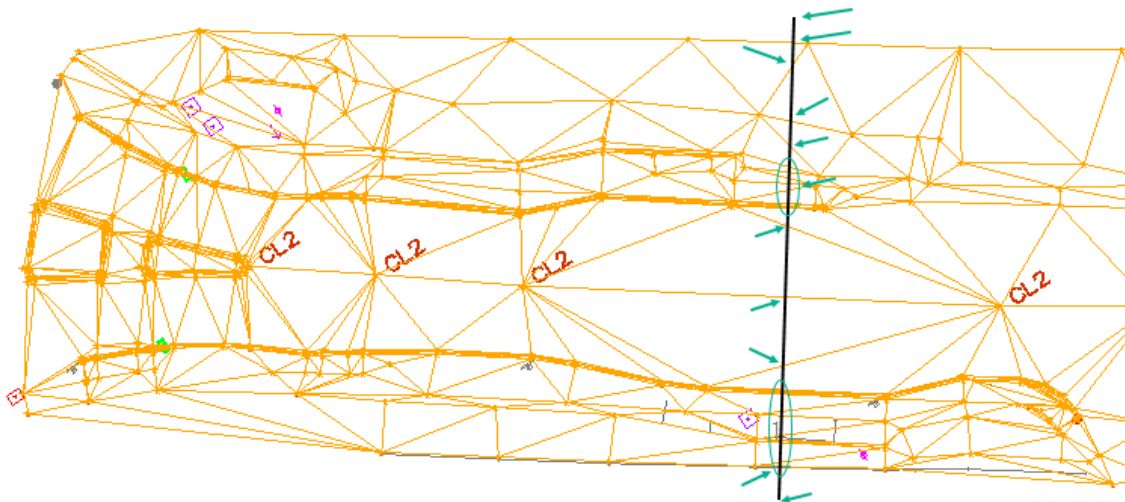
The horizontal and vertical nature of the terrain dictates most of the point spacing and TBC linestring requirements to produce accurate ground models for volume calculations.

The following sections discuss linestrings and surfaces, and address survey point density and spacing as they relate to surface modeling.

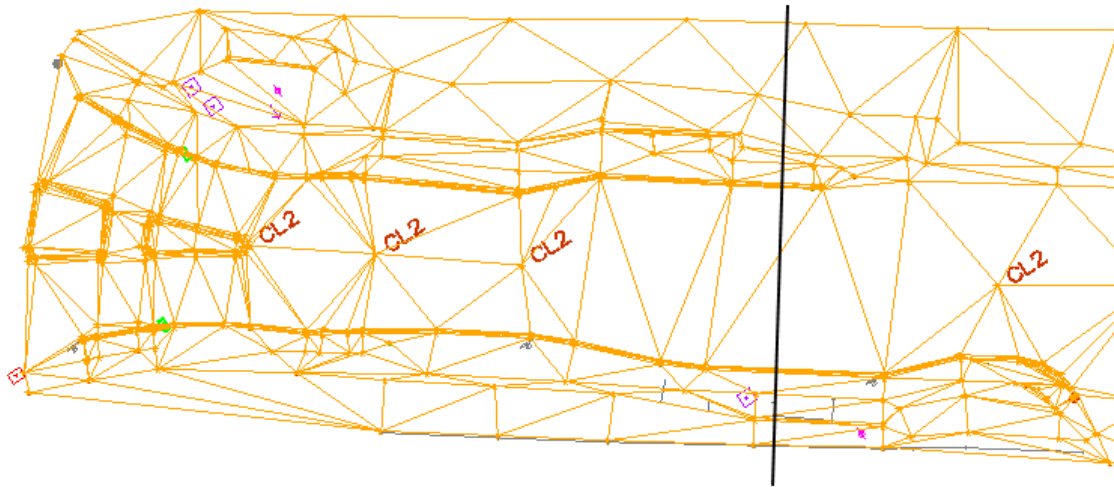
3.03.01 Linestrings and Surfaces

It is important to understand the nature of a TIN (Triangulated Irregular Network) model in TBC, and how linestring data affects surface triangulation. If a profile or a cross section is created from a surface, the data points for the profile or section are acquired where the alignment, or section line intersects a TIN line, and at the end points of the alignment or section line.

In the following illustration, the centreline linestring is included in the surface, as a *breakline*, and the triangulation is therefore forced along the breakline. The green arrows indicate the location of the data points for the cross section. Note that a data point has been interpolated between two consecutive shots along the centreline linestring.



If the centerline linestring is removed there is no longer a triangulation line connecting the centerline points, which means that the section data will omit the road crown. This is shown in the following illustration:



Therefore, when creating linestrings from feature codes in the FXL file with *Include in surface* property set to *Yes*, ensure that the linestrings represent distinct terrain breaks.

Linestrings created from feature codes in the FXL file with the *Include in surface* property set to *Yes* are used as TIN *breaklines* when they are added as surface members. A breakline is a distinct terrain break and triangulation lines are always forced along the breakline to properly define the surface.

Examples of features that are breaklines are as follows:

- Road crowns, pavement edges, curb lines, sidewalk edges, shoulder lines
- Tops and bottoms of banks
- Ditch tops and bottoms
- Tops and bottoms of retaining walls

The construction surveyor should make every effort to ensure linestrings do not overlap one another, as a TIN cannot model 2 elevations at the same location.

Finally, horizon and remeasure surfaces can be coded using spot elevation codes (J* and Y* for remeasure and horizon surfaces respectively) or linestring codes (K* and Z* for remeasure and horizon surfaces respectively), all of which have the *Include in surface* property set to *Yes* (from the FXL). When surveying horizon and remeasure surfaces, use linestrings in the following circumstances:

- To represent distinct terrain breaks, so that triangulation lines follow the break
- To represent a soft terrain break such as the bottom of a drainage swale to prevent triangulation from crossing across the bottom of the swale from the adjacent swale tops

The construction surveyor should use their best judgement when surveying linestrings on horizon and remeasure surfaces, as there is not necessarily a distinct “feature” (pavement edge, bottom of bank etc.) to be followed.

3.03.02 Point Spacing / 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.

Some guidelines for point spacing are summarized in the following bullets:

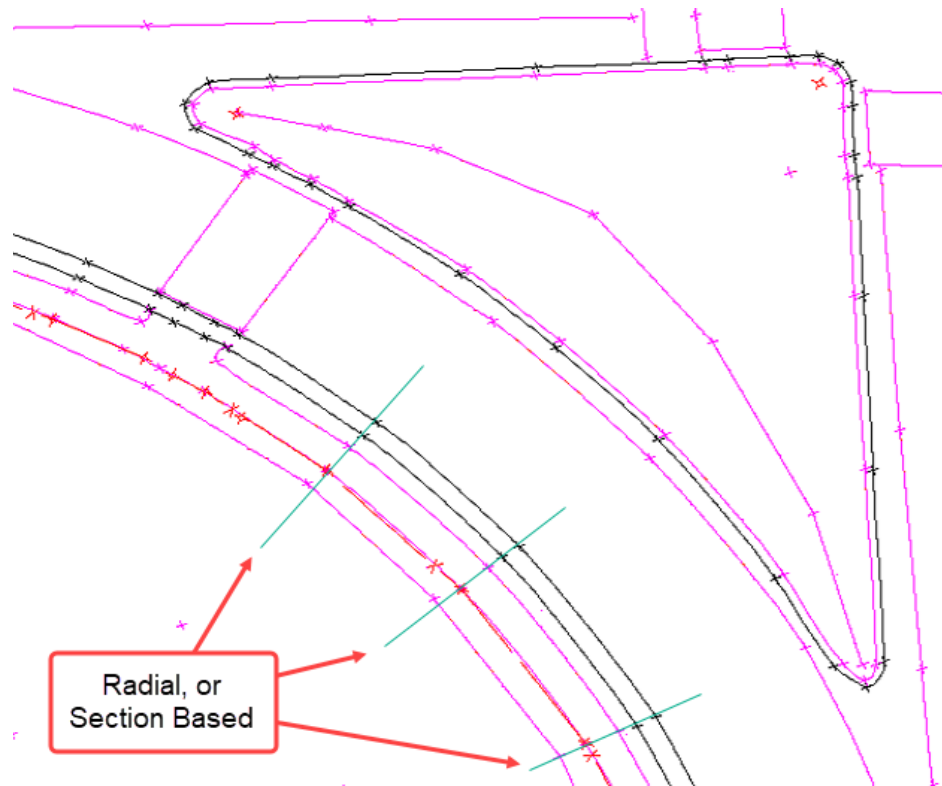
- Point spacing shall be agreed upon by the Ministry Representative.
- Point spacing shall not exceed 10m for both linework and point features
- Point spacing may be less than 5m in areas where drainage or quantities are a concern
- Steep terrain: 5-20m
- Undulating/natural terrain: 5-20m
- Rock: 5-10m
- Intersections, curb returns, traffic islands: 1-5m
- Curb and gutter, small radius curves, ditches, and water courses: 5-10m

The construction surveyor must consider point spacing in the context of both surface modeling and accurately measuring surveyed items for payment quantities. Finally, and, whenever possible point data should be collected in cross section format along an alignment or a feature to create a good surface model to ensure linestrings do no overlap.

The following image represents a poor example of point spacing / density, as it results in linestrings that overlap one another.



Collecting points in a cross section, or in the case of the following image, radial to the returns, will result in linestrings that do not cross over each other.



While linestrings can be edited in Trimble Business Center, the construction surveyor should make every effort to employ sound field procedures to minimize editing in the office.

300.04 Working with Ground Modeler

The Ground Modeler assumes the following construction supervision responsibilities, as they relate to the activity of the construction surveyor:

- Preparation of the construction survey data package.
- Rerun design corridor models against construction horizons.

If the Construction Survey Data Package is incomplete or requires clarification or refinements, the construction surveyor should contact the project ground modeler and request updates as required.

Corridor models prepared by designers are processed against surveyed (total station, GPS and LiDAR) original ground horizons, assumed stripping horizons and assumed TYPEA horizons.

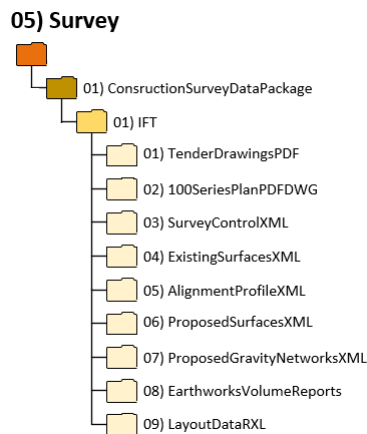
The COG horizon used by designers may change in LiDAR surveyed areas, as LiDAR data is collected in areas where tree removal, and clearing and grubbing is required. In these circumstances, the Ministry Representative will elect to survey these areas and recreate the original ground surface by aggregating Geomatics SOG (Surveyed Original Ground) data with COG (Construction Original Ground) survey data to form an actual Construction Original Ground horizon. This COG horizon (either complete or representative of a project milestone) is handed off to the ground modeler via an XML file, which is exported from Trimble Business Center. The name of the XML file is to be the same as the surface name as it exists in TBC, with the date in the surface name prefix representative of the current date.

400 Geomatics and Design Data Consumption

This section discusses the consumption of the project geomatics (survey) and design data by the construction surveyor.

The primary deliverable to the construction surveyor is the Construction Survey Data Package (CSDP), which is prepared by the project's ground modeler. For more information on the contents please refer to [Section 100.11 Construction Survey Data Package \(CSDP\)](#). The construction survey data package is copied to the standardized folder structure, which is shown in [Section 200.01 Construction Survey Folders and Data Organization](#).

The folders in the CSDP are shown in the following diagram:



TBC projects for geomatics and design data consumption are created from the contents of the following folder:

\05) Survey\01) ConstructionSurveyDataPackage\01) IFT\02) 100SeriesPlanPDFDWG

AutoCAD DWG data in *\02) 100SeriesPlanPDFDWG* folder, at a minimum, should consist of the following:

- Design Data – AutoCAD entities created from model space (no sheet layouts) of the 100 series production drawing
- Geomatics VSOG Data – AutoCAD entities created from the SURVBASE-VSOG (Surveyed Original Ground) drawing
- Underground Utilities – AutoCAD entities created from STSNWM (Storm, Sanitary and Watermain) design model drawings

If any other data is required for TBC consumption, the construction surveyor should contact the project ground modeler so they can provide the necessary files.

400.01 TBC Project Creation – Design Data Consumption

TBC projects for design data consumption are created using the following TBC project template:

BCMoTI-1Geomatics and Design-R#.vct (where # is the version of the project template)

After creating the project, save the project using the following name:

PROJ-DESC (PROJ is an abbreviated project name, and DESC describes the contents of the data being consumed).

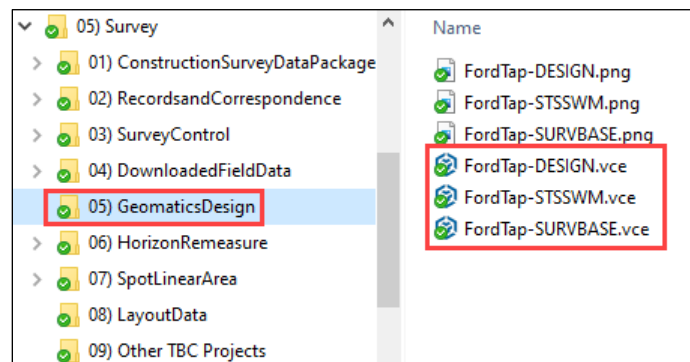
Examples are as follows:

- HWY9932-SOG (Highway 99 / 32nd Avenue Survey Original Ground, from Geomatics)
- HWY1Glover-COG (Highway 1 / Glover Road Combined Original Ground, from Geomatics)
- NSTP-DESIGN (North Surrey Truck Parking, created from 100 series production drawings)
- HWY1FordTappen-DRAINAGE (Highway 1 Ford to Tappen, drainage design)

TBC projects for consuming geomatics and design data are saved in the following location:

\05) Survey\05) GeomaticsDesign

This is shown in the following illustration:



Once the project has been created, the DWGs from the CSDP can be added and then viewed using the layers and layer groups defined in the project template.

500 Survey Control

The most important survey aspect for construction projects are the survey controls. Control surveys provide horizontal and vertical positions of points from which additional surveys are based on, and provide the standard of accuracy for subsequent surveys to attain. Survey control is the foundation for all surveying as all field observations and measurements are based on having proper survey control in place.

Survey control applicable to Ministry geomatics, design and construction supervision workflows consists of both primary and secondary control. Primary and secondary control are established from higher order corridor and origin control points, with the origin control point being the highest order coordinate from which corridor control networks are built.

Ministry surveyors should refer to the [BC Ministry of Transportation Geomatics General Survey Guide](#) for more information and best practices as they relate to survey control, and other related survey tasks.


Primary and secondary control points, as they relate to construction supervision activity, are discussed in the following sections.

500.01 Primary Control Points

Primary, or project control points are the highest standard of control reference for the project, and are set outside the construction site away from potential construction disturbance (machines, and vibration).

Project specific primary control points are established by Ministry Geomatics surveyors before detailed design begins and remain in place throughout the duration of the project. They are usually a metal bar that is marked with adjacent wooden stakes. Primary control point data is provided to the construction surveyor in an XML file as part of the Construction Survey Data Package (CSDP).

Details of the primary control points (along with the corridor and origin control points) are provided in the construction drawing set in a table, as per the following image:

Date: 2018-07-24		Origin: 80C026 confirmed with NRCAN PPP Solution on TACK12							
Project: MoTI Sample Control Table			Tack Point: TACK-12		ACSF: 0.999790				
Horizontal Datum: UTM Z10 NAD 83 CSRS			Latitude: 55° 54' 27.78726"						
Vertical Datum: HT2_0 geoid using CGVD28 datum			Longitude: -120° 30' 40.12166"						
Point ID	Local		Orthometric Height	UTM		Ellipsoidal Height	C.S.F.	Class	Type
	Northing	Easting		Northing	Easting				
80C026	204095.659	649041.159	661.351	6204094.507	649042.531	646.882	0.999771	Origin	GCM
G1800-15	194246.177	661955.054	796.995	6194247.093	661953.714	782.324	0.999799	Corridor	Mon
G1801-15	194643.924	661610.080	798.724	6194644.756	661608.813	784.058	0.999798	Corridor	Mon
GEORGE-08	195689.472	660115.569	793.221	6195690.085	660114.616	778.573	0.999793	Corridor	Mon
K1802-15	195249.397	660732.788	802.035	6195250.102	660731.705	787.380	0.999794	Corridor	Mon
K1803-15	195499.619	660295.267	796.554	6195500.272	660294.276	781.904	0.999793	Corridor	Rebar
P1787-18	200378.139	654087.753	739.341	6200377.767	654088.066	724.763	0.999778	Project	Conc. Nail
P1788-18	199982.974	654388.334	726.489	6199982.685	654388.583	711.905	0.999781	Project	Conc. Nail
P1789-18	199512.933	654745.914	698.581	6199512.743	654746.088	683.991	0.999787	Project	Rebar
RD237-08	196885.230	657636.335	715.553	6196885.592	657635.902	700.931	0.999795	Project	Rebar
RICH-08	200711.962	653788.005	743.671	6200711.520	653788.381	729.098	0.999776	Project	8" Spike
SM12-08	194917.085	661371.622	801.330	6194917.860	661370.405	786.667	0.999796	Project	8" Spike
TACK-12	198608.002	655575.954	688.520	6198608.002	655575.954	673.918	0.999791	Project	Rebar
All local coordinates are derived by first scaling from the Tack Point and then removing the millionth digit from the Northing									

In this example the primary control points are indicated with the “Project” Class and include local and grid (UTM) coordinates along with a combined scale factor. Grid to ground coordinate (and vice versa) transformations are all based on applying the scale factor at the tack point location, which can be determined by the Point ID (TACK-12, in the table above).

Although not always required, a check of the primary control may be warranted in the following circumstances:

- When primary control stakes / markers appear to have been disturbed
- If the surveyor wants additional confidence that both equipment and procedures are functioning properly
- As a Quality Assurance practice

If primary control points have been disturbed, construction surveyors are required to contact Ministry Geomatics, provided that they are able to properly demonstrate with observations and calculations, the nature of the issue.

500.02 Secondary Control

Secondary control is a lower order of control point established from primary control and does not require the same level of accuracy as primary control but should be treated with the same degree of importance as primary control. Secondary control points are established in the immediate project area and are the main reference points that will be used for construction survey activity for original ground surveys, horizon and remeasure surveys, spot/linear/area quantity surveys and construction layout surveys.

Construction surveyors are responsible for establishing secondary control for the project, taking the following points into consideration:

- Establish by traverse with a total station instrument, or by GNSS RTK (Global Navigation Satellite System RTK Real Time Kinematic) processing, and always closing to primary control
- Intervisible (viewable from each other)
- Referenced by a stake with pink and blue flagging or if on pavement, with paint marking and offset stake with pink and blue flagging
- Point descriptions

Details of secondary control including point ID's, ground based coordinates, elevations and point descriptions are to be recorded and provided to the Ministry Representative.

500.03 Primary and Secondary Survey Control Tolerances

The required tolerances for Primary and Secondary Control are summarized in the following table:

Point Classification	Relative to Parent Control		Relative to Neighboring Point		Spacing
	Horizontal (mm)	Vertical (mm)	Horizontal (mm)	Vertical (mm)	
Origin Control	Determined by source of point				
Corridor Control	5 + 0.5 ppm	10 + 0.5 ppm	5 + 0.5 ppm	10 + 0.5 ppm	5km to 20km
Primary Control	15	15	10	10	200m to 2km
Monitoring Point	Project Specific				

Secondary Control	20	20	10	10	50m to 300m
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500.04 Secondary Survey Control Point Names and Feature Codes

This section discusses secondary control point names, which are the alphanumeric point ID, and point descriptions.

5.04.01 Secondary Control Point Names

The point name represents the point ID. All secondary control points must follow a naming convention to indicate how and when the points are set. If a brass cap monument is used with an alphanumeric name, then only a suffix of “-YY” is needed where YY are the last two digits of the year the monument was set. E.g. Tonka-15. For control points using tags or a simple numeric identifier, a prefix and suffix are required. E.g. G4321-18.

Prefixes:

- G – GPS Primary (Static)
- K – GPS Secondary (RTK)
- T – Total Station Primary (Closed and adjusted control loop)
- S – Total Station Secondary (Side shot)

5.04.02 Secondary Control Point Codes

Codes for secondary control must match available descriptions in the Ministry TBC Feature Definition FXL file. Allowable codes for secondary control are summarized in the following table:

Point Code	Description	TBC Layer	TBC Layer Group
DH	Hub – Detail / Traverse Hub	V-CTRL-MINR	00 – EX Control
RP	Reference Point	V-CTRL-REFP	00 – EX Control

500.05 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

Detail hubs must satisfy the survey accuracies documented in:

- Section 3.06.03 of the General Survey Guide for topographic original ground surveys
- Section [11.14.01 Slope Staking Requirements](#) in this document
- 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.

500.06 Quality Control

- All previous survey information conforming to the “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 levelled in kilometres.
- Records of control point check surveys will contain all electronic survey files, reports and other relevant survey data showing closures.

The following image shows an example of a check point showing closures:

DUNNSTAKE.JOB November 19, 2004	
Raw Data Report	
<u>Line#</u>	<u>Record Type</u>
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).

600 Construction Original Ground (COG)

The construction original ground survey and surface is one of the first major tasks undertaken by the construction surveyor. The purpose of this task is as follows:

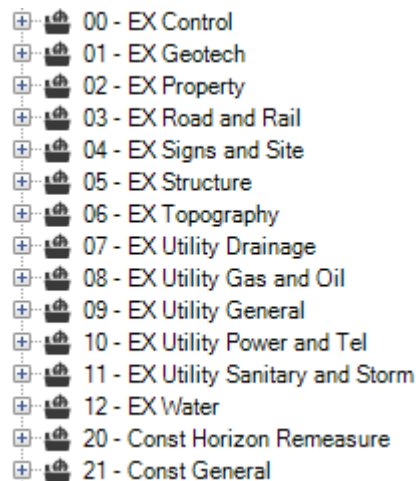
1. Create a construction original ground surface model which is the basis for earthworks calculations
2. Collect featurized data for the calculation of spot, linear and area removal quantities

COG survey data must be collected using Ministry standardized point names (ID's) and feature codes (description). The feature codes are available in the Trimble Feature Definition FXL file.

600.01 Construction Original Ground with Features

There are feature code options to be considered when surveying Construction Original Ground. For this section please refer to the latest version of the Ministry's Feature Code Definition FXL file.

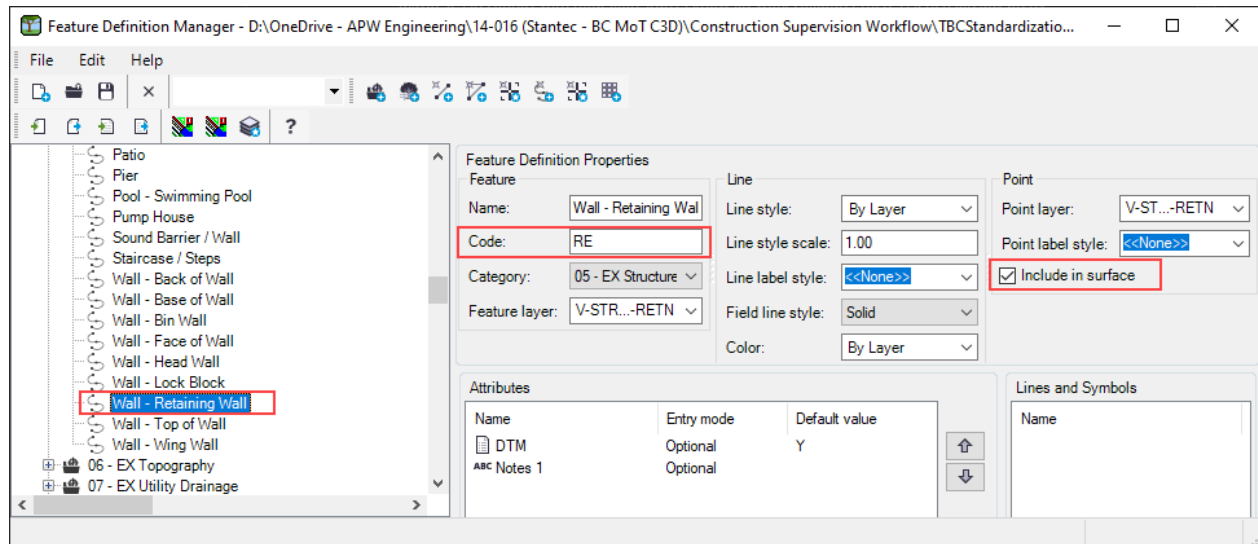
Feature codes are organized into categories, as per the following image:



Categories 00 through 12 originate from Geomatics for pre-engineering survey work, and for the most part contain feature codes that represent actual field features – such as pavement edges, fences, manholes and power poles. Categories 20 and 21 have been specifically developed for construction supervision and are used specially for construction supervision measurements for the purpose of quantification.

Featurized Construction Original Ground survey data is only required if removal quantity measurements are required. When surveying Construction Original Ground the construction surveyor should be aware that featurized data was collected as part of the VSOG (Surveyed Original Ground), and that if applicable, removal quantities could be calculated from Geomatics VSOG data. SURVBASE VSOG and SURVBASE COG (Combined Original Ground) ACAD DWG data is made available as part of the Construction Supervision Data Package. Featurized COG data can therefore be used to i) calculate removal quantities and ii) be incorporated into the Construction Original Ground surface, provided that the *Use in surface* property for the feature code is set to Yes.

A retaining wall for example is a “feature” that is part of the Construction Original Ground survey and surface model as the *Include in surface* property is set to Yes. This is shown in the following illustration:



The retaining wall is also a feature that requires quantification for removal. A retaining wall observation, therefore, serves 2 purposes. The construction surveyor should also be aware that the geomatics survey base data (SURVBASE-VSOG) in the Construction Survey Data Package, could be sourced to quantify items for removal.

Please note that the mechanism for surface inclusion is the *Include in surface* property. The optional DTM property is not used in Trimble Business Center.

600.02 Construction Original Ground Without Features

If removal quantities are not required from Construction Original Ground surveys care must be taken to ensure the use of the original ground codes in the *20 – Const Horizon Remeasure* category, which are as follows:

- YO – spot elevation COG horizon
- ZO# - linestring COG horizon (for #, use unique number to distinguish linework)

This is important because when the Process Feature Codes command is used, the FXL will place the points on specific layers, which are recognized by predefined layer groups in the TBC project template. In no circumstances should surveyors use Geomatics codes for original ground surface modeling such as BZ (breakline), SE (spot elevation) and OG (original ground).

600.03 Construction Original Ground TBC Project Setup

The Construction Original Ground TBC project contains only data required for COG surface modeling and measurements for construction pay item removals. All other data relating to horizon/remeasure surfaces, new feature pay item quantities, layout data generation and monitoring is imported to separate TBC projects.

Before creating the COG project, ensure that the following settings have been disabled in TBC Options:

- Use project subfolders
- Copy imported files to import folder

This is because the onus is on the Construction Surveyor to copy and locate the sourced data files appropriately.

TBC projects for Construction Original Ground are to be created using the following TBC project template:

- *BCMoTI-1ConstOGVR#.vct* (where # is the version of the project template)

After creating the project, save the project using the following name:

- *PROJ-COG* (PROJ is an abbreviated project name, which is used as a prefix for all TBC projects).

