BC Ministry of Transportation AutoCAD Civil 3D Implementation

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Infrastructure Data Consultant

BRITISH COLUMBIA | Ministry of Transportation and Infrastructure

AUTODESK. UNIVERSITY

Andrew Walther, P.Eng.

- Infrastructure Industry Consultant
- 25 Years Experience
- Infrastructure Workflows and Standards
- Data Structure/Sharing and Customization
- Video Creation and Production (Retrieve)

BC Ministry of Transportation and Infrastructure

The Ministry of Transportation and Infrastructure plans transportation networks, provides transportation services and infrastructure, develops and implements transportation policies, and administers many related acts and regulations as well as federal-provincial funding programs, including the Building Canada Fund.

Province of British Columbia

1. 1200kM (815 Miles) North/South
2. 800kM (500 Miles) East/West
3. 3 x Regional Offices
    - South Coast Region (Burnaby)
    - Southern Interior Region (Kamloops)
    - Northern Region (Prince George)

Technology History

PANTERRA
1995 to 2006

CAICE
2006 to 2016

CIVIL 3D
2014 to current day.

Facts & Numbers

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$1.5
BILLION

Total Investment in Infrastructure (2018/2019)

42,000
KM

Total Length of Roads and Highways

60
SEATS

Ministry Survey, Design and Construction Supervision Staff using Civil 3D

300
CONSULTANTS

Consultants using Civil 3D for Survey, Design and Construction Workflows

Highway 1 / Port Mann ($2.46 Billion)

Sea to Sky Highway $600 Million

South Fraser Perimeter Road $658 Million

Technology Drivers

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EFFICIENCY

Optimized survey, design and construction workflows to maximize efficiency throughout project lifecycle

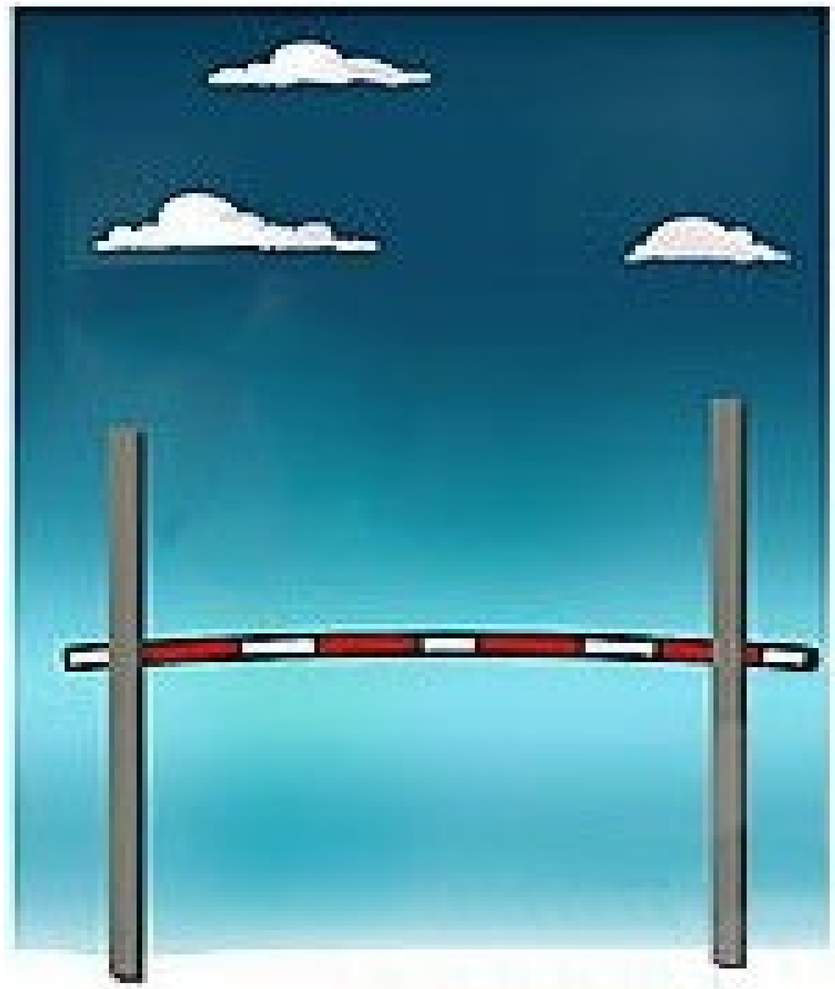
DRAWING PRODUCTION STANDARDS

Consistency in appearance of design and construction drawings

CONSTRUCTION SUPERVISION DELIVERABLES

Field measurements and volume calculations for contractor payments

“ To ***Set the Bar*** is to ***Set the Standard*** ”



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Public Agencies are the Leaders who ***Make the Policy*** and ***Set the Rules***

Project Phases

EXISTING CONDITIONS

HISTORY

Developing a full understanding of the business and the people involved with transportation project procurement

WORKFLOW IDENTIFICATION

DATA HAND OFF

Clear definition of inputs and outputs to and from survey, design and construction workflows. Identify the parties and roles involved.