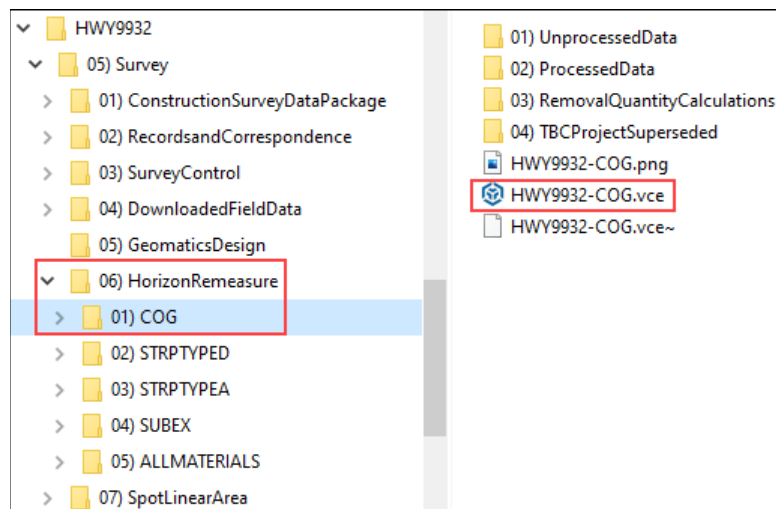
Examples are as follows:

- HWY9932-COG (Highway 99 / 32nd Avenue)
- HWY1Glover-COG (Highway 1 / Glover Road)
- NSTP-COG (North Surrey Truck Parking)
- HWY1FordTappen-COG (Highway 1 Ford to Tappen)

The *PROJ-COG* TBC project is saved in the following location:

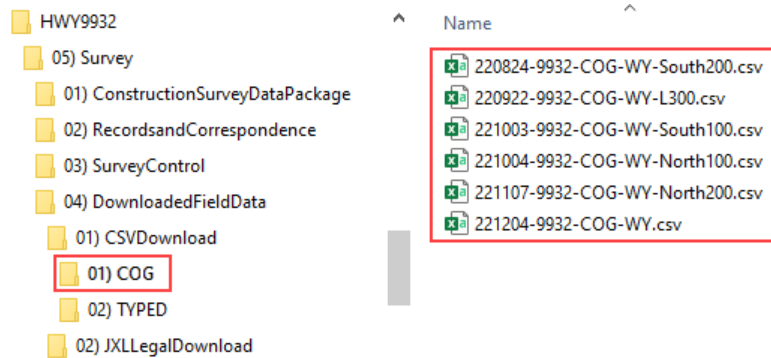
\05) Survey\06) HorizonRemeasure\01) COG

This is shown in the following illustration:



Once the project is created the procedure to copy data files from the controller to the project subfolders, is as follows:

1. Download files from controller to a task specific folder in the *\04) DownloadedFieldData* folder:



These files are to remain untouched and unedited.

2. Copy the corresponding JXL (RAW survey data) to a task specific folder under \04) DownloadedFieldData\02) JXLLegalDownload\ folder. These files represent the legal record of survey (instrument observations, as opposed to reduced coordinates).
3. Copy the files to \06) HorizonRemeasure\01) COG\01) UnprocessedData\ folder
4. Once the files are imported to the COG TBC project, move the files from \01) UnprocessedData\ to \02) ProcessedData\

Step number 4 is only required if there are several files, and the construction surveyor needs to keep track of which files have been imported versus which files still need to be imported. When all is said and done, all files imported to TBC need to reside in \02) ProcessedData.

The final step is to run the Survey → Process Feature Codes command to generate linestrings, assign points and linestrings to the correct layers and identify nonstandard survey codes. Addressing nonstandard codes can be done in TBC or in the source data file. For the latter, reimport the file and run the Process Feature Codes command again.

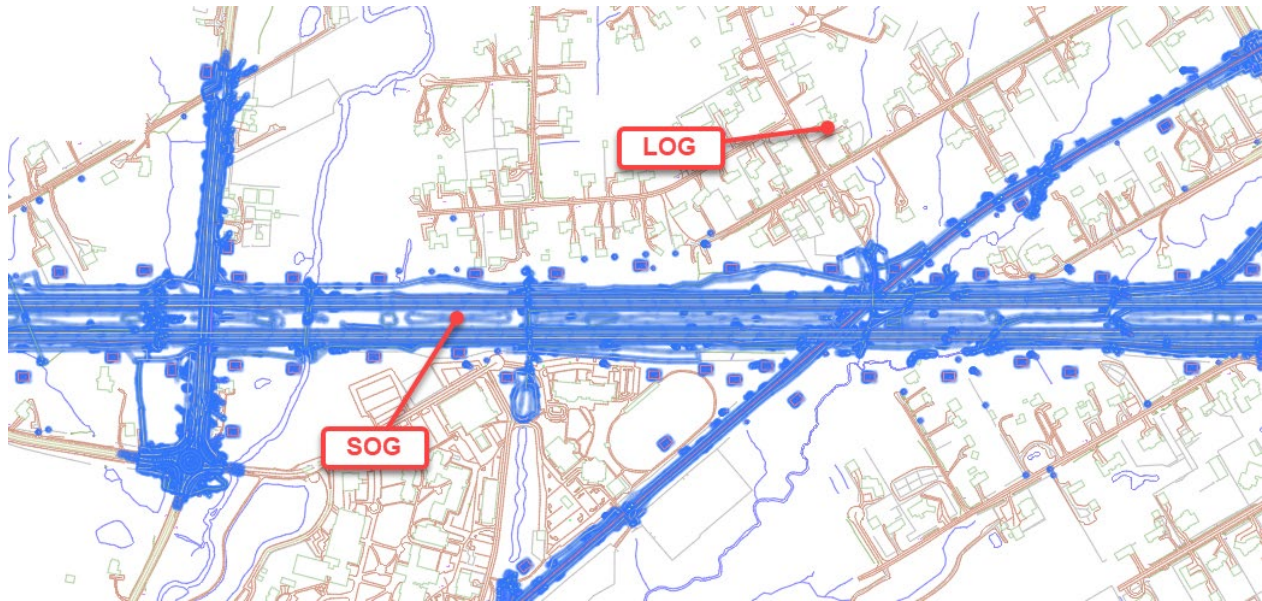
600.04 Construction Original Ground COG Surface Model

The Construction Original Ground surface model is used for calculating STRP (stripping) quantities. Once the COG surface is complete, it is then referenced by the TYPEDSTRP project to calculate stripping quantities.

Prior to conducting the COG survey, the construction supervision team, under the direction of the Ministry Representative, should consider that the Geomatics surveyors, as part of the design process, have conducted a detailed survey using total station and/or GPS, to create the VSOG (Surveyed Original Ground) surface, and survey base (SURVBASE) drawing. In many projects, the VSOG surface is aggregated with the VLOG (LiDAR Original Ground) surface to create the VCOG (Combined Original Ground) surface. This is summarized in the following bullets:

- VSOG – Surveyed Original Ground (collected using GPS and/or Total Station)
- LOG – LiDAR Original Ground (collected mostly using aerial and sometimes terrestrial LiDAR data collection system)
- COG – Combined Original Ground, which combines the LOG and VSOG data

An example of VSOG, LOG and COG (Combined Original Ground) data is shown in the following illustration:



The Geomatics COG (Combined Original Ground) is created by effectively cutting a hole in the LOG and replacing the removed LOG data with VSOG data.

When considering the Construction Original Ground survey, the construction surveyor and the Ministry Representative need to be aware of the existence and physical extents of VSOG data, as the VSOG data is the only Geomatics survey data that could be used during construction supervision. Consideration should be given to the following:

- Date of the VSOG survey
- Extent of disturbed areas on the project (clearing and grubbing)
- Due diligence elevation checks on the VSOG

In no circumstances would the LOG be suitable for reuse during construction supervision. If VSOG data were to be reused, Construction Original Ground surveys would be limited to areas of Geomatics LOG coverage that fall within proposed construction limits.

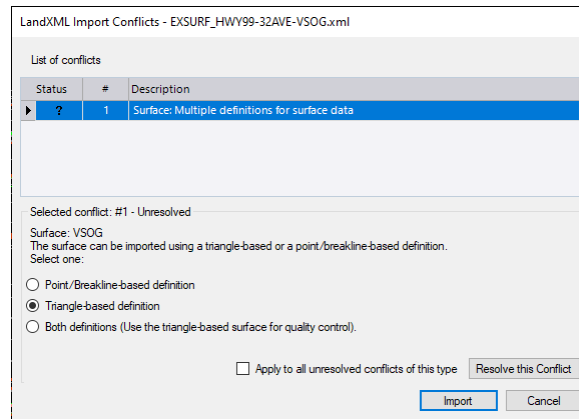
The Geomatics VSOG surface should be imported to the Construction Original Ground TBC project for the following reasons:

- To check random observations, in the areas of the VSOG, to validate the use of the VSOG surface
- Potential use of the VSOG surface to eliminate the need for resurveying existing features
- To identify plan limits of VSOG surface so locations for additional ground surveys can be identified

The VSOG surface is available in the following folder:

\01) ConstructionSurveyDataPackage\01) IFT\04) ExistingSurfacesXML

When importing the VSOG XML file use Triangle-based definition to prevent the addition of unwanted point and breakline data to the TBC project. This is shown in the following illustration:



If the VSOG XML file is not in the CSDP, the surveyor should contact the project ground modeler.

Should additional survey work be required for Construction Original Ground surface modeling, care must be taken to use line and point feature definitions from the Feature Definition FXL File that have the Include in surface property set to Yes. If COG survey data is not required for removal item quantification codes in the *20 – Const Horizon Remeasure* category of the Ministry Feature Definition FXL file. If the construction surveyor chooses to use the Geomatics VSOG surface, it can be combined with the Construction Original Ground surface using the TBC Surfaces → Combine Surfaces command.

Refer to section 200.05 for naming standards for the COG surface.

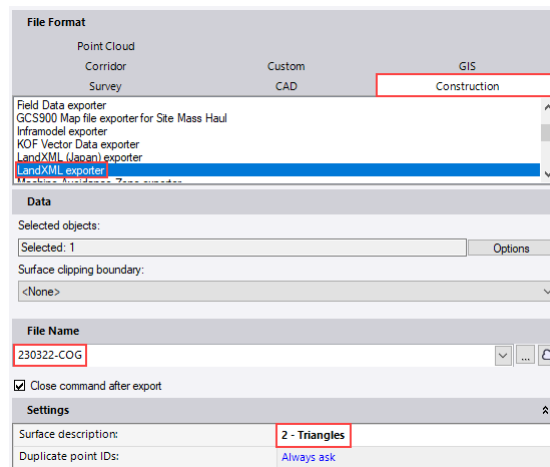
600.05 COG Data Transfer to Ground Modeler

The COG surface may be required by the project Ground Modeler, upon request by the Ministry Representatives, for the purpose of rerunning the corridor model. In these circumstances the COG surface is exported to a Land XML file using TBC Home → Export → Construction (tab) → LandXML exporter routine.

The surface name and the XML file name should be the same, using the following format:

- YYMMDD-COG
- YYMMDD = date of the last operation on the COG surface

For LandXML export settings, ensure the Surface description is set to *2 – Triangles*, as shown in the following illustration:



The XML file is exported to the following folder:

\02) Records and Correspondence\04) GMDDataTransfer\01) Sent

Once the export is complete the construction surveyor provides the surface XML file to the ground modeler.

700 Horizon and Remeasure Surveys, Surface Modeling and Volumes

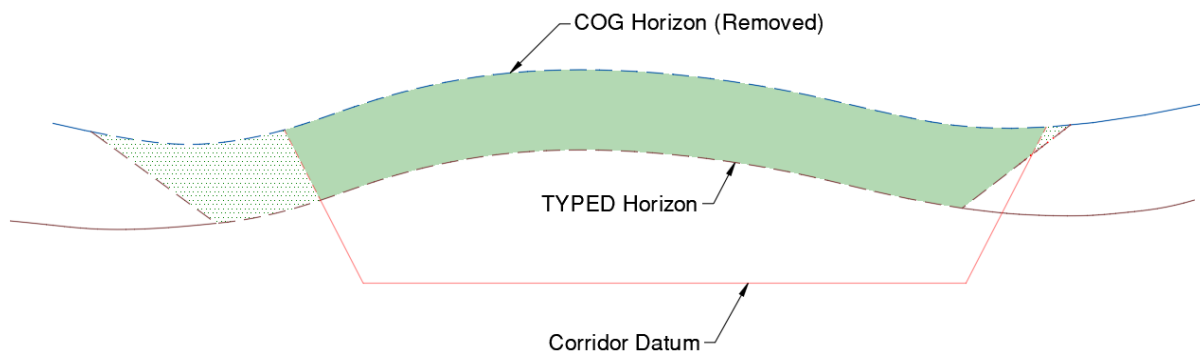
This section describes procedures and standards associated with surveying and modeling horizon and remeasure surfaces and calculating volumes using surface to surface volume calculation method.

700.01 Horizon Surfaces

A *horizon* surface represents the top of a particular material. Examples of horizon surfaces include the following:

- TYPEDH – Top of TYPED (earth) material
- TYPEAH – Top of TYPEA (rock) material
- SUBEXH – Top of SUBEX (subexcavation) material

The following illustration shows examples of the COG Horizon surface and the TYPED Horizon surface in cross section format.



The shaded area between the COG Horizon and the TYPED Horizon represents the STRP (stripping) quantity, and the dashed lines represent the actual excavation.

Horizon surfaces are used for the following tasks:

- Calculation of material specific excavation volumes for monthly contractor payments
- Corridor are rerun against measured horizon surfaces (actual) by the Ground Modeler so that actual material excavation quantities can be calculated

The construction surveyor maintains the active horizon surfaces in a TBC project should be in regular communication with the Ground Modeler to provide horizon surfaces as requested. Horizon surfaces are exported to LandXML files for handoff to the Ground Modeler.

Please refer to Section 200.05 Naming Standards for horizon surface naming requirements.

7.01.01 Stripping

Stripping is a quantity and should therefore never be modelled as a horizon surface. The bottom of the stripping material is usually the TYPED horizon, but can sometimes be a TYPEA horizon. A STRPR stripping remeasure surface is only possible in circumstances where the Ministry Representative determines that additional stripping material needs to be removed after surveying the initial excavation. In this

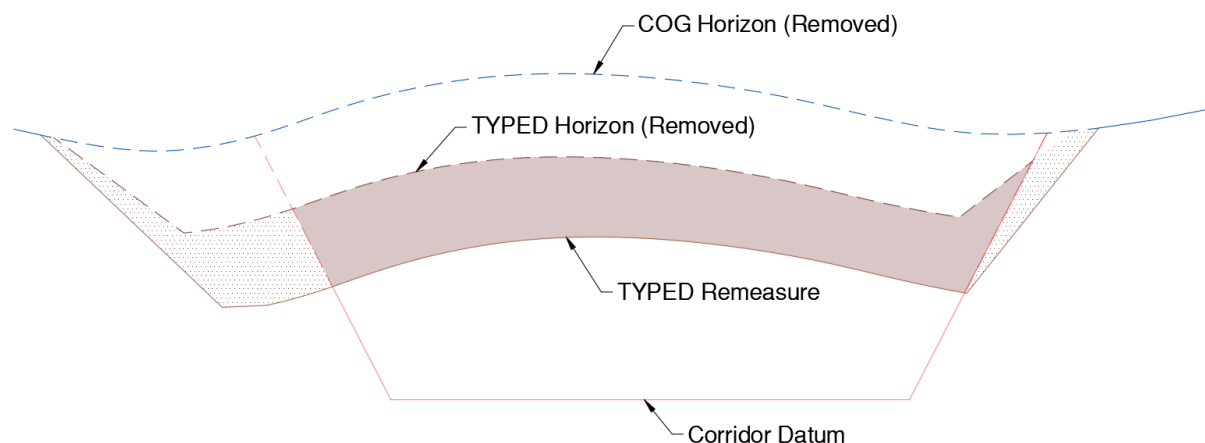
circumstance, after the stripping material was removed, the surveyor would have initially used TYPEDH codes (ZD* and YD) for the underlying TYPED horizon, or TYPEAH codes (ZA* and YA) for the underlying TYPEA horizon.

If the Ministry Representative requires further excavation to remove additional stripping material, the original data files should be copied and then edited to change the TYPEDH (or TYPEAH) codes to STRPR stripping remeasure (KS* and JS) codes. The original TYPEDH (or TYPEAH) data should be removed from the TBC project by deleting the file from the TBC Imported Files collection in Project Explorer, and the new file with the renamed codes is then imported. These changes should be noted in the survey data tracking spreadsheet.

700.02 Remeasure Surfaces

A *remeasure* surface represents an excavation within any given material and is measured and modeled by the construction surveyor solely for the purpose of monthly volume calculation to support contractor payment. The remeasure surface is compared against the horizon surface for that material to calculate the monthly excavation volume for that material.

An example of a TYPED Remeasure surface is shown in the following illustration, which assumes just stripping (above TYPED Horizon) and TYPED material is present:



The shaded area between the TYPED horizon and the TYPED remeasure surface represents the TYPED remeasure quantity for that month. Note that the contractor is only compensated for quantities that fall within the corridor datum “neat line”.

Remeasure surfaces are not required by the Ground Modeler.

700.03 Horizon and Remeasure Feature Codes

Horizon and remeasure feature codes are found in the 20 – *Const Horizon Remeasure* category of the Ministry Feature Definition FXL File. In no circumstances should codes in categories 01 through 12 be used for horizon and remeasure surveys (other than Construction Original Ground COG horizon, when feature

data is required for removal pay item quantities). Codes in these categories originate from Ministry Geomatics and, for the most part, represent actual field features.

The codes in the 20 – Const Horizon Remeasure category consist of both point (spot elevation) and line codes (horizon and change to) for the following:

1. COG horizon
2. Gravel horizon and remeasure
3. STRP (stripping) remeasure only
4. TYPED (earth) horizon and remeasure
5. TYPEA (rock) horizon and remeasure
6. Waste (waste material) horizon and remeasure
7. RipRap horizon and remeasure
8. SUBEX (subexcavation) horizon and remeasure

Line codes and spot elevation codes use the following conventions:

1. Z* = Horizon Material (Top of native material, prior to excavation)
2. K* = Remeasure Material (Top of material, after excavation)
3. X* = Change to Material (Interface of two materials)
 - a. Linestrings can be copied / exported for use with *another* surface
4. Y* = Horizon Material Spot Elevation
5. J* = Remeasure Material Spot Elevation

A summary of the horizon and remeasure feature codes, along with the respective TBC layers, is shown in the following illustration:

20 - Const Horizon Remeasure				
Name:		20 - Const Horizon Remeasure		
Name	Group	Code	Layer	Color
Horizon Spot Elevation - COG	20 - Const Horiz..	YO	C-TOPO-HORZ-OGND	By Layer
Horizon Spot Elevation - Gravel	20 - Const Horiz..	YG	C-TOPO-HORZ-GRVL	By Layer
Horizon Spot Elevation - Type A	20 - Const Horiz..	YA	C-TOPO-HORZ-TYPA	By Layer
Horizon Spot Elevation - Type D	20 - Const Horiz..	YD	C-TOPO-HORZ-TYPD	By Layer
Horizon Spot Elevation - Waste	20 - Const Horiz..	YW	C-TOPO-HORZ-WAST	By Layer
Remeasure Sport Elevation - Stripping	20 - Const Horiz..	JS	C-TOPO-RMSR-STRP	By Layer
Remeasure Spot Elevation - COG	20 - Const Horiz..	JG	C-TOPO-RMSR-OGND	By Layer
Remeasure Spot Elevation - Type A	20 - Const Horiz..	JA	C-TOPO-RMSR-TYPA	By Layer
Remeasure Spot Elevation - Type D	20 - Const Horiz..	JD	C-TOPO-RMSR-TYPD	By Layer
Remeasure Spot Elevation - Waste	20 - Const Horiz..	JW	C-TOPO-RMSR-WAST	By Layer
Change to - COG	20 - Const Horiz..	XO	C-TOPO-CHNG-OGND	By Layer
Change to - Gravel	20 - Const Horiz..	XG	C-TOPO-CHNG-GRVL	By Layer
Change to - RipRap	20 - Const Horiz..	XR	C-TOPO-CHNG-RPRP	By Layer
Change to - Sub Excavation	20 - Const Horiz..	XU	C-TOPO-CHNG-SUBX	By Layer
Change to - Type A	20 - Const Horiz..	XA	C-TOPO-CHNG-TYPA	By Layer
Change to - Type D	20 - Const Horiz..	XD	C-TOPO-CHNG-TYPD	By Layer
Change to - Waste	20 - Const Horiz..	XW	C-TOPO-CHNG-WAST	By Layer
Horizon - COG	20 - Const Horiz..	ZO	C-TOPO-HORZ-OGND	By Layer
Horizon - Gravel	20 - Const Horiz..	ZG	C-TOPO-HORZ-GRVL	By Layer
Horizon - RipRap	20 - Const Horiz..	ZR	C-TOPO-HORZ-RPRP	By Layer
Horizon - Sub Excavation	20 - Const Horiz..	ZU	C-TOPO-HORZ-SUBX	By Layer
Horizon - Type A	20 - Const Horiz..	ZA	C-TOPO-HORZ-TYPA	By Layer
Horizon - Type D	20 - Const Horiz..	ZD	C-TOPO-HORZ-TYPD	By Layer
Horizon - Waste	20 - Const Horiz..	ZW	C-TOPO-HORZ-WAST	By Layer
Remeasure - Gravel	20 - Const Horiz..	KG	C-TOPO-RMSR-GRVL	By Layer
Remeasure - RipRap	20 - Const Horiz..	KR	C-TOPO-RMSR-RPRP	By Layer
Remeasure - Stripping	20 - Const Horiz..	KS	C-TOPO-RMSR-STRP	By Layer
Remeasure - Sub Excavation	20 - Const Horiz..	KU	C-TOPO-RMSR-SUBX	By Layer
Remeasure - Type A	20 - Const Horiz..	KA	C-TOPO-RMSR-TYPA	By Layer
Remeasure - Type D	20 - Const Horiz..	KD	C-TOPO-RMSR-TYPD	By Layer
Remeasure - Waste	20 - Const Horiz..	KW	C-TOPO-RMSR-WAST	By Layer

Please refer to Appendix B for diagrams showing examples of horizon, remeasure and change to codes.

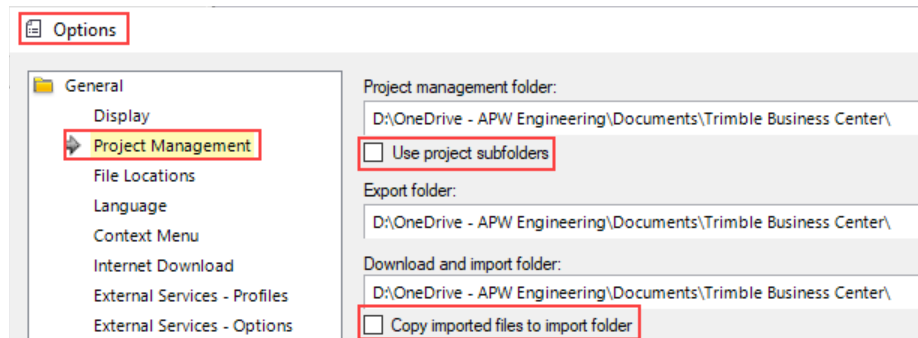
700.04 TBC Horizon and Remeasure Project Setup

Data sharing capabilities in Trimble Business Center allow for the creation of task-based TBC projects, where the only data residing in a TBC project could relate to a specific task (TYPED and TYPEA project, for example). Creating task-based TBC projects is preferred for the following reasons:

- Reduces the amount of data in each TBC project
- Simplifies data management in each TBC project

Before creating the Horizon and Remeasure project, ensure that the following settings have been disabled in TBC Options:

- Use project subfolders
- Copy imported files to import folder



These settings are disabled because workflows put the onus is on the Construction Surveyor to copy and locate the source data files appropriately.

Horizon and remeasure TBC projects are to be created using the following TBC project template:

BCMoTI-2HorizonRemeasureR#.vct (where # is the version of the project template)

After creating the project, save the project using the following name:

PROJ-TASK.vct

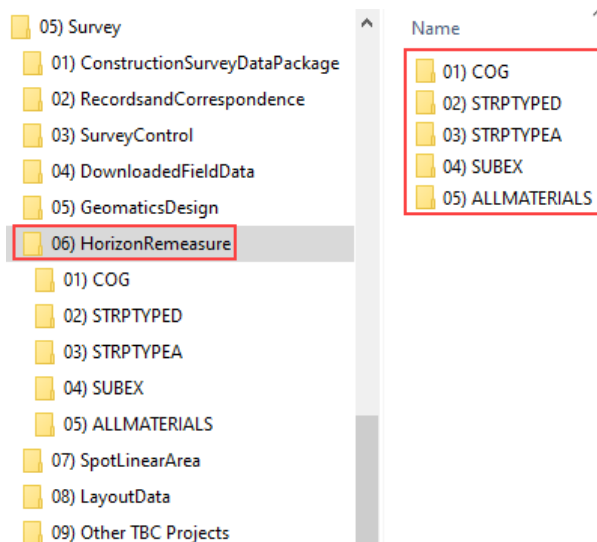
PROJ is abbreviated project name, which is used as a prefix for all TBC projects

TASK describes the task in the TBC project

Examples are as follows:

- HWY9932-STRPTYPED (Highway 99 / 32nd Avenue Stripping and TYPED)
- CHASEW-TYPEA (Chase West TYPEA)

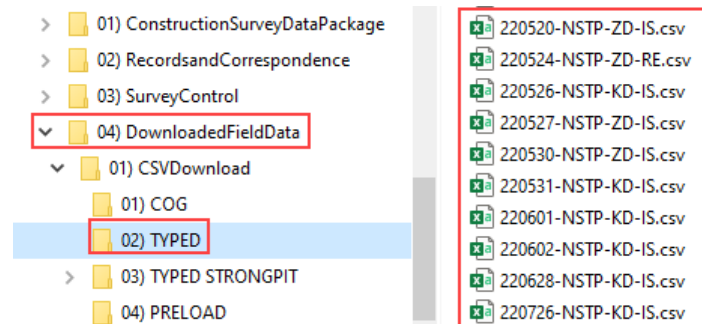
Horizon and remeasure projects are stored in the task-based folder under the standard folder structure. Task-based folders are shown in the following illustration:



For example, the *PROJ-STRPTYPED* TBC VCT project files is stored in the *\02) STRPTYPED* folder and the *PROJ-STRPTYPEA* TBC VCT project file is stored in the *\03) STRPTYPEA* folder. Folders under *\06) HorizonRemeasure* that are not required can be removed.

After the TBC project has been created, the procedure to copy data files from the controller to the project subfolders is as follows:

1. Download files from controller to a task specific folder in the `\04) DownloadedFieldData\` folder



These files are to remain untouched and unedited.

2. Copy the corresponding JXL (RAW survey data) to a task specific folder under `\04) DownloadedFieldData\02) JXLLegalDownload\` folder. These files represent the legal record of survey (instrument observations, as opposed to reduced coordinates)
3. Copy the CSV files to `\06) HorizonRemeasure\TASK\01) UnprocessedData\` folder.
4. Once the files are imported to the COG TBC project, move the files from `\01) UnprocessedData\` to `\02) ProcessedData\`

Step number 4 is only required if there are several files, and the construction surveyor needs to keep track of which files have been imported versus which files still need to be imported. When all is said and done, all files imported to TBC need to reside in `\02) ProcessedData\`.

The final step is to run the Survey → Process Feature Codes command to generate linestrings, assign points and linestrings to the correct layers and identify nonstandard survey codes. Addressing nonstandard codes can be done in TBC or in the source data file. For the latter, reimport the file and run the Process Feature Codes command again.

700.05 Horizon and Remeasure Surface Modeling

All horizon and remeasure spot elevation and linework field codes have the *Include in surface* parameter toggled on. Use linework codes to generate terrain breaks in the surface model which i) forces triangulation along the break and ii) prevents surface triangulation from being generated across terrain breaks. Use Surfaces → Create → Surface Boundaries and/or Surfaces → Edit → Trim Surface Edge to remove long and inaccurate triangulation lines from the outside limits of the surface.

700.06 Volume Calculations

The construction surveyor is responsible for the calculation and reporting of monthly excavation volumes. Monthly volumes based on field surveys and surfaces are calculated using Surfaces (ribbon tab) → View (panel) → Earthwork Report (command).

All monthly volume calculations are to be calculated against horizon surfaces. The following sections detail some examples.

7.06.01 Stripping Volumes

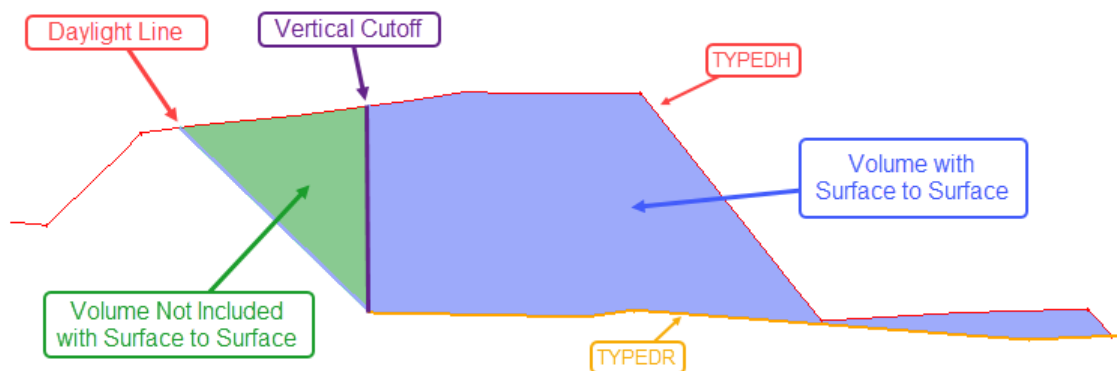
Stripping volumes are calculated in the TYPEDSTRP project, which references the COG surface from the COG project. Calculate the stripping volume using the COG surface as the Initial surface and the TYPEDH surface as the Final surface.

7.06.02 TYPED Volumes

TYPED volumes are always calculated against the TYPEDH horizon surface. Assuming that there are multiple remeasure surfaces (one for each month), including the final remeasure, and that only TYPED material is present, calculate the TYPED excavation quantity by comparing the TYPEDR remeasure surface against the TYPEDH horizon surface. For remeasure surfaces beyond the first payment period, calculate the remeasure volume against the TYPEDH horizon surface, and subtract TYPED volumes from the prior months excavations to determine the current month volumes.

Volume calculations using the TBC Earthworks report command are calculated using “surface to surface” volume calculation methodology. This means that if daylight (catch) lines to the TYPEDH horizon surface are not included in the TYPEDR surface, then volumes are based on a vertical cut-off to the limits of the TYPEDR remeasure surface.

This is shown in the following illustration:



To eliminate the vertical cut-off for volume calculation, and to provide more accurate volumes, construction surveyors can use either of the following methods:

- Include daylight line linestring in TYPEDR surface model
- Use TBC Surfaces (ribbon tab) → Create (panel) → Surface Tie (command) to project a slope from a linestring to a surface (linestring at the outer limits of the TYPEDR surface)

Surface to surface volume calculations are sufficient for monthly quantity calculations and can be reconciled by the projects ground modeler by running the corridor model against measured construction horizons.

7.06.03 TYPEA Volumes

TYPEA volume calculations are based on the same general principles for TYPED volume calculations. Surface to surface volumes will generally be more accurate due to the steep slopes (0.5:1, for example) associated with TYPEA excavation. As with TYPED volumes, TYPEA volumes are always calculated between

the TYPEAR remeasure surface and the TYPEAH horizon surface. In instances where multiple remeasure surfaces are measured, then the monthly volume is determined by subtracting prior months volumes. Surface closures using surveyed daylight linestrings or TBC surface ties will always yield more accurate results.

7.06.04 Volume Calculation in Trimble Business Center

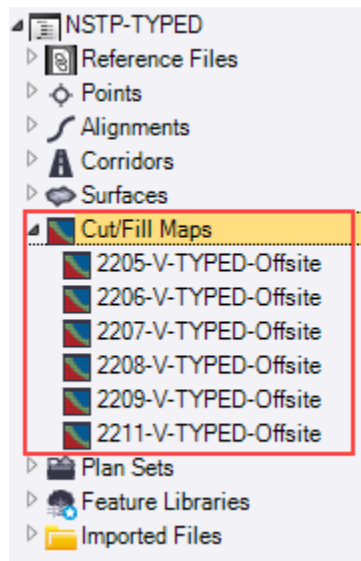
To calculate a volume between 2 surfaces in TBC use the Surfaces (ribbon tab) → View (panel) → Earthwork Report (command), using the following options:

- Report Type: Surface to surface
- Initial: COG or TYPEDH/TYPEAH horizon surface
- Final: TYPED (for stripping) or TYPEDR/TYPEAR remeasure surface
- Boundary: Optional closed linestring for limiting volumes calculation to a specific area
- Volume Breakdown: Volume totals only

After clicking OK the routine will i) create and display an HTML Earthwork Report in your current browser and ii) create an *Isopach* surface in the Cut/Fill Maps collection in Project Explorer.

An isopach surface is a net surface with positive and negative elevations, representing the depth of fill and cut respectively and should only be displayed to verify the planimetric location limits for the volume calculation. The isopach surface should immediately be renamed using the isopach surface naming standards identified in Section 200.05.

The following illustration shows a collection of isopach (volume) surfaces in TBC Project Explorer:



The V indicates volume, and by leaving the date as a prefix surface data sorting is better in TBC View Filter Manager. This is shown in the following illustration:

<input type="checkbox"/>	2206-TYPEDR
<input type="checkbox"/>	2206-V-TYPED-Offsite
<input type="checkbox"/>	2207-TYPEDR
<input type="checkbox"/>	2207-V-TYPED-Offsite
<input type="checkbox"/>	2208-TYPEDR
<input type="checkbox"/>	2208-V-TYPED-Offsite
<input type="checkbox"/>	2209-TYPEDR
<input type="checkbox"/>	2209-V-TYPED-Offsite
<input type="checkbox"/>	2211-COG
<input type="checkbox"/>	2211-Preload
<input type="checkbox"/>	2211-TYPEDR
<input type="checkbox"/>	2211-V-TYPED-Offsite

Renamed isopach surface provide an excellent record of a specific calculation as properties of the isopach surface include the following:

- Cut and fill volumes and areas
- Minimum and maximum elevations (maximum depths of cut and fill respectively)
- Initial and final surfaces (which can be edited)

Isopach surface are created on Layer 0 by default, can be toggled on and off in the View Filter Manager, and can therefore be incorporated into a View Filter.

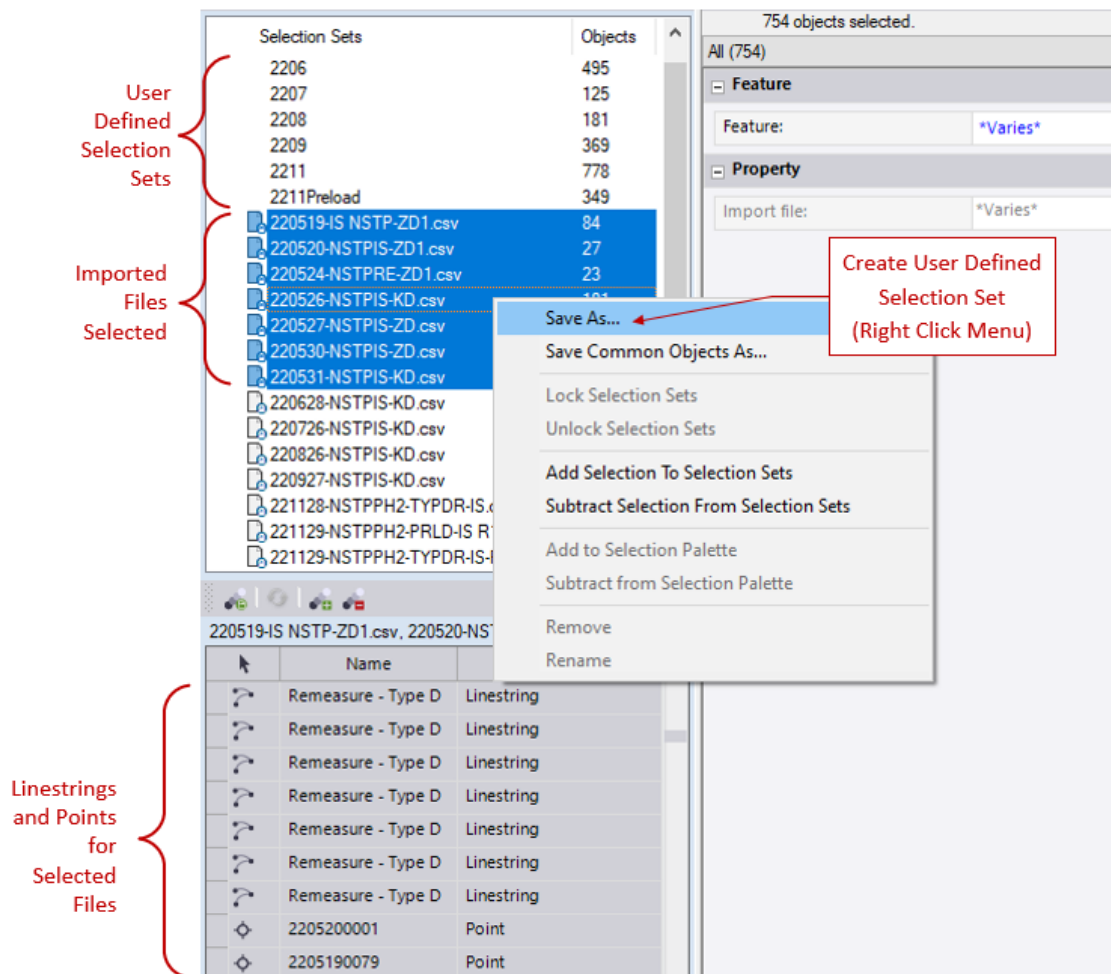
7.06.05 TBC Selection Sets, View Filters and Construction Data Management

Trimble Business Center is an excellent application for the management of construction data over the course of a lengthy project. To effectively manage data, construction surveyors need to understand the inner workings of both Selection Sets and View Filter Manager.

These are discussed in the following sections.

7.06.05.01 TBC Selection Sets

Selection Sets are available on the Selection Explorer palette. A selection set is a collection of common elements that can be “selected” for manipulation. An example of a selection set is a collection of points and linestrings imported to TBC relating to a specific task. All files imported to TBC are displayed in the Selection Explorer. The following image shows how to create a selection set from a collection of imported data files that have been processed against the project FXL file:



A task specific selection set is created for import files for each pay period to facilitate data management and viewing for any given pay period. In this example, the project is a TYPED project so the name of the selection set is indicative of the date only (YYMM) and does not require the task. Selection sets can be incorporated into view filters which makes it easy to view the point data and surfaces for any given pay period. This is addressed in the next section.

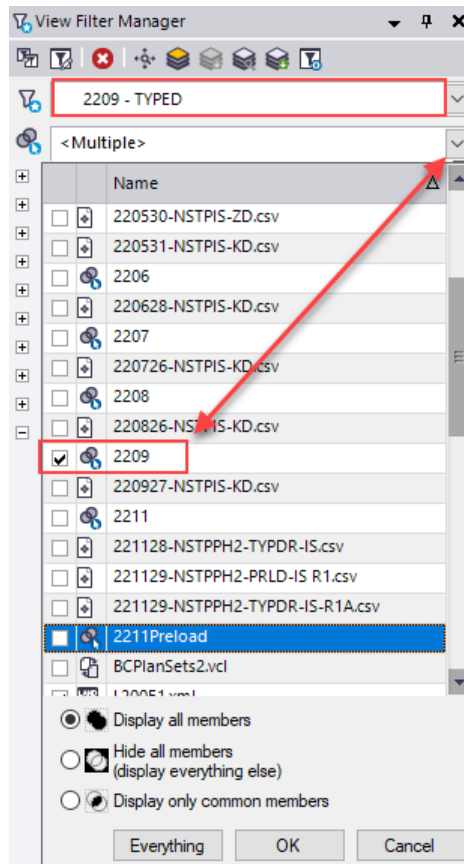
7.06.05.02 TBC View Filters

View filters area available on the TBC View Filter Manager palette and are used to control the visibility and selectability of different data types and layers in graphic views. For example, a view filter in a TYPED Horizon and Remeasure project, when set current, would display the TYPED layers. This is shown in the following illustration:

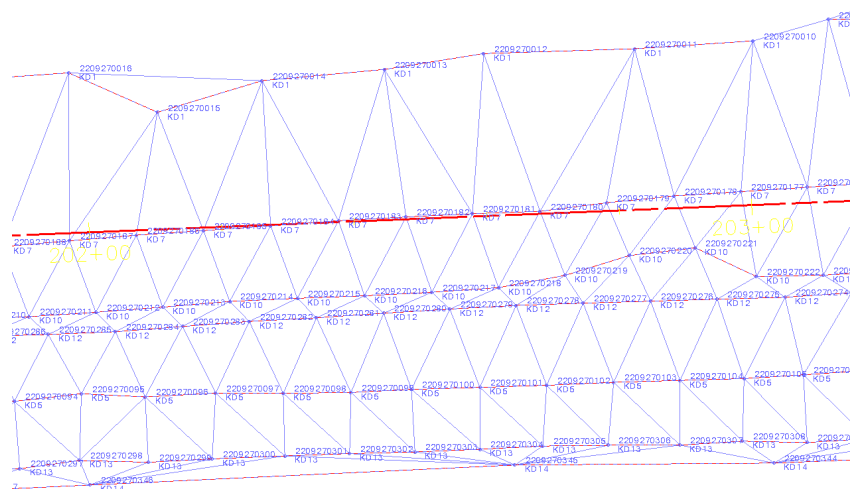
<input checked="" type="checkbox"/>	Layers
<input checked="" type="checkbox"/>	0
<input checked="" type="checkbox"/>	Points
<input type="checkbox"/>	00 - CONTROL
<input type="checkbox"/>	01 - COG
<input checked="" type="checkbox"/>	02 - TYPED
<input checked="" type="checkbox"/>	C-TOPO-BNDY-TYPD
<input checked="" type="checkbox"/>	C-TOPO-CHNG-TYPD
<input checked="" type="checkbox"/>	C-TOPO-HORZ-TYPD
<input checked="" type="checkbox"/>	C-TOPO-RMSR-TYPD
<input checked="" type="checkbox"/>	C-TOPO-TEXT-TYPD
<input type="checkbox"/>	03 - TYPEA
<input type="checkbox"/>	04 - SUBEX
<input type="checkbox"/>	05 - WASTE
<input type="checkbox"/>	06 - GRAV
<input type="checkbox"/>	07 - RIPRAP
<input type="checkbox"/>	08 - STRP
<input type="checkbox"/>	10 - CONSTRUCTION GENERAL
<input type="checkbox"/>	20 - GEOMATICS
<input checked="" type="checkbox"/>	20 - TITLE BLOCKS
<input checked="" type="checkbox"/>	30 - ALIGNMENTS
<input type="checkbox"/>	Surface
<input type="checkbox"/>	Reference Files

View filters make it easy to configure views to display specific data types by simply toggling the display of specific layers on and off.

Layer based view filters can also be combined with selection sets. For example, a surveyor may choose to create view filters for TYPED data for every pay period. This is accomplished in the View Filter Manager by choosing a previously created selection set in the drop-down menu below the view filter. This is shown in the following illustration:

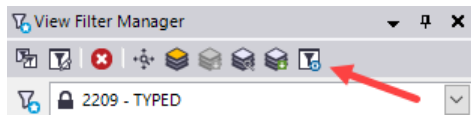


In this example the TYPED data for September, 2022 (points, linestrings and surfaces) is displayed in the graphics area, as per the following illustration:

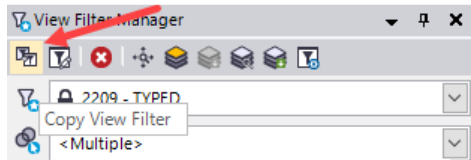


Construction surveyors must always be cognisant of the current view filter when adjusting layer and other view filter settings. The following items should be given consideration when working with view filters:

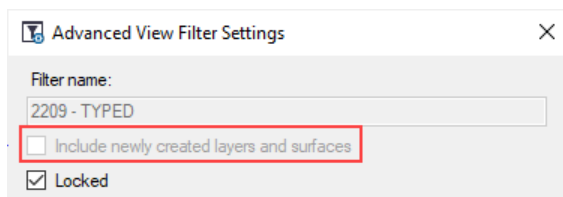
- After creating a view filter lock it so it can not be disrupted. Use Advanced View Filter Settings to lock view filters.



- For layer manipulation use the My Filter view filter, or create a copy of the current view filter



- When creating view filters, muse Advanced View Filter Settings, and disable *Include newly created layers and surfaces* as this will disrupt custom view filters and display data not intended to be viewed with that view filter



Finally, the combination of TBC view filters and selection sets are what makes TBC extremely well suited to construction data management. The construction surveyor priority should be to become proficient with the use of these tools.

800 Spot, Linear and Area Survey Quantity Calculations

This task involves conducting surveys to measure spot, linear and area quantities associated with pay items for newly constructed features and features to be removed as part of a contract. Standardized components associated with this task include survey feature codes, the TBC project template, and the MS Excel quantity tracking spreadsheet.

As there is not a standardized list of pay items that apply to every Ministry construction project, these standardized components serve as “templates” to assist with workflows associated with measuring and calculating spot, linear and area quantities, and are discussed in the following sections.

800.01 Survey Codes

Measurement of newly constructed spot, linear and area features make use of survey codes in the Ministry’s FXL file. Commonly used codes for typical pay items are indicated in the standard pay item reports (worksheets) for quantity tracking. Refer to [Section 100.02 Survey Quantity Tracking](#) for details.

800.02 TBC Project Creation

TBC projects created for spot, linear and area quantity calculations are created using the following TBC project template:

BCMoTI-4SpotLinearAreaQuantitiesR#.vct (where # is the version of the project template)

After creating the project, save the project using the following name:

PROJ-TASK.vct

PROJ is abbreviated project name, which is used as a prefix for all TBC projects

TASK describes the task in the TBC project

Examples are as follows:

- HWY9932-QUANT (Highway 99 / 32nd Avenue quantities)
- CHASEW-STORM (Chase West storm sewer quantities)

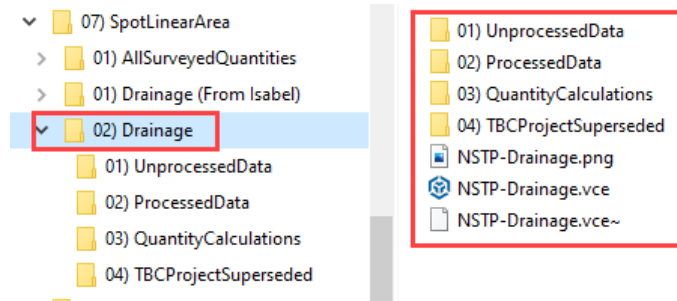
TBC projects for spot, linear and area calculations are to be stored in the following folder:

\05) Survey\07) SpotLinearArea\PROJFOLDER

PROJFOLDER represents the folder name for the project. Examples are as follows:

- 01) AllSurveyedQuantities
- 02) DrainageQuantities

This is shown in the following illustration:



Once the TBC project has been saved, survey data can be imported to create TBC features for quantification.

900 Other Types of Surveys

Construction surveyors may also be required to undertake other types of surveys, which are discussed in the following sections:

900.01 Monitoring

Monitoring surveys are required to identify movement of construction elements over time. These include items such as slope stability, settlement (preload, for example) and 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.

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

- Accuracy and stability of control
- Survey equipment used and expected tolerances (total station, GPS, terrestrial scanners)
- Instrument calibration
- Monitoring methods
- Timing of measurements
- Redundancy in measurements
- Qualitative analysis of results
- Identification of and understanding sources of error

A thorough understanding of survey best practices is required to ensure reliable results for monitoring surveys.

900.02 Pits and Piles

Pits (also known as borrow bits) represent locations and sources of gravels and other materials required for use on the project. Piles are typically stockpiles of materials that have been removed from the construction area and can be stored either on or off site.

The following general points shall be considered for gravel pits and piles:

- Identify legal and excavation boundaries where applicable
- May require surveys to identify right of way location and borrow boundaries
- Pre and post excavation surfaces may be required to calculate volume of material removed
- Additional flagging and staking may be required to identify potential conflicts with underground utilities, gas and other private utilities, overhead power, and other wires

When surveying for volumes, surfaces must consist of the appropriate boundaries and point densities should be detailed enough to calculate accurate quantities. Incorporate linestrings to define distinctive terrain breaks in the surface models and use descriptions in the *20 – Const Horizon Remeasure* category in the Ministry FXL file.

1000 Survey Data Tracking and Quantity Reports

A core aspect of construction surveyor quality management is to keep accurate records for the following:

- Survey data files downloaded from the controller
- Quantity reports with metadata supporting the final numbers

Standards reports for survey data file tracking and quantity reporting are available, and discussed in the following sections.

1000.01 Survey Data File Tracking

The file format for TBC project data consumption is a CSV (comma separated value). Details of file names, file content format and where to locate them are available in [Section 200.04 Data Collector Downloads](#).

Ideally data files downloaded from the controller contain only data specific to a task. The task could be COG, TYPEDR or spot/linear/area data for quantification of newly constructed assets. In some instances a survey data file may contain multiple tasks. When multiple tasks are represented in a single downloaded file, the original survey data file should be copied to create task specific data files for consumption in TBC projects.

10.01.01 Survey Controller Data File Tracking

The MS Excel workbook for survey controller data file tracking is called *SurveyControllerDataFiles.xlsx*, and is located in the following folder:

\05) Survey\02) RecordsandCorrespondence\02) SurveyDataFileTracking

Data columns in the survey controller data file tracking workbook are shown in the following illustration:

Survey Controller Download - Data File Tracking

Project Name: HWY1 Ford to Tappen

Project Number: 24913-0001

Download Date	Surveyor Initials	Survey Checked	File Name (*.csv and *.jxl)	Primary Task in File	Other Tasks in File	Additional Comments (Alignment, Station Range etc.)
2022-08-03	BM	Y	220803-CW-TYPEDH-APW.csv	TYPEDH	TYPEAH, TYPEDR	L100 100+50 to 101+00 LHS

Note that all survey data files should be checked to ensure data is correct and the standard feature codes have been applied.

10.01.02 Survey Task Data File Tracking

Task specific survey data files are created from data files downloaded from the controller and copied to the task specific folder. Note that if the downloaded file is task specific, the file still needs to be duplicated and copied to the task specific folder in order to ensure preservation of the original data file.

The MS Excel workbook for survey task data file tracking is called *SurveyTaskDataFiles.xls*, and is located in the following folder:

\05) Survey\02) RecordsandCorrespondence\02) SurveyDataFileTracking

Data columns in the survey task data file tracking workbook are shown in the following illustration:

Survey Tasks - Data File Tracking

Project Name: HWY1 Ford to Tappen

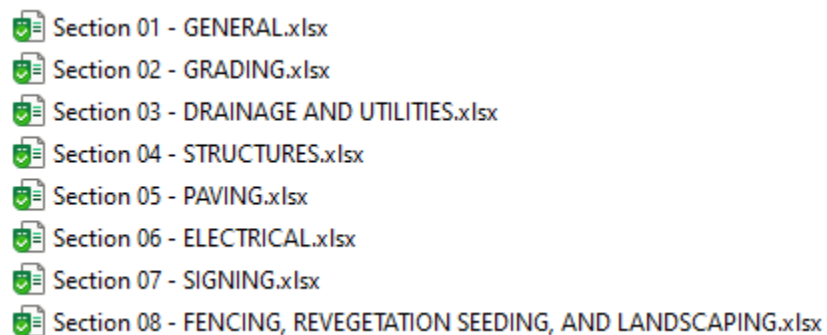
Project Number: 24913-0001

Download Date	Surveyor Initials	Task File Name	Source Data File	Additional Comments (Alignment, Station Range, Offset etc.)
2022-08-03	BM	220803-FORD-TYPEDR-BM.csv	220803-FORD-TYPEDH-BM.csv	L100 100+50 to 101+00 LHS

Task specific data files are to be recorded, even if the original downloaded data file is a task specific file.

1000.02 Survey Quantity Tracking

The construction surveyor is responsible for measuring, calculating, and tracking quantities for both item removal and newly constructed assets on construction projects. Pay item quantity tracking is enabled using the following workbooks, which have been created to reflect the 8 major sections included in Schedule 7 – Approximate Quantities and Unit Prices, which is prepared by the designers:



Each of these workbooks contains the following:

1. A totals worksheet that summarizes quantity to date, % complete and quantity remaining for each of the pay items in the workbook
2. A collection of worksheets for sample pay items that can be used directly, or copied and modified to represent pay items specific to the project
3. Formulas in the worksheets (represented by red text) for various types of calculations and cell population

Section items and categories are not consistent across Ministry projects. Surveyors will need to rename workbooks and worksheets to reflect the correct Section number and category.

Pay items and will also vary significantly from project to project and the first construction surveyor tasks is to configure the quantity tracking workbooks to reflect the pay items for the project. Individual worksheets also indicate the feature code and layer (from FXL file) for each pay item.

The following image shows the Totals worksheet in the Section 02 – Grading workbook.

Totals Section 2 - Grading

Project Name: HWY1 Ford to Tappen		Quantities to Date: 2023-04-30					
Project #: 24913-0001							
Section 2 - Grading							
Pay Item No.	Item Description	Unit	Quantity to Date	Schedule 7 Quantity	% Complete	Quantity Remaining	Comments
02.01	Clearing & Grubbing	m ²	47,300	50,000	95%	2,700	
02.01.01	Removal Ext Culv	m	100	150	67%	50	
02.03.01	Pavement Cutting	m	180	200	90%	20	
02.03.02	Cold Milling	m ²	1,000	1,100	91%	100	
02.04.01	Stripping	m ³	141,000	150,000	94%	9,000	
02.04.02	Controlled Exc.	m ³	5,000	6,000	83%	1,000	
02.04.03	TYPEA	m ³	5,000	7,000	71%	2,000	
02.04.04	TYPEB	m ³	5,000	8,000	63%	3,000	
02.04.05	Drying of Embankment	m ²	1,000	1,200	83%	200	
02.04.06	Unsuitable to Offsite	m ³	2,500	3,000	83%	500	
02.06.01	SGSB	m ³	1,250	1,500	83%	250	
02.06.02	WGB	m ³	750	1,000	75%	250	
02.06.03	Geogrid	m ²	100	150	67%	50	

The following image shows the TYPEA pay item worksheet in the Section 02 – Grading workbook:

Item 02.04.03 Type A

[illegible][Return to Totals Page](#)

1. Pay item name on report references workseet tab name
2. Copy worksheet tab to create new pay item tab

Feature Code	Name	Category / Layer / Group	Layer
ZA	Horizon Line - TYPEA	20-Cont Horizontal Remeasure	C-TOPO-HORIZ-TYPEA
YA	Horizontal Spot - TYPEA	20-Cont Horizontal Remeasure	C-TOPO-HORIZ-TYPEA
KA	Remeasure Line - TYPEA	20-Cont Horizontal Remeasure	C-TOPO-HORIZ-TYPEA
LA	Remeasure Spot - TYPEA	20-Cont Horizontal Remeasure	C-TOPO-HORIZ-TYPEA
BA	Rock - Bare of Rock	06-EX Topography	V-TOPO-ROCK BARE
BN	Rock - Broken Rock	06-EX Topography	V-TOPO-ROCK BRKN
LR	Rock - Loose Rock	06-EX Topography	V-TOPO-ROCK LOOS
SR	Rock - Solid Rock	06-EX Topography	V-TOPO-ROCK SOLID
TR	Top - Top of Rock	06-EX Topography	V-TOPO-ROCK TRCK
OB	Overbank	06-EX Topography	V-TOPO-ROCK OVBK
OV	Overhang	06-EX Topography	V-TOPO-ROCK MISR

All worksheets in each category workbook are configured specific to each pay item. A key component of each worksheet is the TBC project containing the field measurements, details of the quantity calculation, and where (TBC project) that information can be derived from.