STANDARDS AND CUSTOMIZATION

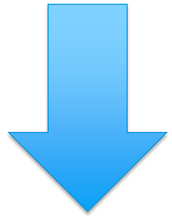
THE TOOLBOX

Survey codes and linework generation, AutoCAD standardized components, Civil 3D standardized components and customization

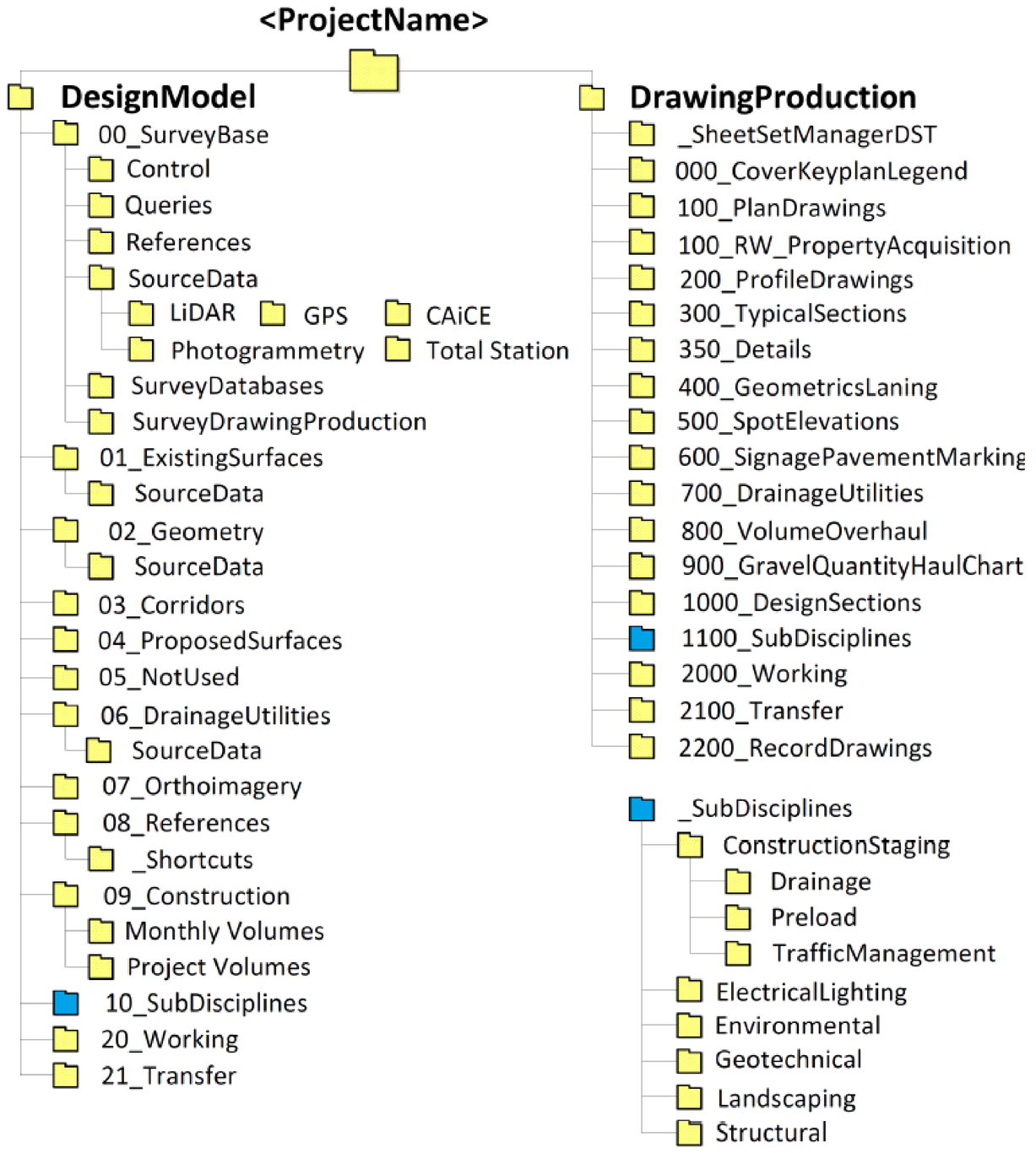
IMPLEMENTATION AND TRAINING

COMMUNICATION

Online videos to support industry training and workflow development. Webinars and workshops. Ministry Civil 3D implementation web site.