1100 Layout Quality Assurance Surveys

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.

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.

1100.01 Right of Way

Right of way data is provided on the 100 Series Plan production drawing in the construction tender drawings. Identification of right of way in the field will ensure that the contractor does not encroach on private property and builds confidence in the property owner that encroachment will not take place.

Right of ways are required to be identified in the field when the proposed works are located within 3m of the existing right of way. The right of way should also be identified in areas where construction machinery and vehicles will travel within 3m of the right of way. Field identification of the entire right of way is encouraged.

- Right of way staking requirements are summarized in the following bullets:
- Right of Way stakes are located between 0.5 and 1.0m offset from the right of way, towards the centreline alignment.
- Line of sight (or 20m maximum intervals) continuously visible blue and white flagging, stake optional, and/or at Ministry representative's request.
- When stakes are used to identify corners and deflection points, the alignment name, station, and offset shall be written on the stakes.

Right of Way data is available in the 100 series plan drawing, or SURVPROP drawing that is provided in the Construction Survey Data Package. This information is consumed by a TBC project in the following location:

`\05) Survey\06) GeomaticsDesign\`

Right of way linework can be exported to a DXF file from the TBC project for data collector upload prior to layout.

1100.02 Clearing and Grubbing

Clearing and grubbing surveys require the following considerations:

- Line of sight (or 20m maximum intervals) with continuously visible flagging
- Stake to identify corners (C/G corner written on stake) with station/offset
- If clearing and grubbing extends to ROW limits then the stake shall be inscribed with Algn/sta/offset, R/W and C/G

Clearing and grubbing data is available in the 100 series plan drawing that is provided in the Construction Survey Data Package. This information is consumed by a TBC project in the following location:

`\05) Survey\06) GeomaticsDesign\`

Clearing and grubbing linework can be exported to a DXF file from the TBC project for data collector upload prior to layout.

1100.03 Working Easements / License to Construct

Contractors, developers, landowners, local governments, and utility companies must apply for a highway works permit to construct, relocate, replace, repair and maintain works on provincial highways, right-of-ways or on highway bridges or structures.

A highway use permit may require a working easement to facilitate construction practices such as the movement of equipment or material. Working easements are sometimes identified during the design and in these circumstances, this data is provided as part of the Construction Survey Data Package.

Working easement data is available in the 100 series plan drawing that is provided in the Construction Survey Data Package. This information is consumed by a TBC project in the following location:

`\05) Survey\06) GeomaticsDesign\`

Working easement stakes must be placed such that they are intervisible, or at a maximum of 20m intervals. The stakes must be inscribed with “Working Easement” or “License to Construct”.

1100.04 Slope Staking

Slope stakes are used to identify the cross-section locations where proposed cut and fill slopes intersect the original ground and at other locations such as major grade breaks (ditches and benches), major elevation changes (retaining walls), locations where the material changes (TYPED to TYPEA) and design locations such as ditch transitions and road widenings.

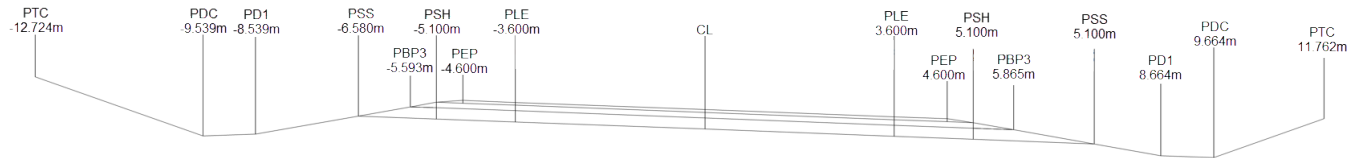
The construction survey data package contains grade sheet documents which are XLSX workbooks containing slope stake data. These files are created for each of the major corridors (alignments), and can be found in the following folder:

`\05) Survey\01) ConstructionSurveyDataPackage\01) IFT\09) Layout\AlignmentName\`

In the *AlignmentName* folder there is a folder called *AlignmentName Grade Sheets*, which contains the slope stake reports for Top surface (toe to toe), Datum surface (toe to toe) and top of granular (PSS to PSS). The slope stake report shows data for each cross section along with a picture showing the coded cross section points. This is shown in the following illustration:

Station:
10+810.000

C1.59	PSS	PBP3	PSH	PEP	PLE	CL		PLE	PEP	PSH	PBP3	C1.05
@3.19	-6.580m	-5.593m	-5.100m	-4.600m	-3.600m	0.000m	0.000m	3.600m	4.600m	5.100m	5.865m	@2.10
01:00.5	421.857m	422.103m	422.227m	422.275m	422.221m	422.026m	422.026m	421.832m	421.778m	421.676m	421.485m	01:00.5
	-25.00%	-25.00%	-25.00%	-9.60%	5.40%		-5.40%	-5.40%	-20.40%	-25.00%	-25.00%	
			PTC	PDC	PD1		PSS	PD1	PDC	PTC		
			-12.724m	-9.539m	-8.539m		7.396m	8.664m	9.664m	11.762m		
			422.910m	421.317m	421.367m		421.102m	420.785m	420.735m	421.784m		
				01:00.5	-5.00%		-25.00%	-5.00%	01:00.5			



The first row of data displays the offset from the centreline to each of the cross section points. The second row of data shows the elevation of each of the cross section points. The third row of data shows the grades between the adjacent points.

For the end columns, C1.59 indicates 1.59m of cut at the PTC (for fill the letter would be an F). The @3.19 indicates an offset value from the prior point, and the slope value is the slope from the prior point.

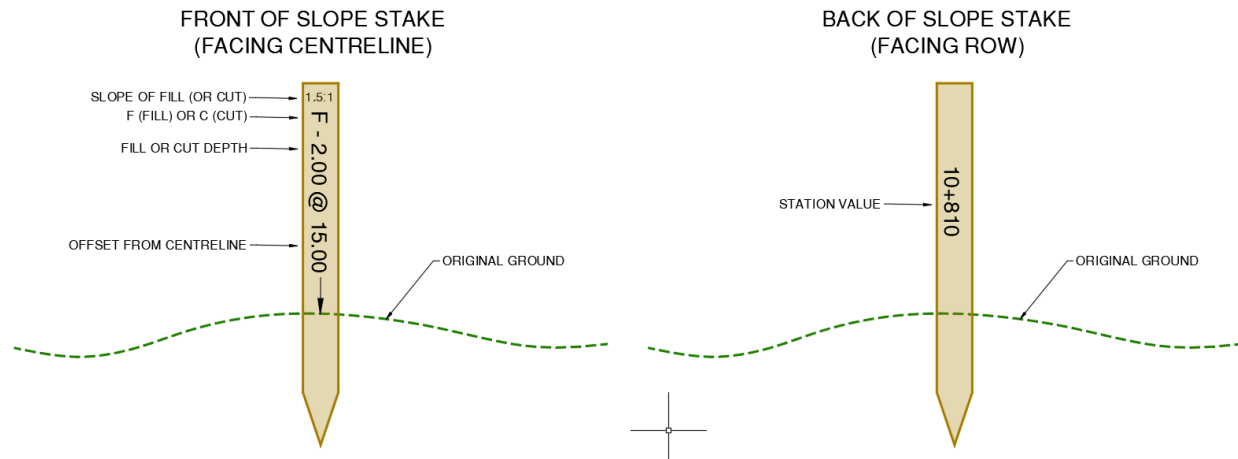
11.04.01 Slope Staking Requirements

The requirements for slope staking are summarized in the following bullets:

- Stakes placed at 20m intervals maximum and 5m intervals in TYPEA (rock) material
- Additional slope stakes are required at major grade/elevation changes, material changes, ditch changes and road widening transition points
- Nonstandard ditches (not represented in alignment typical section) are staked separately as part of the ditch alignment
- Slope stakes can be $\pm 0.030\text{m}$ up or down chainage, or develop slope staking data at new station location to work around an obstruction
- Slope stake CL offset required accuracy is $\pm 0.030\text{m}$
- Vertical accuracy is $\pm 0.015\text{m}$, except for rock cut and fill tolerances of $\pm 50\text{mm}$ as per Standard Specification Section 201.47 (Finished Roadway)
- Offset / guard stakes (in addition to slope stakes) which are placed vertically and indicate offset from slope stake are acceptable. Offset stakes alone are not acceptable
- On cuts/fills greater than 10m (rock benching) the Ministry Representative may require placement of another set of slope stakes during the excavation/backfilling process

11.04.02 Slope Stake Inscriptions – Front and Back Views

An example of a fill slope stake with the proper inscriptions is shown in the following illustration:



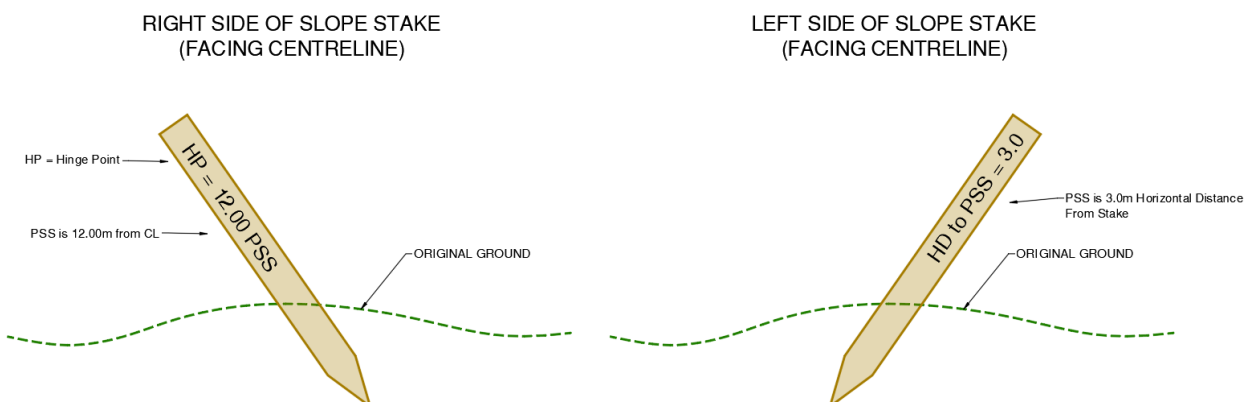
In this example:

- The slope of 1.5:1 is indicated on the top of the outside of the stake
- F represents fill (C would represent cut)
- 2.00 represents the depth of fill (or cut)
- 15.00 represents the offset to the centerline
- The down arrow indicates that the fill (or cut) is measured at the ground line point
- The station value is written on the back of the slope stake (facing the ROW)

The construction surveyor will inscribe the cross section code on the side of the slope stake, which is discussed in the following section.

11.04.03 Slope Stake Inscriptions – Side View

The right side of the slope stake, as shown below, indicates the PSS (Proposed Subgrade Shoulder) and the HP (hinge point) distance, which is 12.00m from the centreline.



The left side of the slope stake indicates the horizontal distance from the slope stake location, towards the centreline, to the PSS hinge point. In other words, this information is what the grader needs to know to properly determine a fill/cut, slope and distance. This information is also provided in a layout RXL file, for

each corridor (alignment), which can be uploaded to Trimble Access for layout tasks. The information has been inscribed on the stake to reduce manual calculation errors in the field.

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.

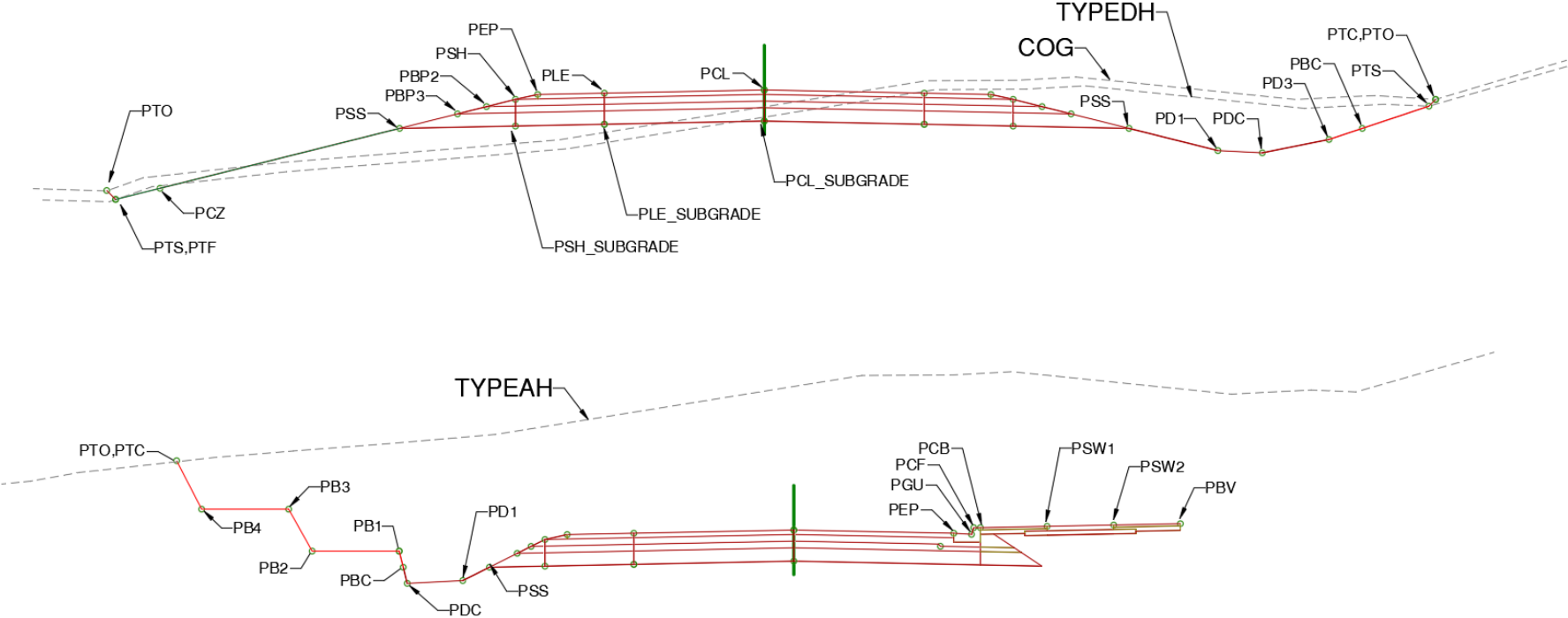
11.04.04 Cross Section Codes

Hinge point examples for slope staking calculations are summarized in the following bullets:

- PSS – Proposed Subshoulder
- PCZ – Proposed Clear Zone*
- PBE – Proposed Bench
- PBC – Proposed Back of Cut
- PTF – Proposed Toe of Fill
- PTC – Proposed Toe of Cut

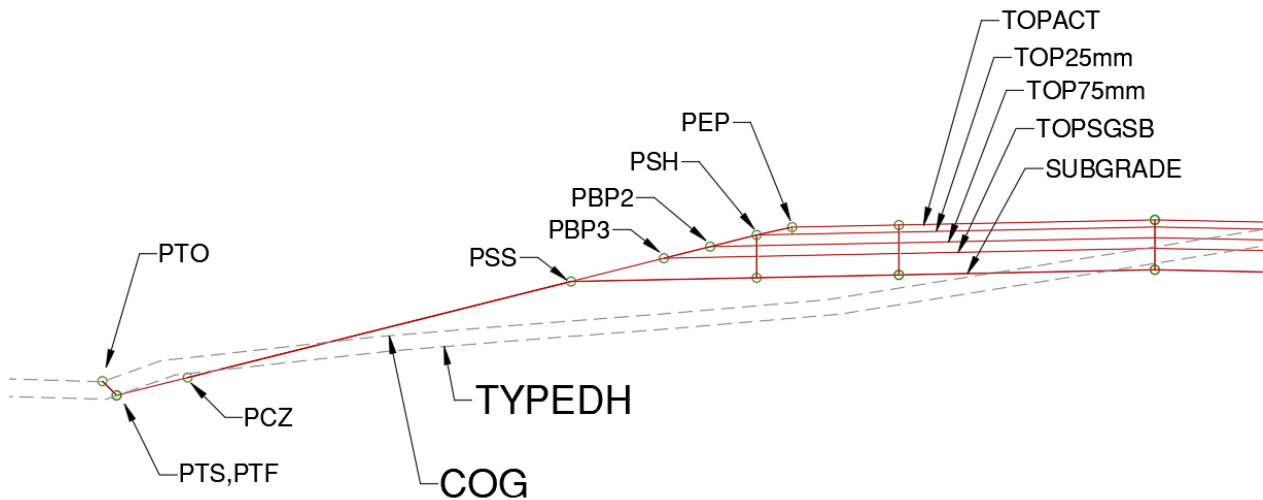
* Additional slope stake required after fill placement to PCZ is complete.

A complete cross section coding diagram, showing all codes, is shown in the following illustration:



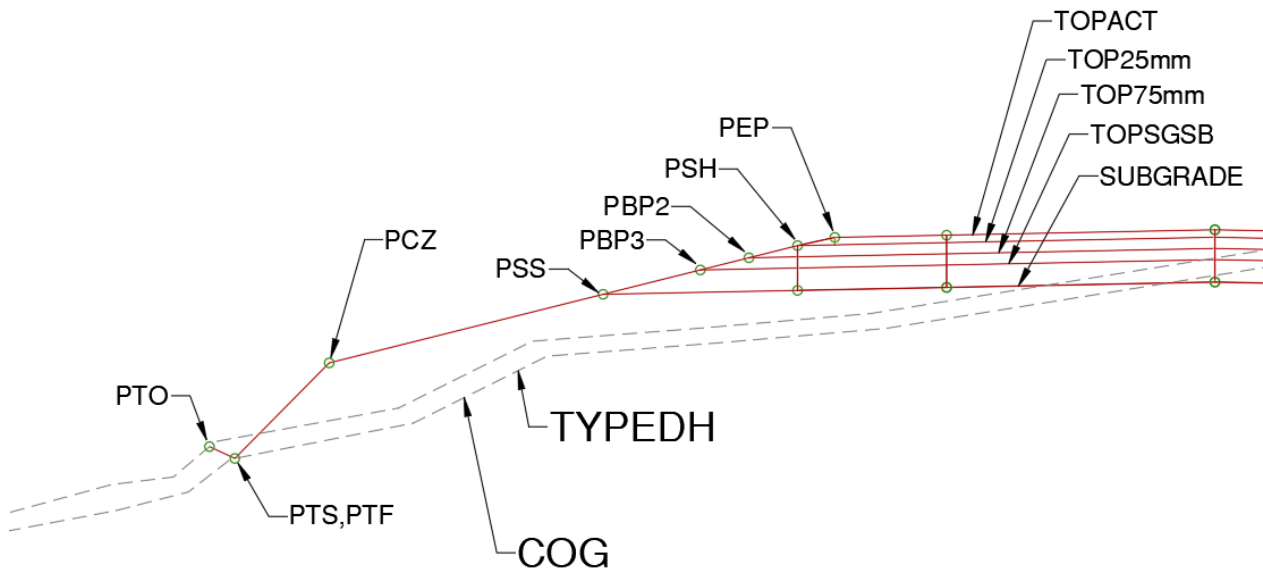
The following sections show examples indicating various slope staking scenarios required and to which Proposed Hinge Point the calculation is based on.

Example 1: Propose Sub Shoulder (PSS) and Probable Fill Slope Stake Location



Fill slope stakes are calculated starting at the PSS (Proposed Sub Shoulder), running out and down at the design slope (1.5:1, for example) to where it intersects the TYPEDH horizon (PTS, PTF).

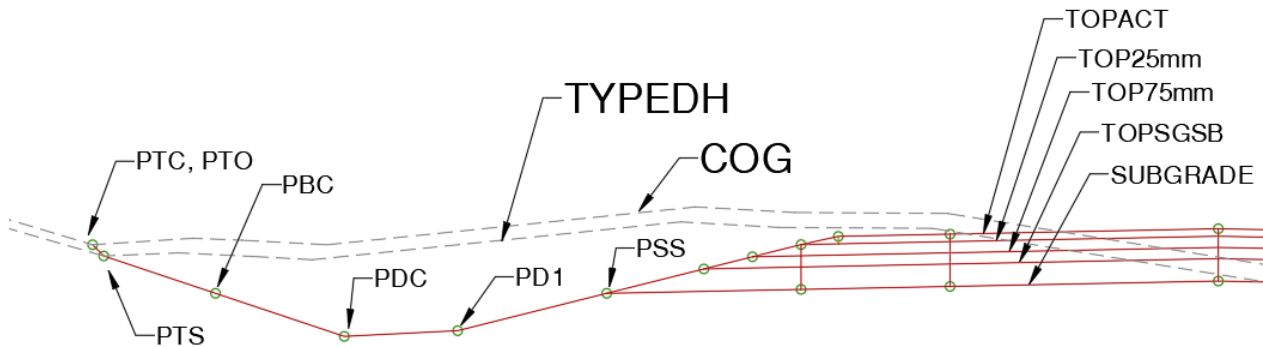
Example 2: Proposed Clear Zone (PCZ) and probably Slope Stake Location



Fill slope stakes in a clear zone area are calculate starting at the PCZ (Proposed Clear Zone), running out and down at the design slope, to where it intersects the TYPEDH horizon (PTS, PTF). Once the fill has

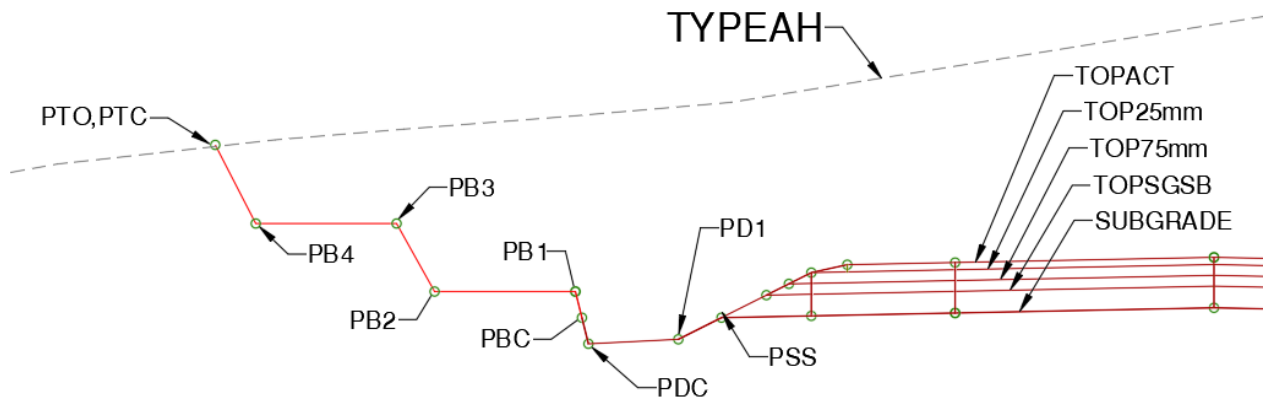
reached the PCZ hinge point, another slope stake calculated from the PSS on differing slopes may be required.

Example 3: Proposed Top of Cut (PTC) and Probable Slope Stake Location



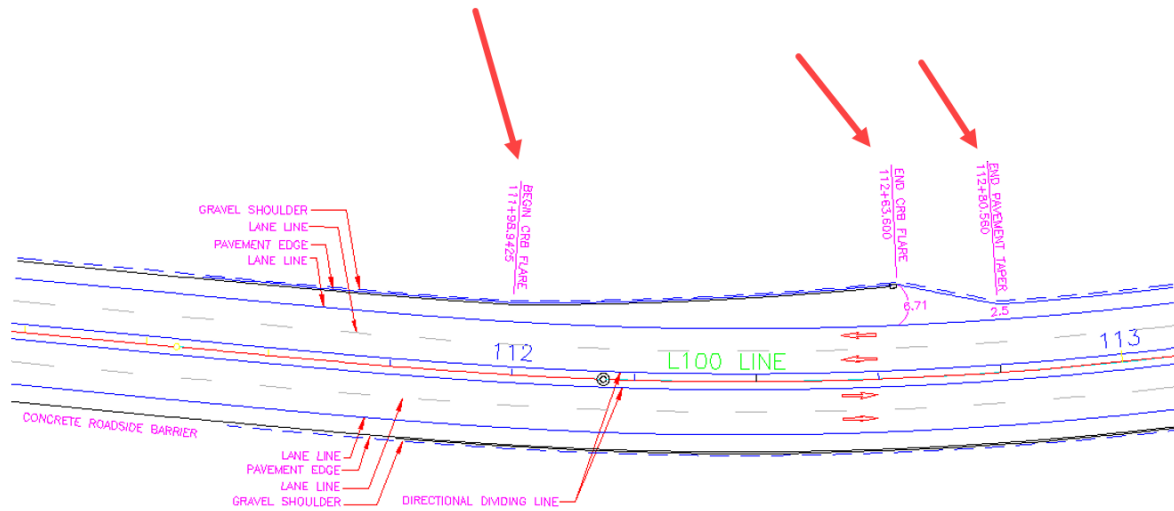
Cut slope stakes in ditch scenarios are calculated starting at the PBC (Proposed Back of Cut, which is at subgrade elevation), running out and up the design slope to where it intersects the TYPEDH horizon surface.

Example 4: Proposed Back of Bench (PBE) and Probably Slope Stake Location



Cut slope stakes in a TYPEA (solid rock) cut are calculated starting at PB1 (Proposed Bench), running out and up the design slopes and benches to where it intersects the TYPEAH, which in this situation is the original ground surface. The material will be removed down to the top bench and then will require another set of slope stakes at the next, and subsequent bench locations.

Example 5: Slope Stakes at Widening Points Along the Chainage



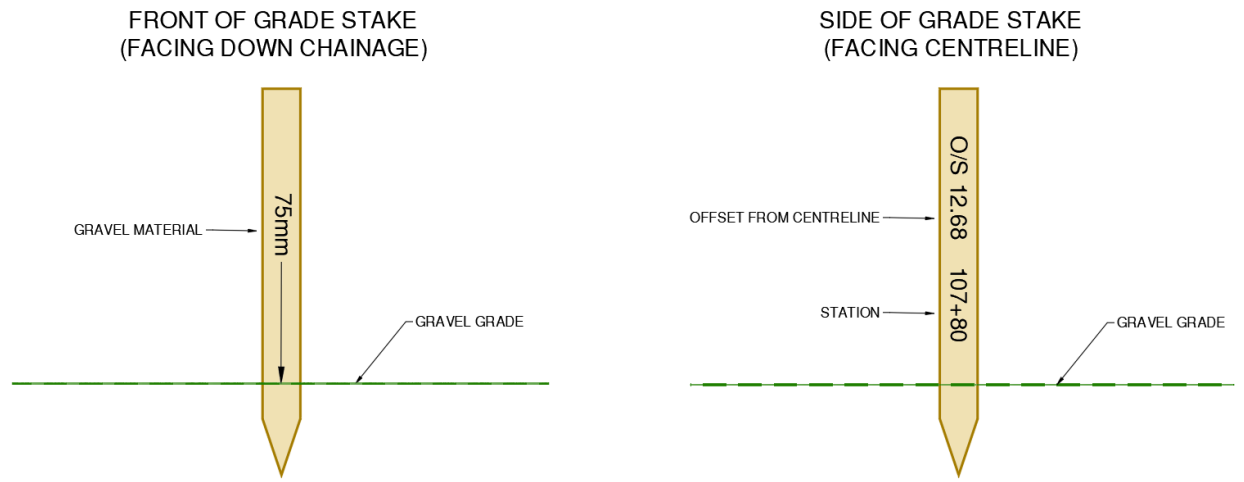
In this example, TYPED slope stakes are required at 20m intervals (10m for TYPEA) with added slope stakes at cross section width changes such as barrier flares.

1100.05 Grade Staking

Grade staking is similar in concept to slope staking and applies to granular materials that constitute the pavement structure. Grade staking requirements are summarized in the following bullets:

- Created at 20m intervals unless otherwise noted in the contract
- Required where typical section changes (gravel depths, slopes, widths etc.)
- All intersection locations (access/intersection curve beginning and ends)
- Grade break locations (BVC, EVC etc.)
- Grade stake density may be reduced when machine control is used
- Grade stake chainage locations required accuracy is $\pm 0.050\text{m}$ up or down chainage
- Grade stake offset location required accuracy is $\pm 0.030\text{m}$ towards or away from CL
- Vertical loop closure accuracies require minimum vertical requirement for a closed level loop is 0.008 times the square root of the level loop distance, in kilometres
- Elevation tolerances are i) Subgrade/SGSB/75mm $\pm 0.015\text{m}$ ii) 25mm $\pm 0.010\text{m}$

Grade stakes are to be inscribed as per the following image:

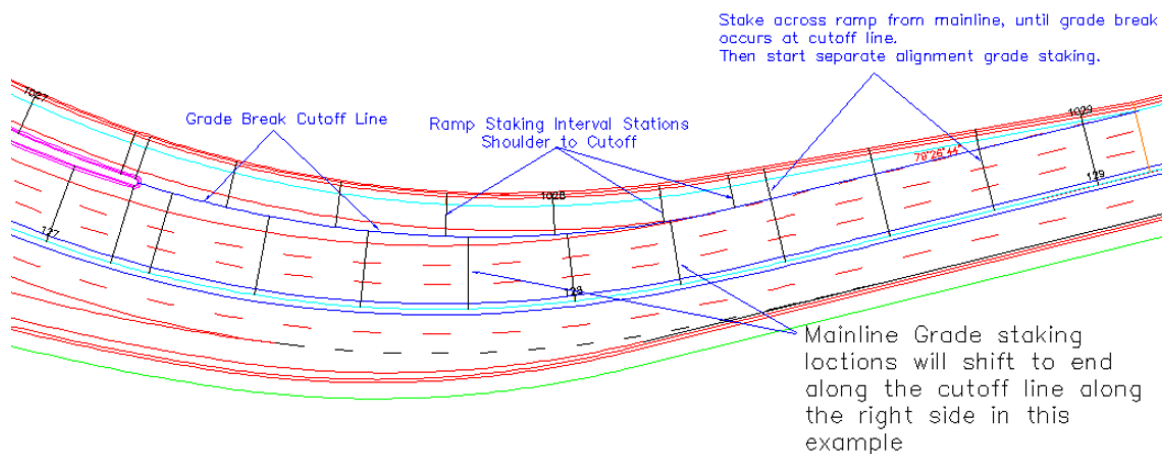


11.05.01 Intersection Layout

Intersection layout often requires an awareness of various grade break locations between converging/diverging mainline and ramp alignments, intersections, intersection islands, roundabouts, acceleration/deceleration lanes, gravel structure variations between different alignments, and gore area grade break locations.

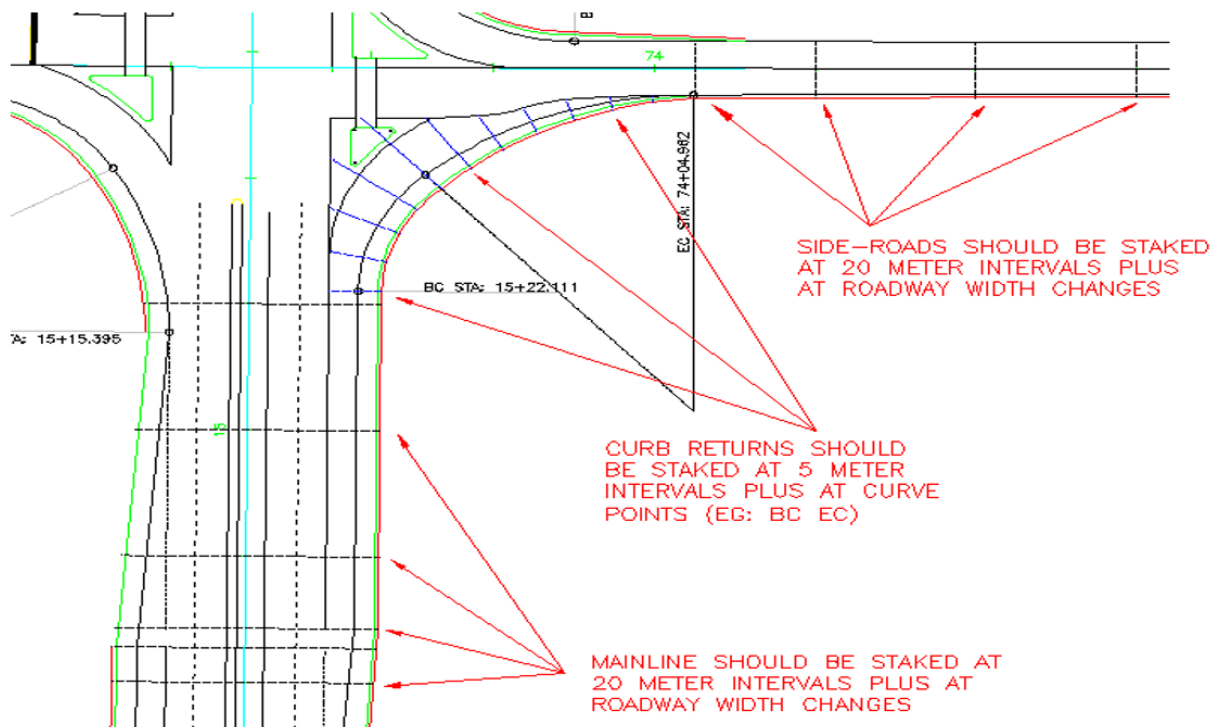
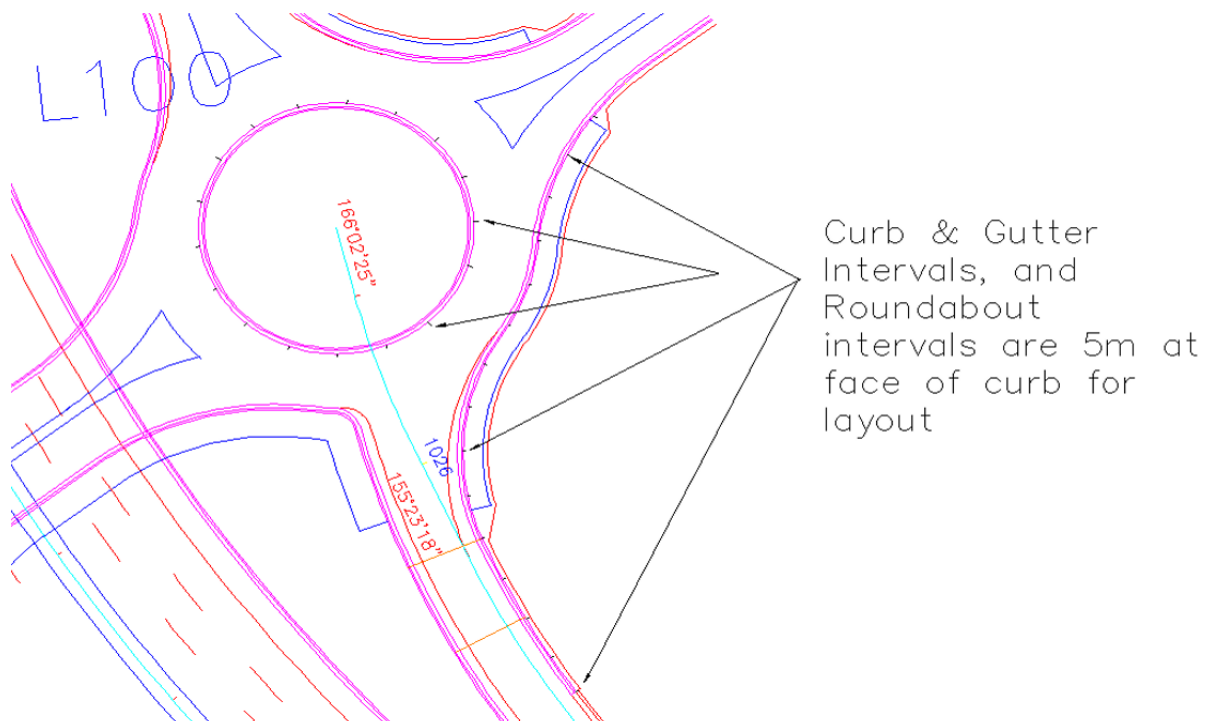
Layout procedure for grade staking these areas must ensure that the lane grade cut off locations match 3D DTM location cut offs. The following examples are a guide to appropriate staking for different grade break cut off scenarios.

Example 1: Gore Area Cut Off Line and Grade Staking Locations



In this example, gore area grade break staking intervals will also indicate where the “grade break” will diverge from the mainline, which will almost always be 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 cut off line.

Generally, the grade break cut off line, indicating the divergence of grades, is near the starting point of the gore area. This may include the areas where there are differing depths of gravel grades. Where different gravel depths occur between a mainline and a ramp the stake must be inscribed with the station value.

Example 2: Intersection Approach and On/Off Ramps**Example 3: Roundabout and Curb and Gutter**

11.05.02 Bridge End Fills

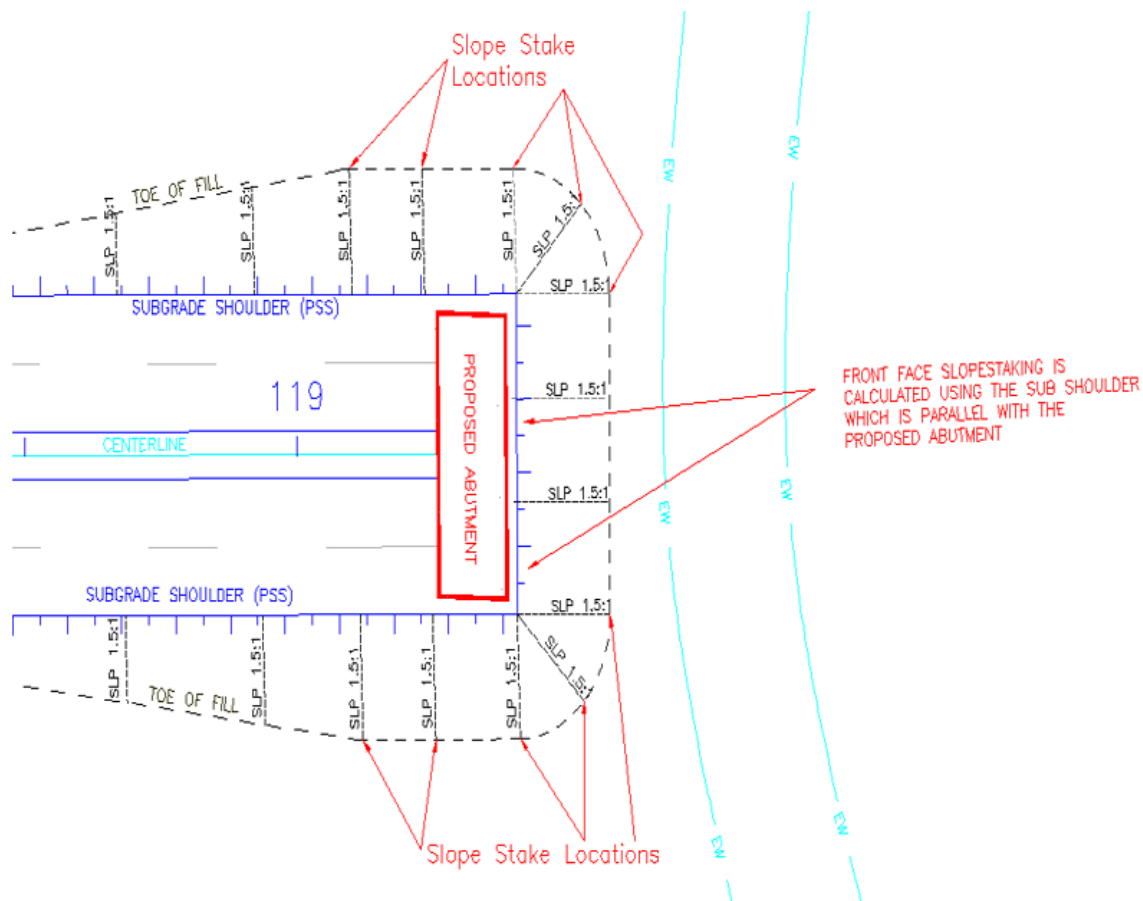
Bridge end fills occur adjacent to both bridge abutments and wingwalls. Layout must consider the following:

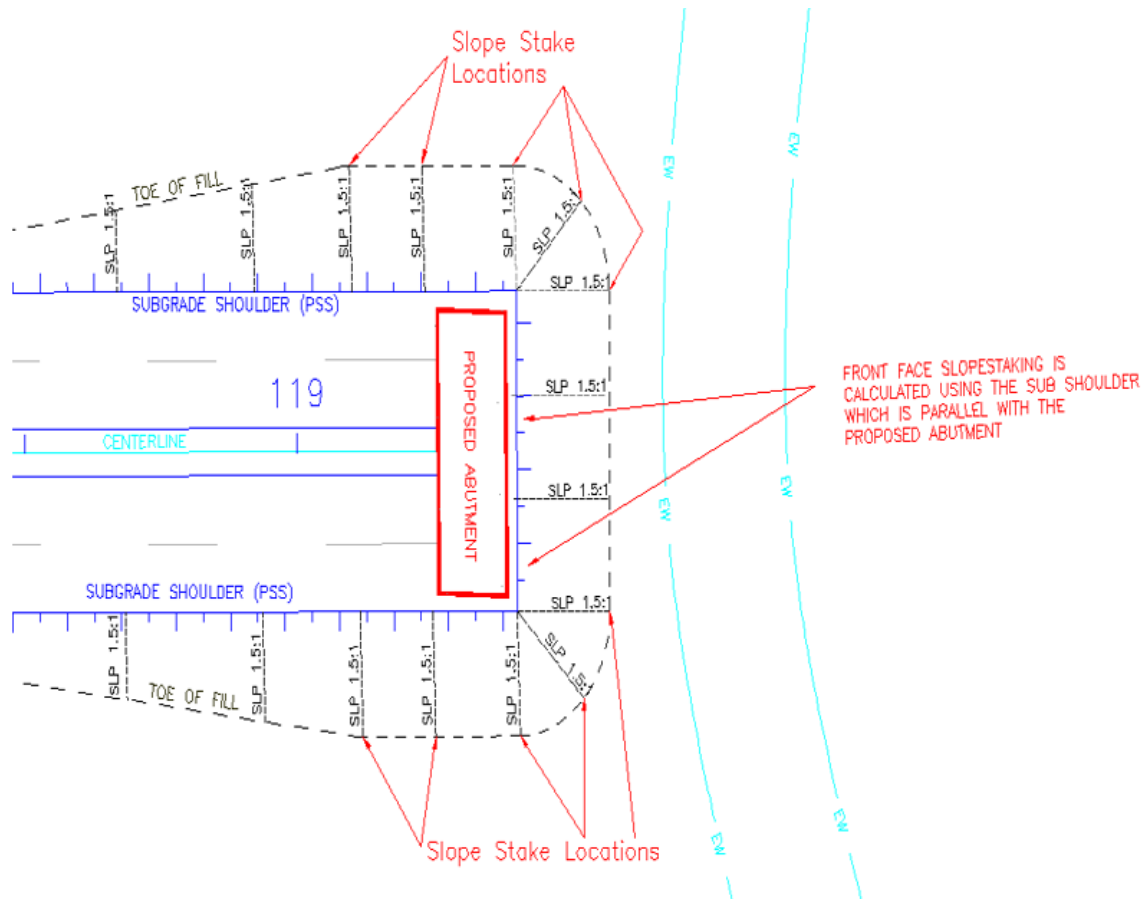
- When setting alignment stakes on fills and especially higher fills, ensure that the subgrade shoulder points are constructed accurately, and at the correct perpendicular or other angle skew required
- On cuts/fills greater than 10m the Ministry Representative may require placement of another set of slope stakes during the fill process
- Bridge design and construction plans are to be reviewed for staking control and alignment as part of bridge end fill layout
- Care must be taken to ensure that location and elevation data is correct, in particular, when skew angles are involved

The following sections provide examples of different bridge end fill layout scenarios.

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

In this scenario a 1.5:1 slope is used on both side slopes and the front face slope towards the creek. To establish the toe on the front face and corner curve locations, stakes are calculated from the corner abutments, offset to the **subgrade shoulder** locations, and placed at 90°, 45°, and 0° angles, as shown in the following illustration:





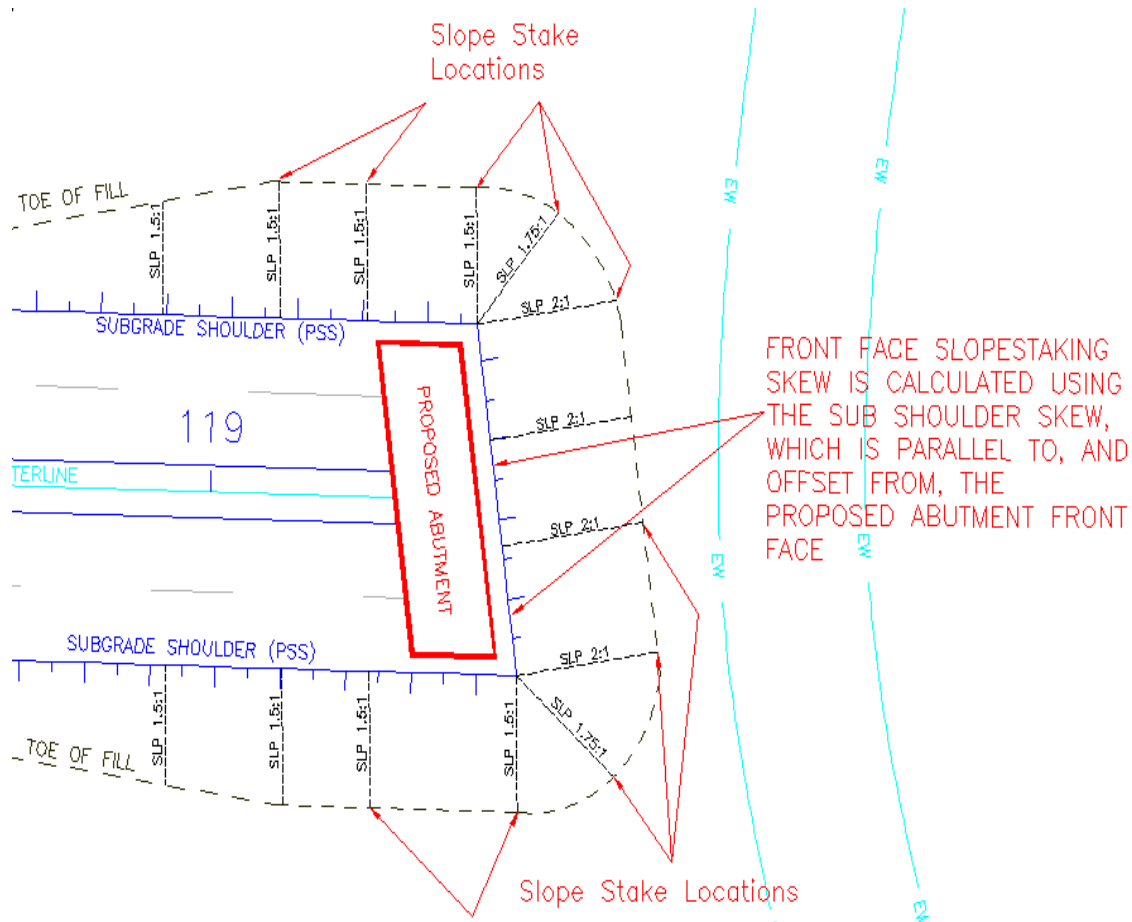
Example 2: Slope Staking Bridge End Fills – Abutment Angle Skewed

In this example the alignment of the abutment is not perpendicular to the centreline. Here we have a 1.5:1 (run over rise) slope on both side slopes and a 2:1 (run over rise) front face slope, along the skew, toward the creek.

To establish the toe of the side slope and corner curve locations, stakes are calculated from the corner abutment subgrade locations, and placed at 90° (perpendicular) to the CL road alignment. The 45° and 0° slopes are calculated from the **skew alignment** along the **face of the abutment**. If the front slope is 2:1, the 45° point becomes 1.75:1, to enable a transition 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 design and construction drawings to ensure sufficient room for the abutment.

This is shown in the following illustration:



1100.06 Drainage

Drainage involves the discharge of runoff water and includes the following:

- Surface runoff features, ditches, channels curb and gutter, extruded asphalt curb etc.
- Circular and box culverts
- Earthen and armoured ditching
- Closed drainage systems with catch basins
- Headwalls and inlet/outlet structures

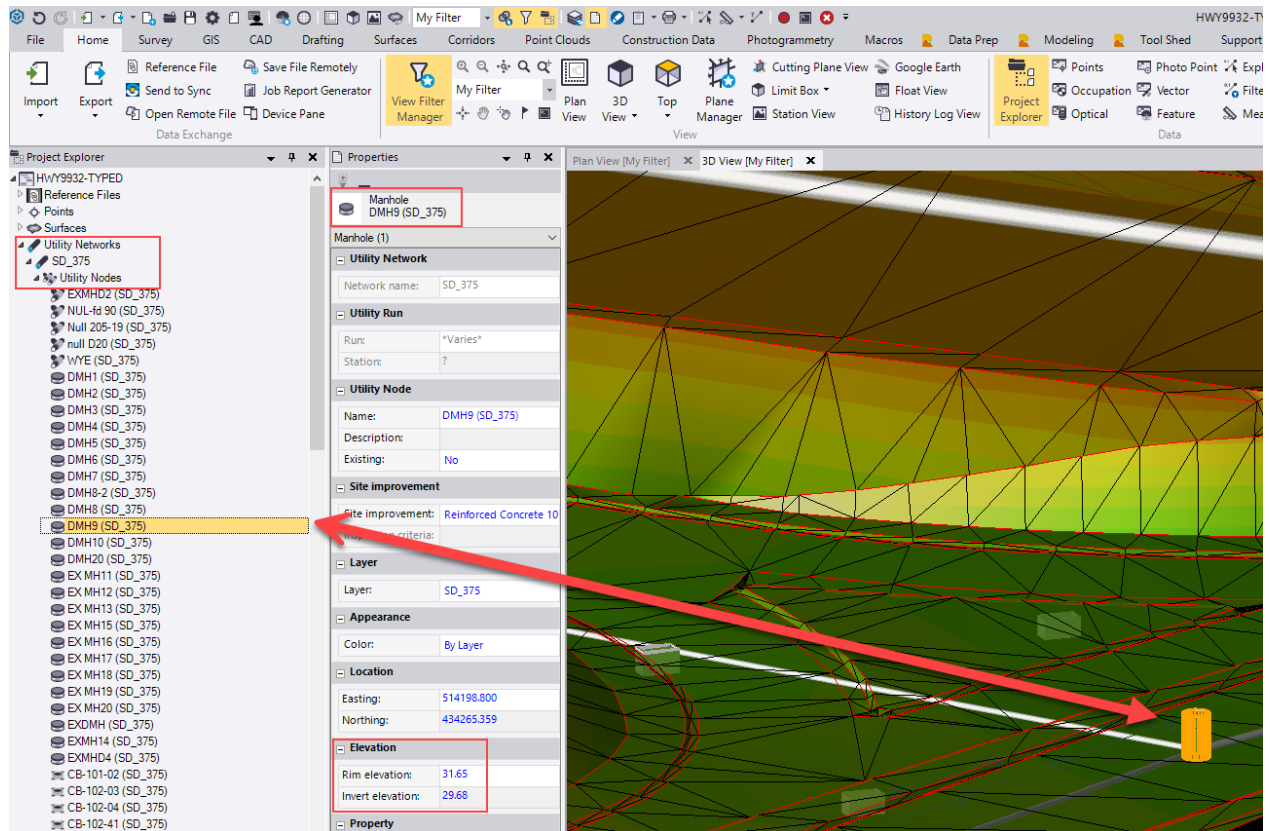
Layout details are provided in the following sections.

11.06.01 Culverts

Culverts are a very common feature of road and highway construction projects. Culvert and other pipe network data is available in the construction survey data package as an XML file, and is located in the following folder:

`\05) Survey\01) ConstructionSurveyDataPackage\01) IFT\07) Proposed Gravity Networks\`

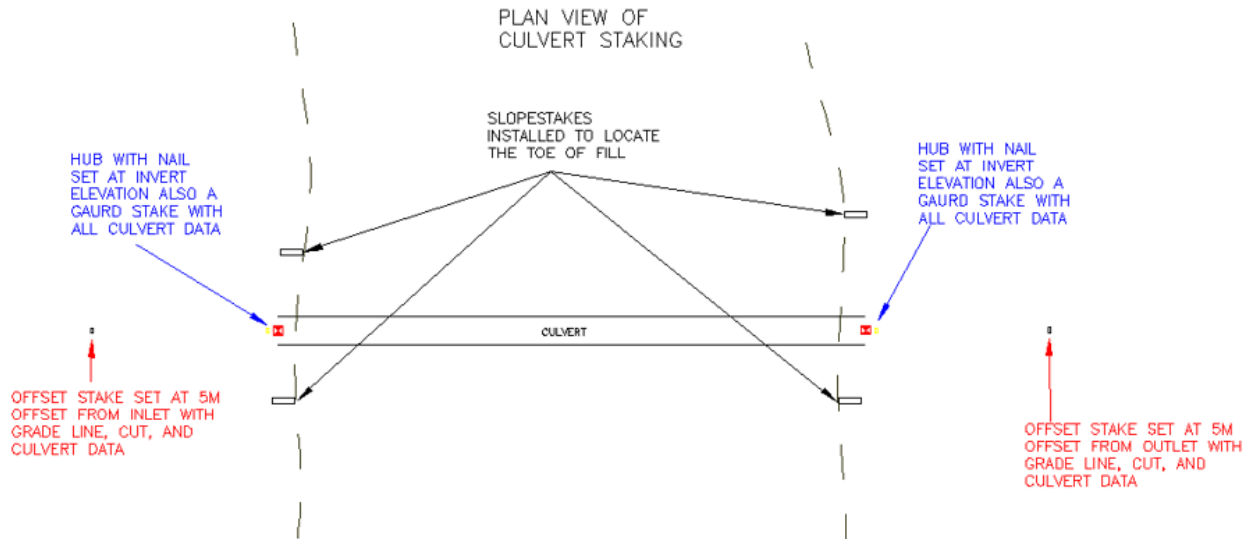
The XML files can be imported into TBC to create Utility Networks. An example is shown in the following illustration:



The following points are important consideration when providing QA on culvert layout:

- Station and offset (culvert length) and/or elevations for culvert layout may require adjustments field fit actual conditions
- Offset hubs with guard stakes for inlet and outlets (guard stake indicates cut/fill and offset to culvert inverts from nail in hub). Hubs are placed along the skew of the pipe at each end
- Guard stake should include pipe size, type, length information and pipe grade in percent noting approximate cardinal direction for inlet and outlet
- Place a stake or painted pavement at each pipe bend/elbow, indicating the degree of the bend
- Slope stakes may be required at culvert inlet and outlet locations
- In TBC check possible infringement on pavement structure by cutting a section along culvert and showing road subgrade surface and TBC pipe object

Layout details are shown in the following illustration.



11.06.02 Ditches

When laying out ditches, take the following requirements into consideration:

- Staking for special ditch situations such as false grading may require ditch specific slope and grade staking
- Ensure the Construction Survey Data Package contains ditch alignment/profile for special ditching
- Ditching layout data is provided in corridor cross section RXL file. If 3D features are required, make the request to the project Ground Modeler

11.06.03 Headwalls, Inlet and Outlet Structures

When laying out headwalls, take the following into consideration:

- Refer to design drawings or Standard Specifications Section 303.31.04
- Layout methods to be determined by agreement between Ministry and contractor

11.06.04 Manholes and Catch Basins

Manholes and catch basins are components of closed drainage systems. Manholes and other types of structures may be required for other underground utilities such as sanitary discharge and water distribution systems.

Like culverts, underground utility pipe network data is available in the construction survey data package as an XML file, and is found in the following folder:

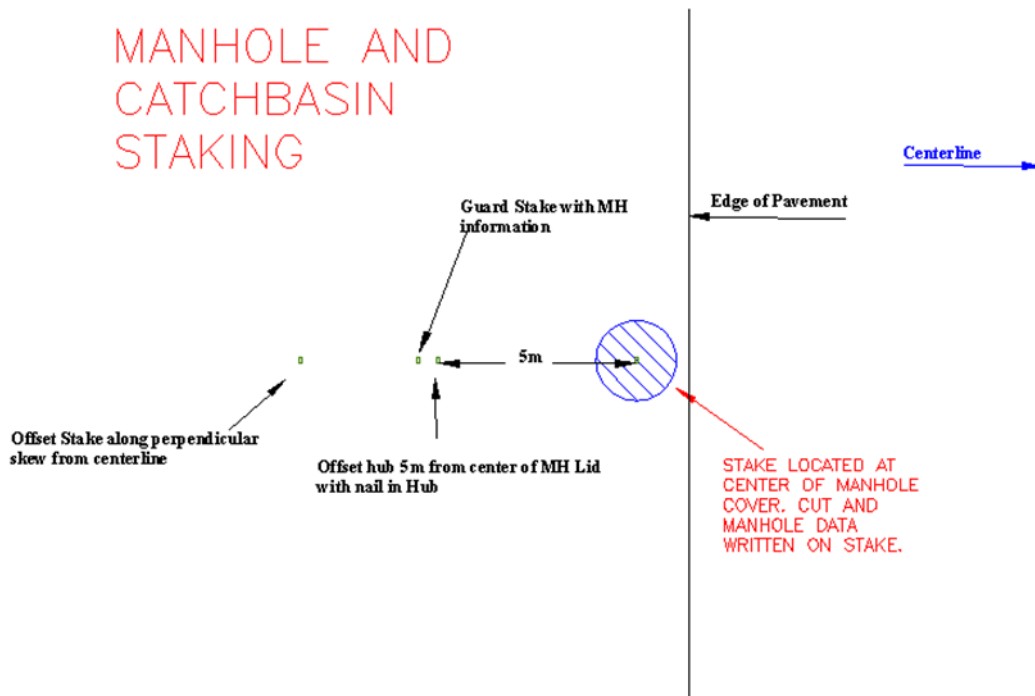
`\05) Survey\01) ConstructionSurveyDataPackage\01) IFT\07) Proposed Gravity Networks\`

The XML files can be imported into TBC to create Utility Networks.

The following points are to be considered when laying out manholes and catch basins:

- The Ministry Representative, construction surveyor and the contractor foreman / superintendent shall agree on methods for layout QA

- Refer to Standard Specifications Section 582.32/33 and Standard Specification Drawings (CBs SP582-02.02) and (MH's SP582-03.02) to ensure proper placement of barrel and lid. Be aware of possible offset lids on certain types of manholes and catch basins
- As a minimum requirement, place a stake at the center of the structure, place an offset hub with nail 5m away, place a guard stake with the required information 0.10m behind the hub and add one offset stake perpendicular to the alignment 3m further away



11.06.05 Curb & Gutter

The following points are to be taken into consideration when laying out curb & gutter:

- Layout data required at minimum 10m on tangents
- Layout data required at minimum 5m or quarter points on intersections/access curve alignments
- For offsets, use nail in hub or spike in ground at 1m offset behind back of gutter with guard stake indicating cut/fill and offset to the gutter grade
- Stakes are required at each end of letdown and at each end of transitions to driveways, sidewalks and wheelchair ramps
- Stakes are required at reverse gutter areas (Traffic Circles) that clearly define the 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 the gutter (offset as required to allow for construction)

11.06.06 Extruded Asphalt Curb

The following points are to be taken into consideration when layout out extruded asphalt curb:

- Layout with paint and/or nails along the face or edge of curb
- Guideline marks at 10m intervals maximum

- Guideline marks at 5m intervals maximum along curves for traffic islands
- Continuous point line (via roping method) must connect guideline marks

11.06.07 Sidewalks

The following points are to be taken into consideration when laying out sidewalk:

- Stakes should indicate type of sidewalk (pave stones, concrete, asphalt etc.)
- Start and end point locations to be identified
- Identify letdown locations (driveways, accesses, wheelchair ramps)
- Sidewalk widths are to be identified

11.06.08 Islands

The following points are to be taken into consideration when laying out islands:

- Grade staking of road widened so gravel widths will accommodate paving 0.5m behind curb face, or as per the design requirements
- Intervals determined by curb return parameters
- Curb types are found in Standard Specifications drawing SP582-01.04 and SP582-01.02
- Curb letdown locations are to be identified

11.06.09 Asphalt

The following points are to be taken into consideration for asphalt layout:

- Method of grade break identification determined by mutual agreement between Ministry 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 spillway locations

Asphalt limits are not to be determined from grade or slope stake reports.

11.06.10 Roadside and Median Barriers

The following points are to be taken into consideration for asphalt layout:

- 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

11.06.11 Paint Lines

The following points are to be taken into consideration for paint line layout:

- 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

11.06.12 Pavement Milling and Overlay

The following points are to be taken into consideration for pavement milling and overlay layout:

- 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

11.06.13 Signage

The following points are to be taken into consideration for layout of roadside signs:

- Stake are required at the sign location indicating the sign type
- Refer to the [Manual of Standard Traffic Signs & Pavement Markings](#)

11.06.14 Fencing

The following points are to be taken into consideration for fencing layout:

- 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

1100.07 Private Utilities

Private utilities include BC Hydro, Fortis BC (natural gas), telephone and cable TV.

Potential conflicts between existing and proposed utilities must be resolved prior to excavation. Prior to commencing work, a locate ticket should be requested from [BC 1 Call](#). When submitting a ticket, the following information is required:

- Name and contact information
- Exact location of the planned excavation
- Depth of proposed excavation
- Timing of proposed excavation
- Digging on private/public property, or both?

The following points should also be taken into consideration prior to excavation:

- Notification of Ministry Representative and lead contractor prior to commencing work
- Ensure communication between Ministry Representative, contractor and surveyor regarding flexibility and methods for layout

11.07.01 Electrical Utilities

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 perpendicularly 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 Civil 3D design data to avoid conflicts

1200 Quality Management for Construction Supervision

Quality management is central to all Ministry construction supervision projects and workflows require both quality control (QC) and quality assurance (QA) measures. Survey and design consultants provide QC on their projects to ensure deliverables meet the needs from a geomatics/design perspective, and from a data compliance perspective. Ministry Field Services staff provide QA on design and construction data to ensure data is complete, reflects the design, is organized, and configured properly prior to construction.

The Ministry's Civil 3D Terms of Reference (ToR) document outlines the requirements for geomatics and design data assembly. When geomatics and design data meets the requirements outlined in the ToR, the project data is deemed to be "compliant".

The Ministry's QA process begins with the Ground Modeler on the construction supervision team, and involves a data compliance review at 90% complete for the following:

- Geomatics and design archive, which is handed off to Field Services for construction supervision
- Construction Tender Data Package (CTDP) which is provided to contractors during construction tendering

Quality Management is also central to the role of the Ministry Representative, who is ultimately responsible for the implementation of the processes and work instructions as outlined in the Quality Management System. Construction surveyor and ground modeler provide Quality Assurance, with the use of consistent procedures and standards, throughout all aspects of construction supervision.

Refer to the Ministry's [Quality Management](#) page on TRANnet for more information. Section QP-600 Contract Administration outlines QM as they relate to construction supervision.

The following sections discuss all aspects of quality assurance as it relates to the technical aspects of construction supervision.

1200.01 Project Folders

All data created by construction surveyors must be stored in the Ministry standard construction supervision folder, as indicated in Section [200.01](#).

1200.02 Survey Data Files – Location and Naming

The following QC items are applicable to survey data files:

- For each reduced (CSV) file downloaded from the controller, the corresponding RAW (JXL) file must also be downloaded. CSV files are calculated files, whereas JXL files record the original instrument observations, and can be used to recalculate the CSV if required. The JXL file is the legal file that will "stand up" in a court of law
- Downloaded survey data files are to be located, and remain unedited, as outlined in Section [200.04](#) of this document
- Downloaded survey data files are to be named in accordance with Section [200.05](#) in this document
- Task specific survey data files are created by copying, or copying and editing the original downloaded CSV files, and placing them in the task specific folder

1200.03 Survey Data Files – Content

The following QC items are applicable to the contents of CSV survey data files:

- Data file internal format is a comma delimited using the following format
Point ID, Northing, Easting, Elevation, Feature Code, Description1, Description2
- Point ID must be in accordance with Section 200.05
- Feature Codes must be in accordance with Ministry standard feature code list (see Appendices)
- Description 1 and Description 2 are optional parameters used to describe the point

1200.04 TBC Projects and Templates

Construction surveyors are responsible for multiple tasks involving data collection to be processed in Trimble Business Center. TBC project templates are available, and should be used for the following tasks:

- Consumption of geomatics and design data provided in the construction tender data package
- Verification of primary control and establishment of secondary control
- Creation of Construction Original Ground surface and calculate removal item quantities
- Creation of horizon and remeasure surface, and calculation of volumetric quantities
- Calculating spot, linear and area quantities for survey data

Description of these tasks and TBC project templates can be found in Sections [600](#), [700](#), [800](#), [900](#), and [1000](#).

1200.05 Reports

Various reports can be generated from Trimble Business Center by the construction surveyor and from Civil 3D (by requesting to the Ground Modeler). MS Excel is a useful tool for aggregating data for various report formats.

Some standard report formats are as follows:

Offset Stake Cut Sheet Report for DTM Design Grade Checks

Station	Offset	Cut (-) / Fill (+)	Constructed Elev.	Design Elev.
---------	--------	--------------------	-------------------	--------------

Offset Stake Cut Sheet Report for C&G, ROW and Working Easements

Station	Offset
---------	--------

Slope Staking Reports

Design slope staking reports are provided by ground modeler and are available in the CSDP and are helpful for QA on cross section layout. Slope staking details and reports are found in Section [1300.04](#).

Volume Reports

Volume reports are provided by the ground modeler and are available in the CSDP. Design volume reports are helpful for comparing design volumes to construction volumes. Design volume reports can be found in the following folder:

\05) Survey\01) ConstructionSurveyDataPackage\01) IFT\08) EarthworksVolumeReports

Construction surveyors calculate volumes in Trimble Business Center using the surface to surface volume calculation method. Details on these types of reports can be found in [Section 900.06 Volume Calculations](#).

1200.06 Survey Data Tracking

Survey data tracking is an important QM practice, as this information is the source for all quantity calculations. Survey data tracking involves tracking downloaded survey data files (from the controller), and task specific data files that are used in task specific TBC projects.

Details on MS Excel workbooks developed for tracking survey data files are found in [Section 1200.01 Survey Data File Tracking](#).

1200.07 Quantity Data Tracking

The construction surveyor is responsible for field measurements and the calculation of quantities for both removed items and newly constructed features.

Details on MS Excel workbooks developed for tracking quantities are found in [Section 1200.01 Survey Quantity Tracking](#).

1200.08 Cross Section Codes

Design data is based on standardized cross section codes, which are reflected in layout RXL files created by the Ground Modeler and delivered as part of the Construction Survey Data Package.

A complete list of design cross section codes can be found in [section 11.04.04 Cross Section Codes](#).

1300 As-Built Data Collection and Recording

1400 Appendix A – Construction Survey Codes

Construction Survey Codes.

Construction Survey Field Codes



Code	Description	FXL Group	Line	DTM	Layer
BM	Benchmark	00 - EX Control			V-CTRL-MAJR
CX	Check Shot	00 - EX Control			V-CTRL
DH	Hub - Detail / Traverse Hub	00 - EX Control			V-CTRL-MINR
LM	Control Monument - Geodetic	00 - EX Control			V-CTRL-GEOD
MR	Monitor Point (Horiz, Vert or H+V)	00 - EX Control			V-CTRL-MINR
OS	Sta. on Offset Line	00 - EX Control		Y	V-CTRL-STAN
PI	Traverse PI	00 - EX Control			V-CTRL
RP	Reference Point	00 - EX Control			V-CTRL-REFP
AH	Geotechnical Auger Hole	01 - EX Geotech			B-BORE-SYMB-HOLE
BT	Geotechnical Borehole	01 - EX Geotech			B-BORE-SYMB-HOLE
GI	Geotechnical Slope Indicator	01 - EX Geotech			B-BORE-SYMB-TEST
LH	Geotechnical Drill Hole (Blasting)	01 - EX Geotech			B-BORE-SYMB-HOLE
OW	Well - Observation Well	01 - EX Geotech			B-BORE-SYMB-TEST
PZ	Geotechnical Piezometer	01 - EX Geotech			B-BORE-SYMB-TEST
RC	Scarp	01 - EX Geotech	Y	Y	V-TOPO
RN	Geotechnical Rock Anchor / Bolt	01 - EX Geotech			B-BORE-SYMB
RO	Scour	01 - EX Geotech	Y	Y	V-TOPO
SP	Geotechnical Settlement Plate (Pipe)	01 - EX Geotech			B-BORE-SYMB-TEST
SQ	Seismic Profile Line	01 - EX Geotech	Y		B-BORE-SPLN
TH	Geotechnical Test Hole	01 - EX Geotech			B-BORE-SYMB-THOL
TN	Tension Crack	01 - EX Geotech	Y	Y	V-TOPO
TT	Geotechnical Test Pit	01 - EX Geotech			B-BORE-SYMB-TPIT
AI	Iron Post - Angle Iron	02 - EX Property			V-PROP-PINS
AP	Aluminium Post	02 - EX Property			V-PROP-PINS
BC	Standard Brass Cap Monument	02 - EX Property			V-PROP-PINS
BD	Boundary Line	02 - EX Property	Y	Y	V-SURV-BNDY
CP	Iron Pin - Capped	02 - EX Property			V-PROP-PINS
DP	Dominion Iron Post	02 - EX Property			V-PROP-PINS
IO	Non-Standard Round Iron Post	02 - EX Property			V-PROP-PINS
IP	Iron Pin - Standard	02 - EX Property			V-PROP-PINS
IS	Non-Standard Square Iron Post	02 - EX Property			V-PROP-PINS
LP	Lead Plug	02 - EX Property			V-PROP-PINS
MN	Monument - Concrete Post	02 - EX Property			V-PROP-PINS
RM	Rock Post Monument	02 - EX Property			V-PROP-PINS
RW	Right of Way	02 - EX Property	Y		V-PROP-RWAY
WN	Post - Wooden Post	02 - EX Property			V-PROP-PINS
WP	Post - Witness Post	02 - EX Property			V-PROP-PINS
AC	Asphalt Curb	03 - EX Road and Rail	Y	Y	V-ROAD-CURB-ASPH
BA	Railway Ballast	03 - EX Road and Rail	Y	Y	V-RAIL-GRVL
BL	White Line - Broken White Line	03 - EX Road and Rail	Y	Y	V-ROAD-MRKG-BRKN
CD	Driveway - Concrete	03 - EX Road and Rail	Y	Y	V-ROAD-DRIV
CF	Bottom of Curb	03 - EX Road and Rail	Y	Y	V-ROAD-CURB-CONC
CL	Centerline - Existing	03 - EX Road and Rail	Y	Y	V-ROAD-CNTR
CR	Crown of Road	03 - EX Road and Rail	Y	Y	V-ROAD
CU	Curb - Concrete	03 - EX Road and Rail	Y	Y	V-ROAD-CURB-CONC
CW	Crosswalk	03 - EX Road and Rail	Y	Y	V-ROAD-MRKG-XWLK
DA	Direction Arrow	03 - EX Road and Rail		Y	V-ROAD-MRKG-ARRW
DL	Yellow Line - Double Yellow Line	03 - EX Road and Rail	Y	Y	V-ROAD-MRKG-YELD
DR	Road - Dirt Road	03 - EX Road and Rail	Y	Y	V-ROAD-DIRT

Construction Survey Field Codes



Code	Description	FXL Group	Line	DTM	Layer
DV	Driveway	03 - EX Road and Rail	Y	Y	V-ROAD-DRIV
EG	Gravel - Edge of Gravel	03 - EX Road and Rail	Y	Y	V-ROAD-GRVL
EP	Pavement Edge - Finished	03 - EX Road and Rail	Y	Y	V-ROAD-PVMT-EDGE
ET	Edge of Travelled Road	03 - EX Road and Rail	Y	Y	V-ROAD
GD	Gravel - Gravel Driveway	03 - EX Road and Rail	Y	Y	V-ROAD-GRVL
GR	Gravel - Gravel Road	03 - EX Road and Rail	Y	Y	V-ROAD-GRVL
GS	Guard Rail with Posts	03 - EX Road and Rail	Y		V-ROAD-BARR-GRAL
IL	Island	03 - EX Road and Rail	Y	Y	V-ROAD-RAIS
LD	Deceleration Lane	03 - EX Road and Rail	Y	Y	V-ROAD-MRKG-DECL
LE	Curb - Letdown	03 - EX Road and Rail	Y	Y	V-ROAD-CURB
LL	Centerline - L-Line	03 - EX Road and Rail	Y	Y	V-ROAD-CNTR-LLIN
MI	Concrete Median Barrier 2.5m	03 - EX Road and Rail	Y		V-ROAD-BARM-CONC
PK	Pavement Crack	03 - EX Road and Rail	Y	Y	V-ROAD-PVMT-CRCK
PV	Pavement	03 - EX Road and Rail	Y	Y	V-ROAD-PVMT
RA	Rest Area	03 - EX Road and Rail	Y	Y	V-ROAD-REST
RB	Concrete Roadside Barrier 2.5m	03 - EX Road and Rail	Y		V-ROAD-BARR-CONC
RD	Road	03 - EX Road and Rail	Y	Y	V-ROAD-ROAD
RL	Railway - Top of Rail	03 - EX Road and Rail	Y	Y	V-RAIL-TOPD
RR	Railway	03 - EX Road and Rail	Y	Y	V-RAIL
SH	Shoulder - Finished Gravel Shoulder	03 - EX Road and Rail	Y	Y	V-ROAD-GRVL-SHLD
SO	Stop Bar Line	03 - EX Road and Rail	Y	Y	V-ROAD-MRKG-WHIT
SW	Sidewalk / Walkway	03 - EX Road and Rail	Y	Y	V-ROAD-SWLK
TO	Toe	03 - EX Road and Rail	Y	Y	V-ROAD-TOES
TU	Curb - Top	03 - EX Road and Rail	Y	Y	V-ROAD-CURB-CONC
UW	Urban Paintline	03 - EX Road and Rail	Y	Y	V-ROAD-MRKG-URPL
WL	White Line	03 - EX Road and Rail	Y	Y	V-ROAD-MRKG-WHIT
WS	Weighscale	03 - EX Road and Rail	Y		V-ROAD-SCAL
YL	Yellow Line	03 - EX Road and Rail	Y	Y	V-ROAD-MRKG-YELO
YP	Yellow Line - Passing	03 - EX Road and Rail	Y	Y	V-ROAD-MRKG-YELP
AY	Archaeology Site	04 - EX Signs and Site	Y	Y	V-SITE-ARCH
BH	Bush Line	04 - EX Signs and Site	Y		V-SITE-VEGE-BUSH
BK	Brick	04 - EX Signs and Site	Y	Y	V-SITE-MISC
BO	Boulder	04 - EX Signs and Site			V-SITE-MISC
BX	Bus or Park Bench/Table/Shelter	04 - EX Signs and Site	Y		V-SITE-MISC
CC	Concrete	04 - EX Signs and Site	Y	Y	V-SITE-MISC
CE	Concrete Pad	04 - EX Signs and Site	Y	Y	V-SITE-MISC
CG	Cattle Guard	04 - EX Signs and Site	Y		V-SITE-CGRD
CN	Concrete Pillar	04 - EX Signs and Site			V-SITE-MISC
DB	Decorative Boulder	04 - EX Signs and Site			V-SITE-MISC
DO	Delineator Post	04 - EX Signs and Site			V-SIGN
DT	Decorative Tree	04 - EX Signs and Site			V-SITE-VEGE-TREE
FB	Flower Box	04 - EX Signs and Site	Y	Y	V-SITE-VEGE-PLNT
FE	Fence	04 - EX Signs and Site	Y		V-SITE-FENC
FG	Flagging	04 - EX Signs and Site	Y		V-SITE-MISC
FP	Fence Post	04 - EX Signs and Site			V-SITE-FENC
GA	Gate	04 - EX Signs and Site	Y		V-SITE-MISC
GC	Clearing and Grubbing	04 - EX Signs and Site	Y		V-SITE-VEGE-CLGR
GL	Gravel	04 - EX Signs and Site	Y	Y	V-SITE-GRVL
GN	Garden	04 - EX Signs and Site	Y	Y	V-SITE-VEGE

Construction Survey Field Codes



Code	Description	FXL Group	Line	DTM	Layer
HB	Trash/Garbage Bin	04 - EX Signs and Site	Y		V-SITE-MISC
HF	Hog Fuel	04 - EX Signs and Site	Y		V-SITE-HOGF
HG	Hedge Line	04 - EX Signs and Site	Y		V-SITE-VEGE-BUSH
HS	Sign - Overhead Sign	04 - EX Signs and Site			V-SIGN
LW	Lawn	04 - EX Signs and Site	Y	Y	V-SITE-VEGE-TURF
MB	Mailbox	04 - EX Signs and Site			V-SITE-MISC
MK	Sign - Marker	04 - EX Signs and Site			V-SIGN
OC	Vegetation - Orchard	04 - EX Signs and Site	Y		V-SITE-VEGE
PF	Flag Pole	04 - EX Signs and Site			V-SITE-MISC
PO	Post - Guard Post	04 - EX Signs and Site			V-SITE-MISC
RZ	Riparian Zone	04 - EX Signs and Site	Y		V-SITE-VEGE
SC	Sign - Commercial Sign	04 - EX Signs and Site			V-SIGN
SI	Sign - Road Sign - One Post	04 - EX Signs and Site			V-SIGN
TC	Trash/Garbage Can	04 - EX Signs and Site			V-SITE-MISC
TE	Tree	04 - EX Signs and Site			V-SITE-VEGE-TREE
TL	Tree Line	04 - EX Signs and Site	Y		V-SITE-VEGE-TROW
TS	Tree - Safety Hazard	04 - EX Signs and Site			V-SITE-VEGE-TREE
VN	Vegetation	04 - EX Signs and Site	Y	Y	V-SITE-VEGE
ZL	Miscellaneous Line	04 - EX Signs and Site	Y		V-SITE-MISC
ZZ	Miscellaneous	04 - EX Signs and Site	Y		V-SITE-MISC
AW	Abutment - Wooden	05 - EX Structure	Y	Y	V-STRC-WALL
BB	Bridge	05 - EX Structure	Y		V-STRC-BRDG
BF	Building - Roof Line	05 - EX Structure	Y	Y	V-SITE-BLDG-ROOF
BG	Building	05 - EX Structure	Y	Y	V-SITE-BLDG
BI	Wall - Bin Wall	05 - EX Structure	Y	Y	V-STRC-WALL-BINW
BJ	Bridge Expansion Joint	05 - EX Structure	Y		V-STRC-BRDG
BP	Building - Support Post	05 - EX Structure		Y	V-SITE-BLDG
BU	Abutment	05 - EX Structure	Y	Y	V-STRC-WALL
BW	Wall - Base of Wall	05 - EX Structure	Y	Y	V-STRC-WALL
CA	Abutment - Concrete	05 - EX Structure	Y	Y	V-STRC-WALL
EV	Eave, Soffit or Overhang	05 - EX Structure	Y		V-STRC
FN	Foundation	05 - EX Structure	Y	Y	V-STRC
FW	Wall - Face of Wall	05 - EX Structure	Y	Y	V-STRC-WALL
GG	Garage	05 - EX Structure	Y	Y	V-SITE-BLDG
HD	Wall - Head Wall	05 - EX Structure	Y	Y	V-STRC-WALL-HEAD
HO	House	05 - EX Structure	Y	Y	V-SITE-BLDG
LK	Wall - Lock Block	05 - EX Structure	Y		V-STRC-WALL
MP	Pool - Swimming Pool	05 - EX Structure	Y	Y	V-STRC-SITE
OH	Outhouse	05 - EX Structure	Y	Y	V-SITE-BLDG
PA	Patio	05 - EX Structure	Y	Y	V-STRC-SITE
PE	Pier	05 - EX Structure	Y		V-STRC
PG	Piling	05 - EX Structure			V-STRC
PU	Pump House	05 - EX Structure	Y	Y	V-SITE-BLDG
RE	Wall - Retaining Wall	05 - EX Structure	Y	Y	V-STRC-WALL-RETN
SB	Sound Barrier / Wall	05 - EX Structure	Y		V-STRC
SZ	Staircase / Steps	05 - EX Structure	Y	Y	V-STRC-SITE
TW	Wall - Top of Wall	05 - EX Structure	Y	Y	V-STRC-WALL
WA	Wall - Back of Wall	05 - EX Structure	Y	Y	V-STRC-WALL
WB	Bridge Parapet Wall	05 - EX Structure	Y		V-STRC-BRDG

Construction Survey Field Codes



Code	Description	FXL Group	Line	DTM	Layer
WW	Wall - Wing Wall	05 - EX Structure	Y	Y	V-STRC-WALL-WING
AE	Area of Exclusion	06 - EX Topography	Y		V-TOPO
AF	Active Flood Plain	06 - EX Topography	Y	Y	V-TOPO-WATR-FDPL
BE	Berm in Cut or Fill	06 - EX Topography	Y	Y	V-TOPO-BERM
BN	Rock - Broken Rock	06 - EX Topography	Y	Y	V-TOPO-ROCK-BRKN
BR	Rock - Base of Rock	06 - EX Topography	Y	Y	V-TOPO-ROCK-BRCK
BS	Slope - Base of Slope	06 - EX Topography	Y	Y	V-TOPO-BOTB
BZ	Break in Ground-Line	06 - EX Topography	Y	Y	V-TOPO-BRKL
CK	Water - Center - Narrow Waters	06 - EX Topography	Y	Y	V-TOPO-WATR-CNTR
EB	Cobbles	06 - EX Topography	Y	Y	V-TOPO
EE	Edge of Erosion / Washout	06 - EX Topography	Y	Y	V-TOPO-EROS
EH	Water - Extreme High Water Mark	06 - EX Topography	Y		V-TOPO-WATR-EHWM
EW	Water - Edge - Wider Waters	06 - EX Topography	Y	Y	V-TOPO-WATR-EDGE
GK	Ground Crack or Sawcut	06 - EX Topography	Y	Y	V-TOPO-CRCK
HW	Water - High Water Mark	06 - EX Topography	Y		V-TOPO-WATR-HIGH
IC	Ice	06 - EX Topography	Y		V-TOPO-WATR-OBJT
LJ	Log Jam	06 - EX Topography	Y		V-TOPO-WATR-OBJT
LR	Rock - Loose Rock	06 - EX Topography	Y	Y	V-TOPO-ROCK-LOOS
MS	Marsh / Swamp	06 - EX Topography	Y	Y	V-TOPO-WETL
OB	Overbreak	06 - EX Topography	Y	Y	V-TOPO-ROCK-OVBK
OM	Ground - Original Material	06 - EX Topography	Y	Y	V-TOPO
OR	Organic Soil / Peat	06 - EX Topography	Y	Y	V-TOPO-PEAT
OV	Overhang	06 - EX Topography	Y	Y	V-TOPO-ROCK-MISC
PM	Unmarked Measured Point	06 - EX Topography			V-TOPO-MISC
SA	Sand	06 - EX Topography	Y	Y	V-TOPO-SAND
SE	Spot Elevation	06 - EX Topography		Y	V-SURV-SPOT
SF	Slide, Sluff (Scarp) Line	06 - EX Topography	Y	Y	V-TOPO-SLGH
SG	Water - Seepage	06 - EX Topography	Y	Y	V-TOPO-WATR-SEEP
SM	Water - Stream	06 - EX Topography	Y	Y	V-TOPO-WATR-STRE
SR	Rock - Solid Rock	06 - EX Topography	Y	Y	V-TOPO-ROCK-SOLD
SS	Survey Stake	06 - EX Topography	Y	Y	V-SURV-SPOT
TB	Slope - Top of Slope (Embankment)	06 - EX Topography	Y	Y	V-TOPO-TOPB
TD	Talus Deposits	06 - EX Topography	Y	Y	V-TOPO-TALS
TI	Trail - Mapping Requirement	06 - EX Topography	Y	Y	V-TOPO-TRAL
TR	Rock - Top of Rock	06 - EX Topography	Y	Y	V-TOPO-ROCK-TRCK
VS	Stripping	06 - EX Topography	Y	Y	V-TOPO-STRP
WE	Waste	06 - EX Topography	Y	Y	V-TOPO-WAST
CI	Culvert Inlet	07 - EX Utility Drainage			V-DRAN-PIPE-SYMB
CO	Culvert Outlet	07 - EX Utility Drainage			V-DRAN-PIPE-SYMB
CS	Pipeline - Corrugated Steel	07 - EX Utility Drainage	Y		V-DRAN-PIPE
CT	Pipeline - Cast Iron	07 - EX Utility Drainage	Y		V-DRAN-PIPE
CV	Culvert (Chain)	07 - EX Utility Drainage	Y		V-DRAN-PIPE
CV	Culvert (Point)	07 - EX Utility Drainage			V-DRAN-PIPE-SYMB
FL	Flume	07 - EX Utility Drainage	Y		V-DRAN-FLUM
GU	Gutter	07 - EX Utility Drainage	Y	Y	V-DRAN-GUTR
KK	Culvert Kink	07 - EX Utility Drainage			V-DRAN-PIPE-SYMB
PC	Pipeline - Plastic	07 - EX Utility Drainage	Y		V-DRAN-PIPE-PLST
PN	Pipeline	07 - EX Utility Drainage	Y		V-DRAN-PIPE
RI	Riprap	07 - EX Utility Drainage	Y	Y	V-DRAN-RRAP

Construction Survey Field Codes



Code	Description	FXL Group	Line	DTM	Layer
FC	Filler Cap	08 - Utility Gas and Oil			V-OIL~-SYMB
FT	Fuel Tank	08 - Utility Gas and Oil			V-OIL~-SYMB
FU	Fuel / Gas Pump	08 - Utility Gas and Oil			V-OIL~-SYMB
GM	Gas Main	08 - Utility Gas and Oil	Y		V-NGAS-PIPE
GV	Gas Valve	08 - Utility Gas and Oil			V-NGAS-SYMB
OL	Oil Line	08 - Utility Gas and Oil	Y		V-OIL~-UGND
US	Underground Gas Service Line	08 - Utility Gas and Oil	Y		V-NGAS
VP	Vent Pipe - Breather / Vent Pipe	08 - Utility Gas and Oil			V-OIL~-SYMB
AN	Anchor	09 - Utility General			V-UTIL-SYMB
AR	Valve - Air Release Valve	09 - Utility General			V-UTIL-SYMB
BY	Brace Pole	09 - Utility General			V-UTIL-SYMB
DK	Dike, Dam, Levee, Flood Control	09 - Utility General	Y		V-WATR
DM	Deadman	09 - Utility General			V-UTIL-SYMB
DW	Manhole/Catch Basin - Drywell	09 - Utility General			V-UTIL-SYMB
GW	Guy Wire	09 - Utility General			V-UTIL-SYMB
IH	Irrigation - Sprinkler Head	09 - Utility General			V-IRRG-SYMB
IJ	Irrigation - Junction Box	09 - Utility General			V-IRRG-SYMB
IR	Irrigation - Pipeline	09 - Utility General	Y		V-IRRG-UGND
JB	Junction Box	09 - Utility General			V-UTIL-SYMB
KI	Utility Kiosk	09 - Utility General			V-UTIL-SYMB
MH	Manhole	09 - Utility General			V-UTIL-SYMB
MU	Manhole - Unknown	09 - Utility General			V-UTIL-SYMB
MV	Manhole - Vault	09 - Utility General			V-UTIL-SYMB
MY	Manhole - Sanitary, Storm Cleanout	09 - Utility General			V-UTIL-SYMB
SN	Signal - Traffic Signal	09 - Utility General			V-UTIL-SYMB
SV	Meter - Service Meter	09 - Utility General			V-UTIL-SYMB
TA	Traffic Counter	09 - Utility General			V-UTIL-SYMB
TX	Traffic Signal Control Box	09 - Utility General			V-UTIL-SYMB
UG	Underground Miscellaneous	09 - Utility General	Y		V-UTIL-UGND
UM	Underground Marker	09 - Utility General			V-UTIL-SYMB
UP	Utility Pole	09 - Utility General			V-UTIL-SYMB
VV	Valve	09 - Utility General			V-UTIL-SYMB
WH	Wire Height	09 - Utility General	Y		V-UTIL
WZ	Well	09 - Utility General			V-UTIL-SYMB
EC	Electrical Conduit	10 - Utility Power and Tel	Y		V-POWR-CNDT
ED	Electrical Pedestal	10 - Utility Power and Tel	Y		V-POWR
EL	Electrical Vault	10 - Utility Power and Tel	Y		V-POWR
EO	Electrical Outlet	10 - Utility Power and Tel			V-POWR-SYMB
FO	Underground Fibre Optic	10 - Utility Power and Tel	Y		V-COMM-CNDT-FIBR
GE	Guy Pole - Power	10 - Utility Power and Tel			V-POWR-SYMB
GT	Guy Pole - Telephone	10 - Utility Power and Tel			V-COMM-SYMB
GY	Guy Pole - Power / Telephone	10 - Utility Power and Tel			V-POWR-SYMB
HT	High Tension Tower	10 - Utility Power and Tel			V-POWR-SYMB
HV	High Tension Pole	10 - Utility Power and Tel			V-POWR-SYMB
LA	Lamp Standard	10 - Utility Power and Tel			V-POWR-SYMB
ME	Manhole - Power	10 - Utility Power and Tel			V-POWR-SYMB
MT	Manhole - Telephone	10 - Utility Power and Tel			V-COMM-SYMB
PB	Telephone Booth	10 - Utility Power and Tel			V-COMM-SYMB
PD	Pedestal - Utility	10 - Utility Power and Tel			V-COMM-SYMB

Construction Survey Field Codes



Code	Description	FXL Group	Line	DTM	Layer
PH	Power / Tel Pole with Transformer	10 - Utility Power and Tel			V-POWR-SYMB
PP	Power Pole	10 - Utility Power and Tel			V-POWR-SYMB
PS	Power Pole with Transformer	10 - Utility Power and Tel			V-POWR-SYMB
PT	Power / Tel Pole	10 - Utility Power and Tel			V-POWR-SYMB
TP	Telephone Pole	10 - Utility Power and Tel			V-COMM-SYMB
UE	Underground Electrical Power	10 - Utility Power and Tel	Y		V-POWR-CNDT
UT	Underground Telephone	10 - Utility Power and Tel	Y		V-COMM-CNDT
UX	Underground Electrical Transformer	10 - Utility Power and Tel			V-POWR-SYMB
CB	Catch Basin - Existing	11 - Utility Sanitary and Storm			V-STRM-SYMB
CM	Catch Basin / Manhole	11 - Utility Sanitary and Storm			V-STRM-SYMB
DG	Drainage Grate	11 - Utility Sanitary and Storm			V-STRM-SYMB
DS	Drain - Storm / Sewer	11 - Utility Sanitary and Storm	Y		V-STRM-PIPE
LB	Catch Basin - Lawn	11 - Utility Sanitary and Storm			V-STRM-SYMB
LG	Lagoon	11 - Utility Sanitary and Storm	Y	Y	V-SSWR
MC	Manhole - Storm Sewer	11 - Utility Sanitary and Storm			V-STRM-SYMB
MX	Manhole - Sanitary Sewer	11 - Utility Sanitary and Storm			V-SSWR-SYMB
ST	Septic Tank	11 - Utility Sanitary and Storm			V-SSWR-SYMB
SU	Sanitary Sewer Line	11 - Utility Sanitary and Storm	Y		V-SSWR-PIPE
SX	Septic Drain Field	11 - Utility Sanitary and Storm	Y	Y	V-SSWR-DFLD
DC	Water - Ditch Center	12 - Utility Water	Y	Y	V-DRAN-DTCH-CNTR
DD	Water - Ditch Block	12 - Utility Water	Y		V-DRAN-DTCH
DE	Water - Ditch Edge	12 - Utility Water	Y	Y	V-DRAN-DTCH-EDGE
DZ	Water - Subdrains	12 - Utility Water	Y		V-WATR-PIPE
ES	Water - Est Water Table Elevation	12 - Utility Water	Y	Y	B-BORE-ESWT
FH	Fire Hydrant	12 - Utility Water			V-WATR-SYMB
MO	Manhole - Water	12 - Utility Water			V-WATR-SYMB
MW	Water - Measured Water Table Elev	12 - Utility Water	Y	Y	B-BORE-MSWT
SD	Standpipe - Water Blowoff	12 - Utility Water			V-WATR-SYMB
WM	Meter - Water Meter	12 - Utility Water			V-WATR-SYMB
WR	Water - Water Main	12 - Utility Water	Y		V-WATR-PIPE
WT	Water - Reservoir Tank	12 - Utility Water	Y		V-WATR
WV	Valve - Water Valve	12 - Utility Water			V-WATR-SYMB
JA	Remeasure Spot Elevation - Type A	20 - Const Horizon Remeasure		Y	C-TOPO-RMSR-TYPA
JD	Remeasure Spot Elevation - Type D	20 - Const Horizon Remeasure		Y	C-TOPO-RMSR-TYPD
JG	Remeasure Spot Elevation - Gravel	20 - Const Horizon Remeasure		Y	C-TOPO-RMSR-GRVL
JS	Remeasure Spot Elevation - Stripping	20 - Const Horizon Remeasure		Y	C-TOPO-RMSR-STRP
JW	Remeasure Spot Elevation - Waste	20 - Const Horizon Remeasure		Y	C-TOPO-RMSR-WAST
KA	Remeasure - Type A	20 - Const Horizon Remeasure	Y	Y	C-TOPO-RMSR-TYPA
KD	Remeasure - Type D	20 - Const Horizon Remeasure	Y	Y	C-TOPO-RMSR-TYPD
KG	Remeasure - Gravel	20 - Const Horizon Remeasure	Y	Y	C-TOPO-RMSR-GRVL
KR	Remeasure - RipRap	20 - Const Horizon Remeasure	Y	Y	C-TOPO-RMSR-RRAP
KS	Remeasure - Stripping	20 - Const Horizon Remeasure	Y	Y	C-TOPO-RMSR-STRP
KU	Remeasure - Sub Excavation	20 - Const Horizon Remeasure	Y	Y	C-TOPO-RMSR-SUBX
KW	Remeasure - Waste	20 - Const Horizon Remeasure	Y	Y	C-TOPO-RMSR-WAST
XA	Change to - Type A	20 - Const Horizon Remeasure	Y	Y	C-TOPO-CHNG-TYPA
XD	Change to - Type D	20 - Const Horizon Remeasure	Y	Y	C-TOPO-CHNG-TYPD
XG	Change to - Gravel	20 - Const Horizon Remeasure	Y	Y	C-TOPO-CHNG-GRVL
XO	Change to - COG	20 - Const Horizon Remeasure	Y	Y	C-TOPO-CHNG-OGND
XR	Change to - RipRap	20 - Const Horizon Remeasure	Y	Y	C-TOPO-CHNG-RRAP

Construction Survey Field Codes



Code	Description	FXL Group	Line	DTM	Layer
XU	Change to - Sub Excavation	20 - Const Horizon Remeasure	Y	Y	C-TOPO-CHNG-SUBX
XW	Change to - Waste	20 - Const Horizon Remeasure	Y	Y	C-TOPO-CHNG-WAST
YA	Horizon Spot Elevation - Type A	20 - Const Horizon Remeasure		Y	C-TOPO-HORZ-TYPA
YD	Horizon Spot Elevation - Type D	20 - Const Horizon Remeasure		Y	C-TOPO-HORZ-TYPD
YG	Horizon Spot Elevation - Gravel	20 - Const Horizon Remeasure		Y	C-TOPO-HORZ-GRVL
YO	Horizon Spot Elevation - COG	20 - Const Horizon Remeasure		Y	C-TOPO-HORZ-OGND
YW	Horizon Spot Elevation - Waste	20 - Const Horizon Remeasure		Y	C-TOPO-HORZ-WAST
ZA	Horizon - Type A	20 - Const Horizon Remeasure	Y	Y	C-TOPO-HORZ-TYPA
ZD	Horizon - Type D	20 - Const Horizon Remeasure	Y	Y	C-TOPO-HORZ-TYPD
ZG	Horizon - Gravel	20 - Const Horizon Remeasure	Y	Y	C-TOPO-HORZ-GRVL
ZO	Horizon - COG	20 - Const Horizon Remeasure	Y	Y	C-TOPO-HORZ-OGND
ZR	Horizon - RipRap	20 - Const Horizon Remeasure	Y	Y	C-TOPO-HORZ-RRAP
ZU	Horizon - Sub Excavation	20 - Const Horizon Remeasure	Y	Y	C-TOPO-HORZ-SUBX
ZW	Horizon - Waste	20 - Const Horizon Remeasure	Y	Y	C-TOPO-HORZ-WAST
AM	Asphalt - Milling	21 - Construction	Y	Y	C-ROAD-MILL
AT	Asphalt - Pavement Cut	21 - Construction	Y	Y	C-ROAD-SCUT
BV	Borrow	21 - Construction	Y	Y	C-TOPO
EF	Gravel - BEF	21 - Construction	Y	Y	C-ROAD-BEF~
EM	Erosion Control Mat	21 - Construction	Y		C-SITE
EX	Sub Excavation	21 - Construction	Y	Y	C-TOPO
FF	Geotextile Cloth	21 - Construction	Y	Y	C-SITE
GO	Geogrid	21 - Construction	Y	Y	C-SITE
GZ	Gravel - SGSB	21 - Construction	Y	Y	C-ROAD-SGSB
HY	Hydro Seeding	21 - Construction	Y	Y	C-SITE
HZ	Compost Blanket	21 - Construction	Y	Y	C-SITE
IG	Gravel - IGB	21 - Construction	Y	Y	C-ROAD-IGB~
IU	Gravel - IGSB	21 - Construction	Y	Y	C-ROAD-IGSB
OO	Gravel - OGB	21 - Construction	Y	Y	C-ROAD-OGB~
OU	Gravel - OGSB	21 - Construction	Y	Y	C-ROAD-OGSB
SK	Stockpile Base	21 - Construction	Y	Y	C-TOPO
TF	Turf Reinforcement Mat	21 - Construction	Y		C-SITE
TK	Tack Coat	21 - Construction	Y		C-ROAD
TM	Material Density Test Location	21 - Construction	Y		C-SITE
WG	Gravel - WGB	21 - Construction	Y	Y	C-ROAD-WGB~

1500 Appendix B – Horizon and Remeasure Coding and Surfaces

Construction Surveying Horizon and Remeasure Survey Codes

Horizon and remeasure surveys are required to measure construction horizons for the purpose of surface modeling and volume calculation. The **Horizon** surface model is the *actual* top of the existing material surface (TYPED, TYPEA etc.) used for *actual* quantity calculations. The **Remeasure** surface is the excavated surface model used for calculating monthly quantities. The **Final Remeasure** surface represents the excavation through all materials for the road subgrade and grading neat line.

Construction Survey Codes

1. Z* = Horizon Material (Top of native material, prior to excavation)
2. K* = Remeasure Material (Top of material, after excavation)
3. X* = Change to Material (Interface of two materials)
 - a. Linestrings can be copied / exported for use with *another* surface
4. Y* = Horizon Material Spot Elevation
5. J* = Remeasure Material Spot Elevation

COG

- Coded as ZO# (linework) or YO (spot) for original ground horizon
- Surveyed beyond cut/fill slopes

STRP Remeasure

- Coded as KS# (linework) or JS (spot) for stripping remeasure only
- Bottom of stripping is coded as ZD# (linework) or YD (spot) for TYPED horizons under stripping, or ZA# (linework) or JA (spot) for TYPEA horizons under stripping

TYPED

- Coded as ZD# (linework) or YD (spot) for TYPED horizon
- Coded as KD# (linework) or JD (spot) for TYPED remeasure

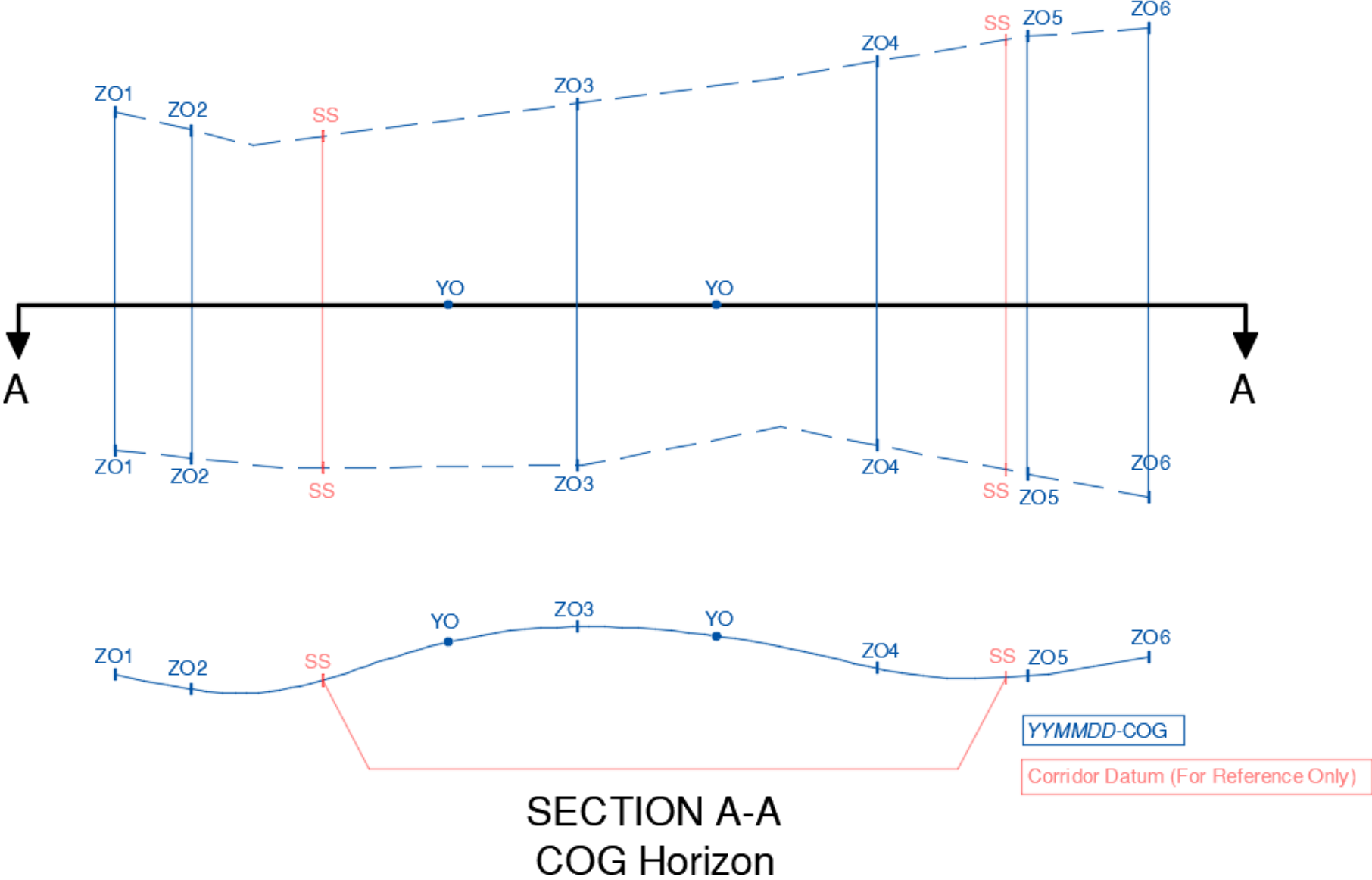
TYPEA

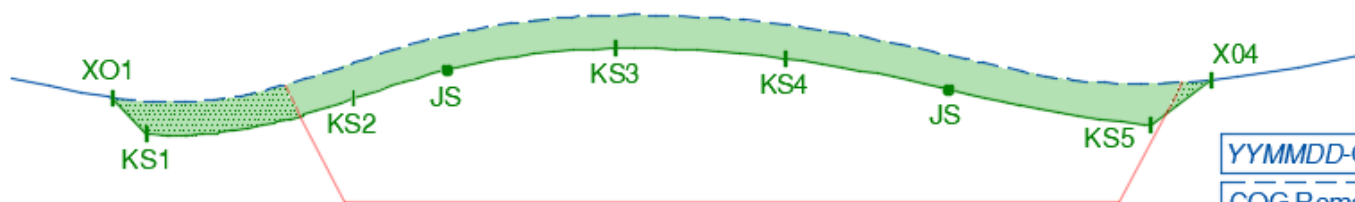
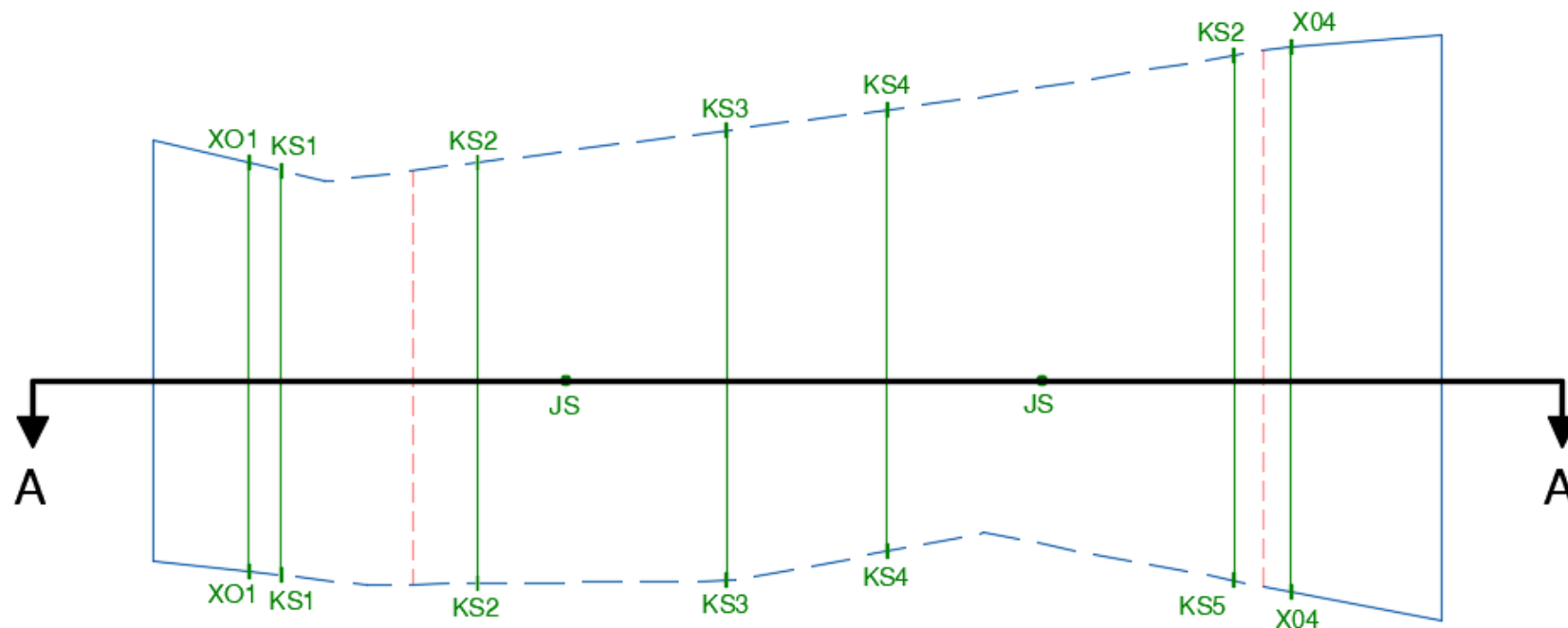
- Coded as ZA# (linework) or YA (spot) for TYPEA horizon
- Coded as KA# (linework) or JA (spot) for TYPEA remeasure

SURFACE NAME STANDARDS

- YYYYMMDD-COG (Construction Original Ground)
- YYYYMMDD-STRPR (Stripping Remeasure)
- YYYYMMDD-TYPEDH (Type D Horizon)
- YYYYMMDD-TYPEDR (Type D Remeasure)
- YYYYMMDD-TYPEAH (Type A Horizon)
- YYYYMMDD-TYPEAR (Type A Remeasure)

EXAMPLE – COG, STRPR, TYPEDH, TYPEDR





- STRP Material Removed to STRPR Surface
- STRPOUT Quantity

YYMMDD-COG

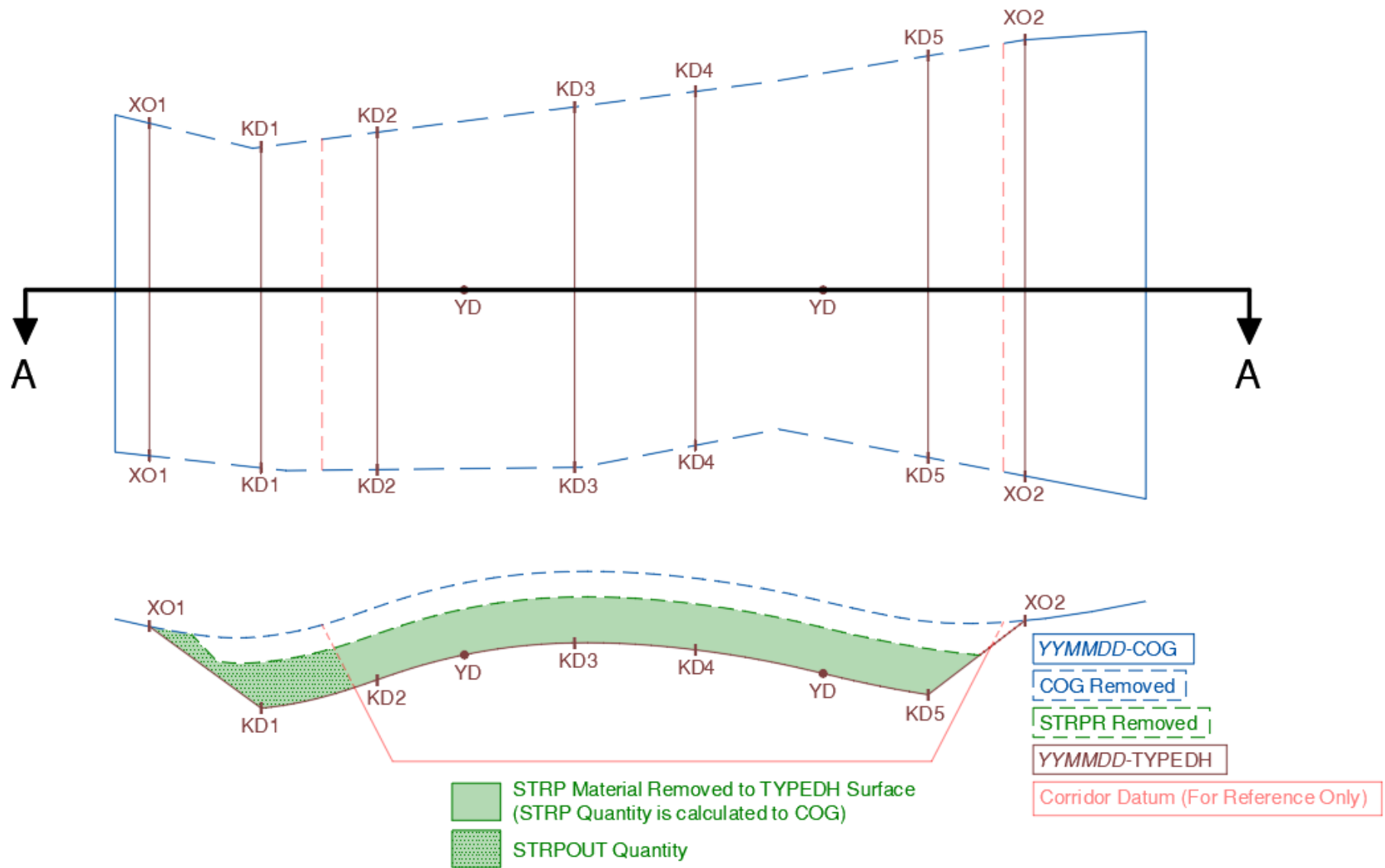
COG Removed

YYMMDD-STRPR

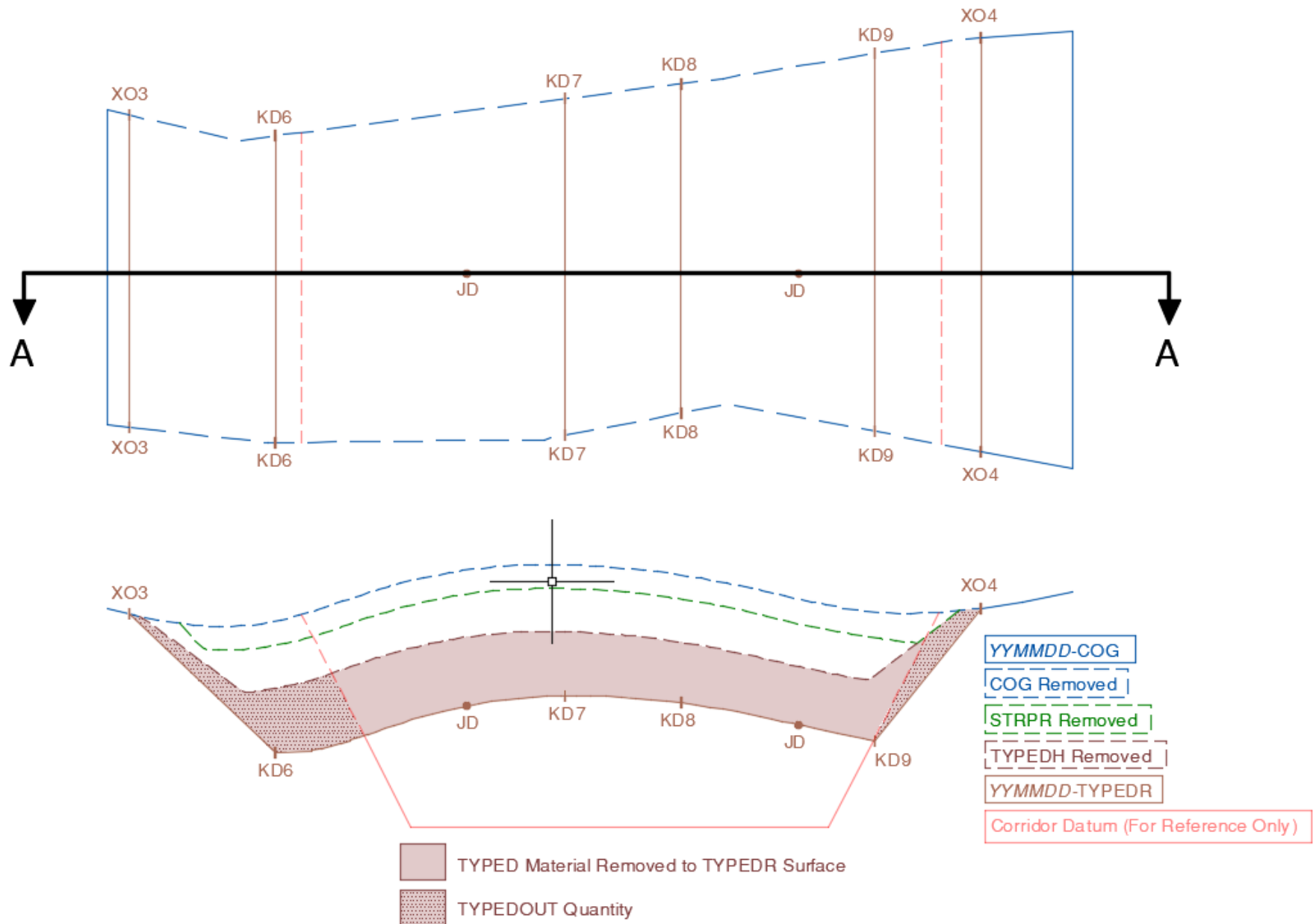
Corridor Datum (For Reference Only)

STRP remeasure codes (KS* and JS) renamed from TYPED horizon codes (ZD* and YD) after identifying a need for further STRP material removal.

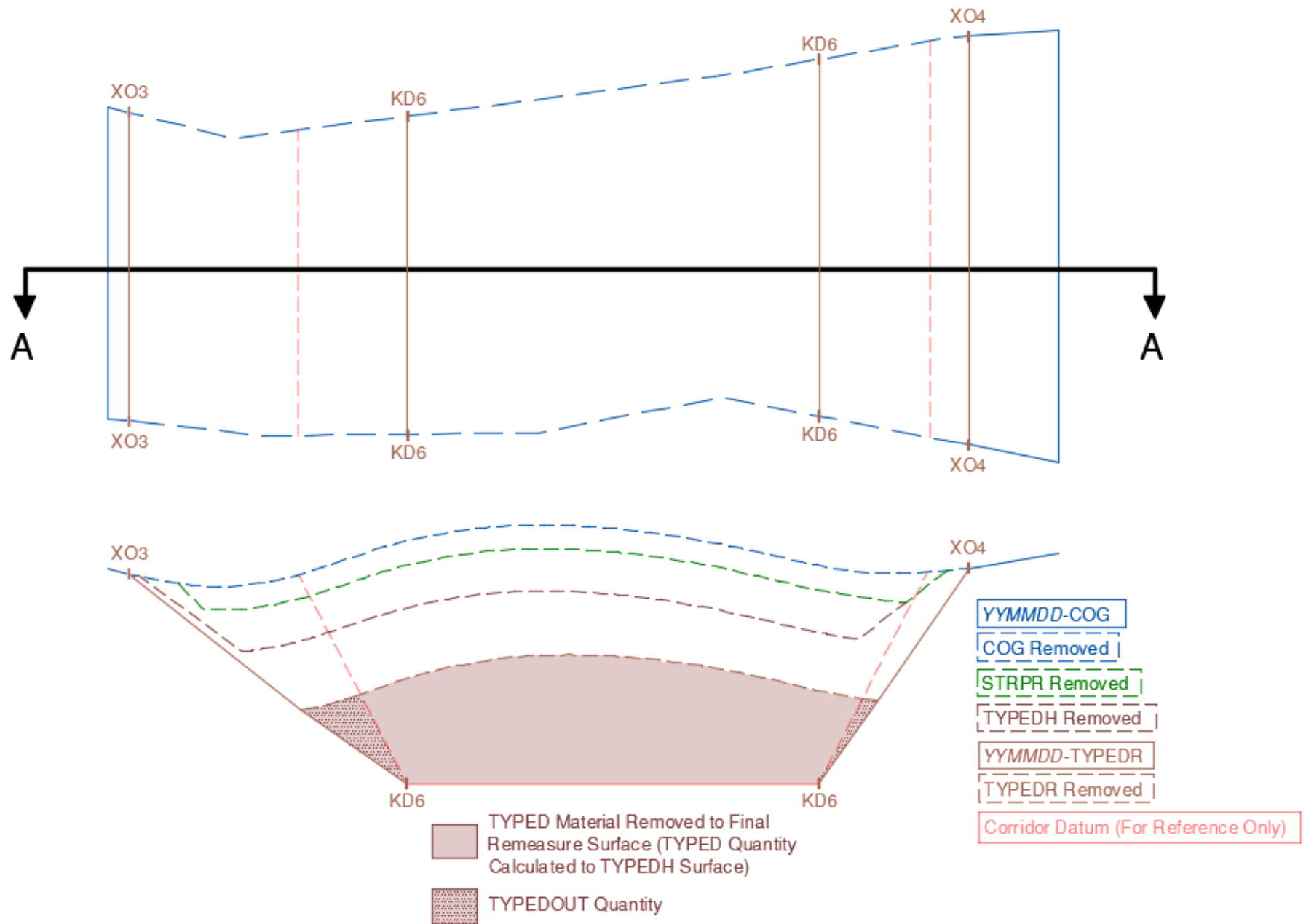
SECTION A-A STRP Remeasure



SECTION A-A TYPED Horizon



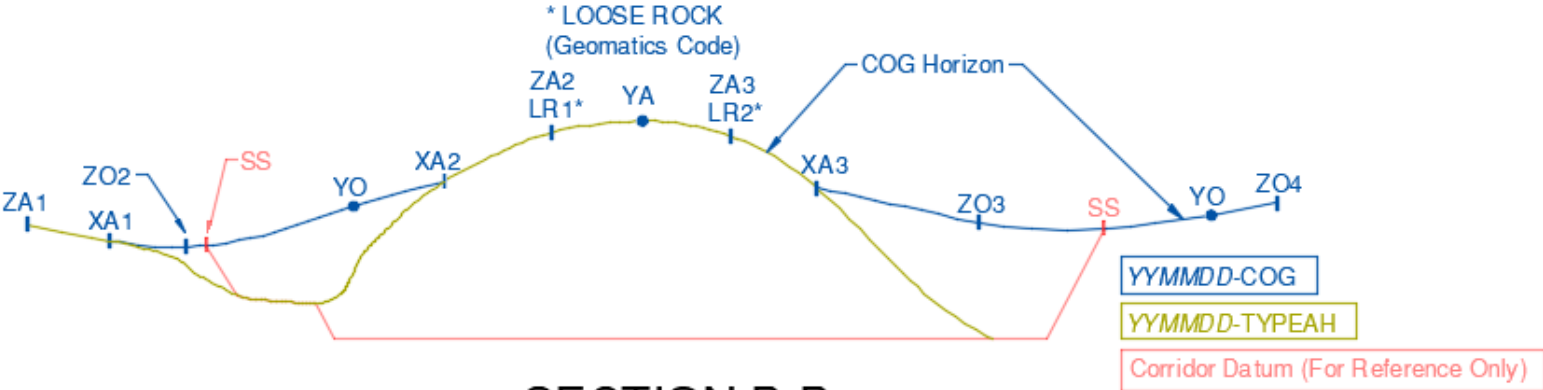
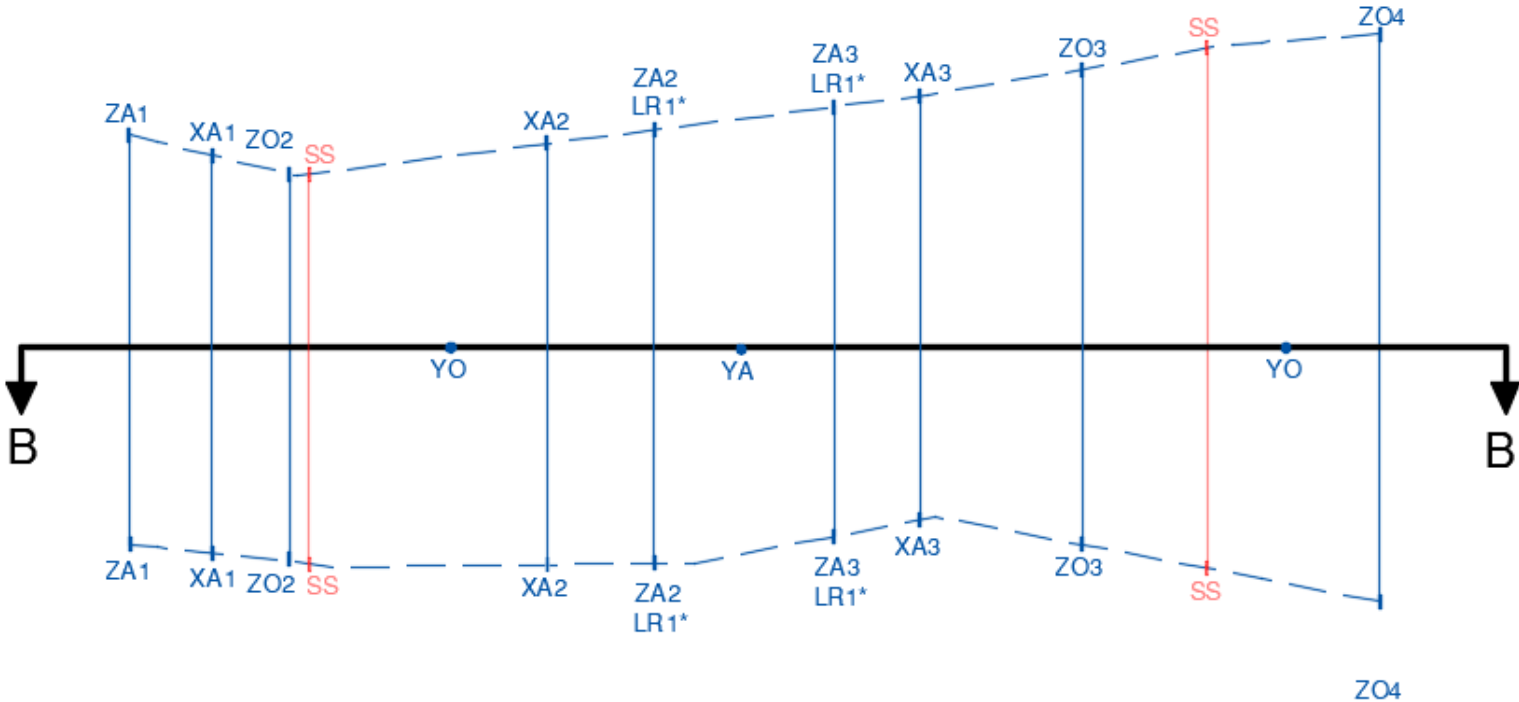
SECTION A-A TYPED Remeasure



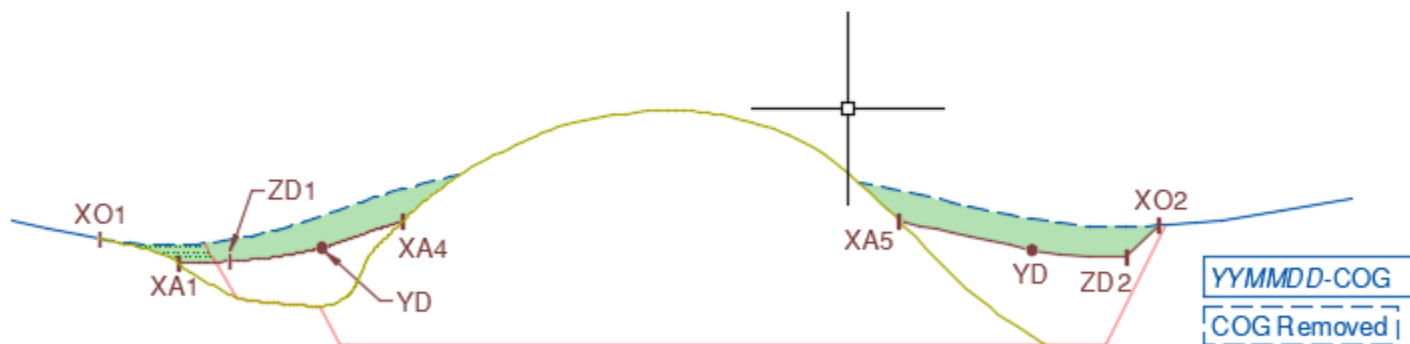
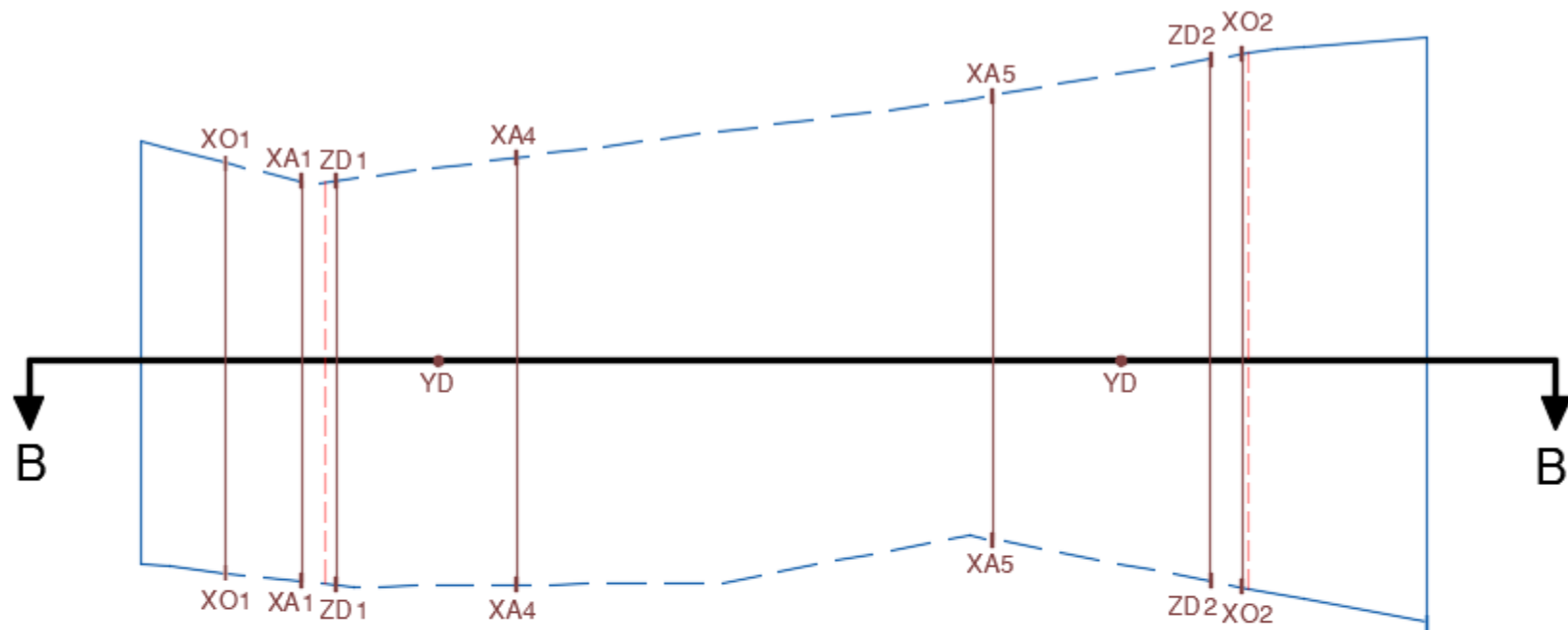
SECTION A-A



As-Built / Final Remeasure

EXAMPLE – COG, TYPEAH, TYPEDH



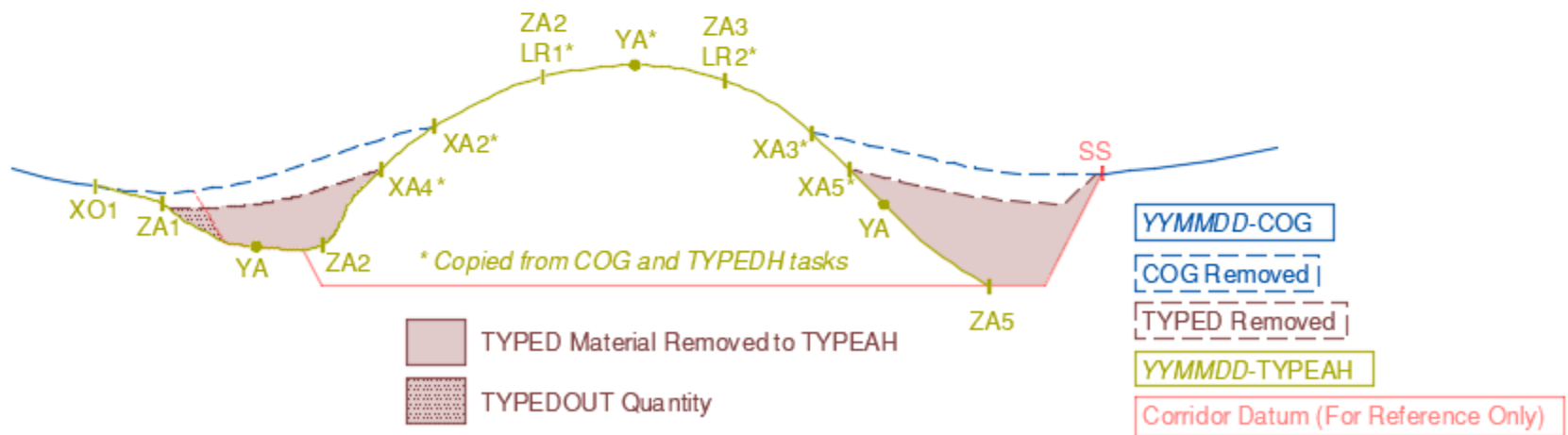
SECTION B-B
COG / TYPEAH

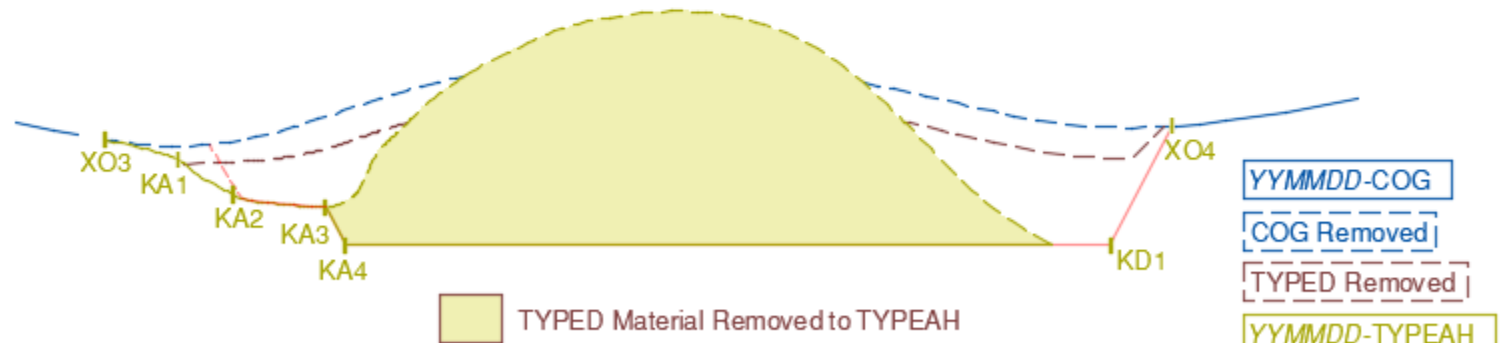
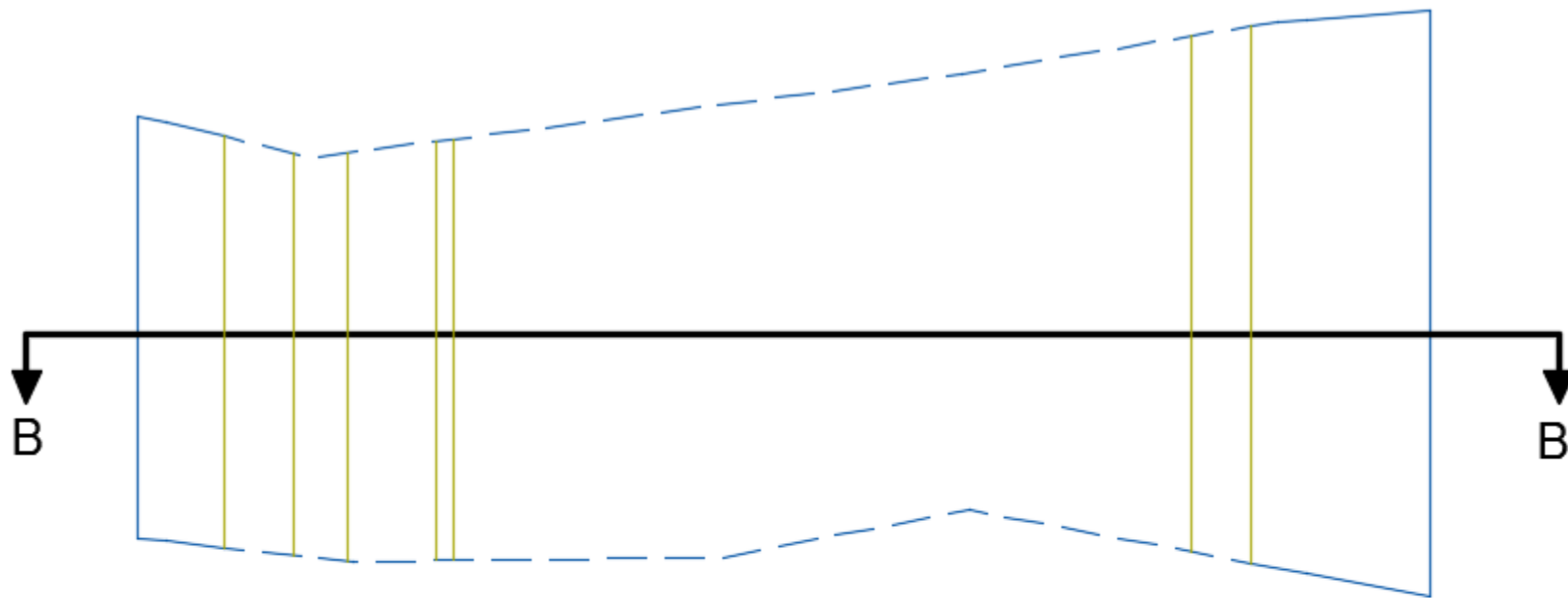


 STRP Material Removed to TYPEDH Surface
 STRPOUT Quantity

YMMDD-COG
 COG Removed
 YMMDD-TYPEAH
 YMMDD-TYPEDH
 Corridor Datum (For Reference Only)

SECTION B-B TYPEDH





SECTION B-B
As-Built / FINAL Remeasure

1600 Appendix C – Flagging Colour Table

Flag Type	Colours
Right of Way	Blue and White
Clearing and Grubbing	Red and 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