CONTINUED DEVELOPMENTS AND IMPROVEMENTS



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Project Folder Structure

- Design Model
- Drawing Production

Survey Workflow

Survey Workflow

Provide information on existing conditions upon which a design can be based:

1. **Survey base (SURVBASE) drawings**
2. **Existing surface (EXSURF) drawing**
3. Existing property (SURVPROP) drawing
4. Existing utilities (SURVUTIL) drawing – Civil 3D Pipe Networks
5. Existing geometry (SURVGEOM) drawing – H&V Alignments
6. Production drawings (SURVPLAN, SURVPROF, SURVSECT – SSM)
7. Source Data

Survey Workflow – **Technical Highlights**

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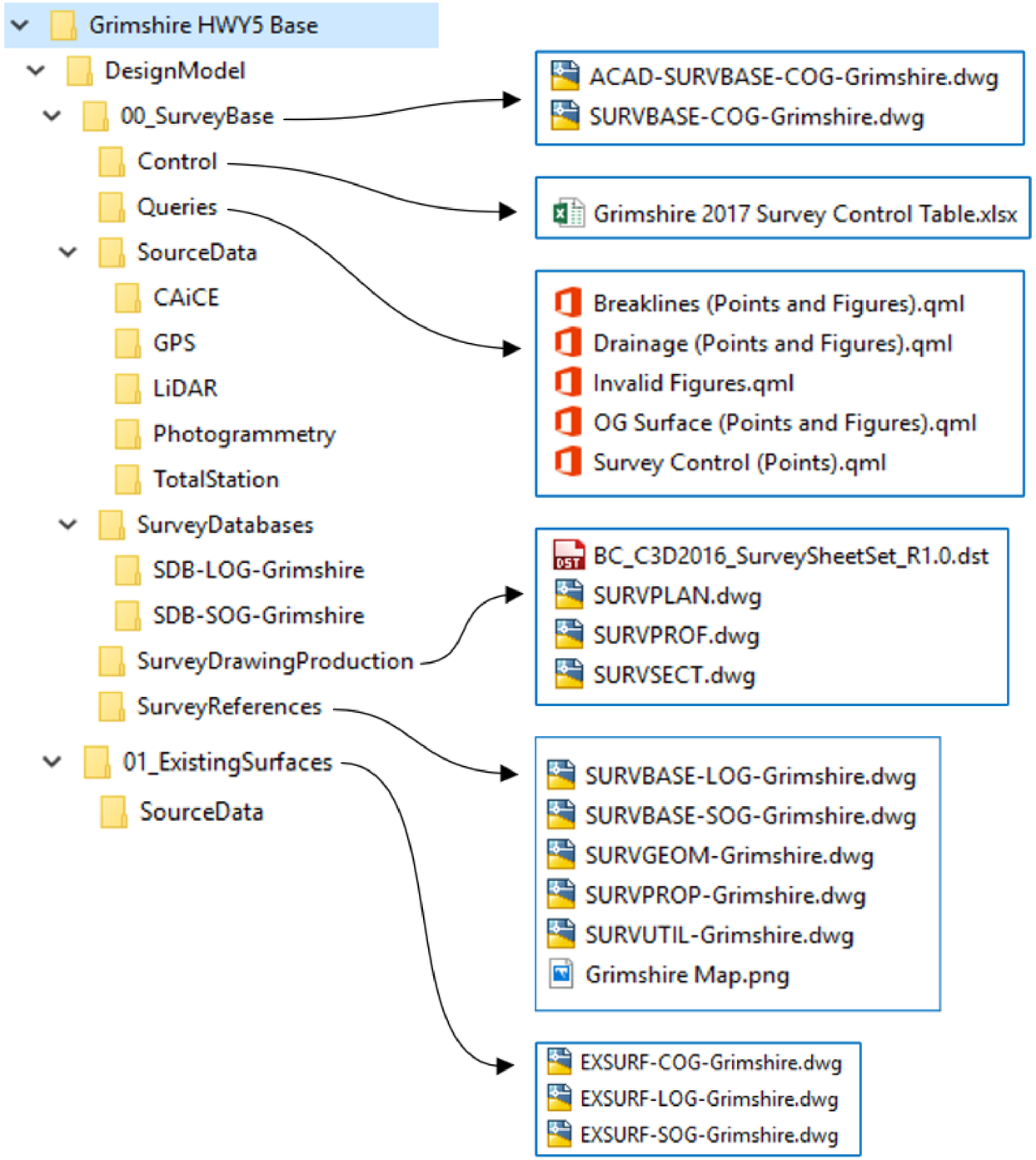
1. **All Feature Data Processed through Civil 3D Survey Database**
    - 100% automatic linework generation (survey figures)
    - Point attribution with user defined properties (ATT1 through ATT5)
    - Managed archive for historical data access
2. **Combining Aerial (LOG) and Ground (SOG) SURVBASE and EXSURF data**
3. **Grid and Ground Coordinate Conversion**
4. **LiDAR Data Management**
5. **CAiCE Data Migration**



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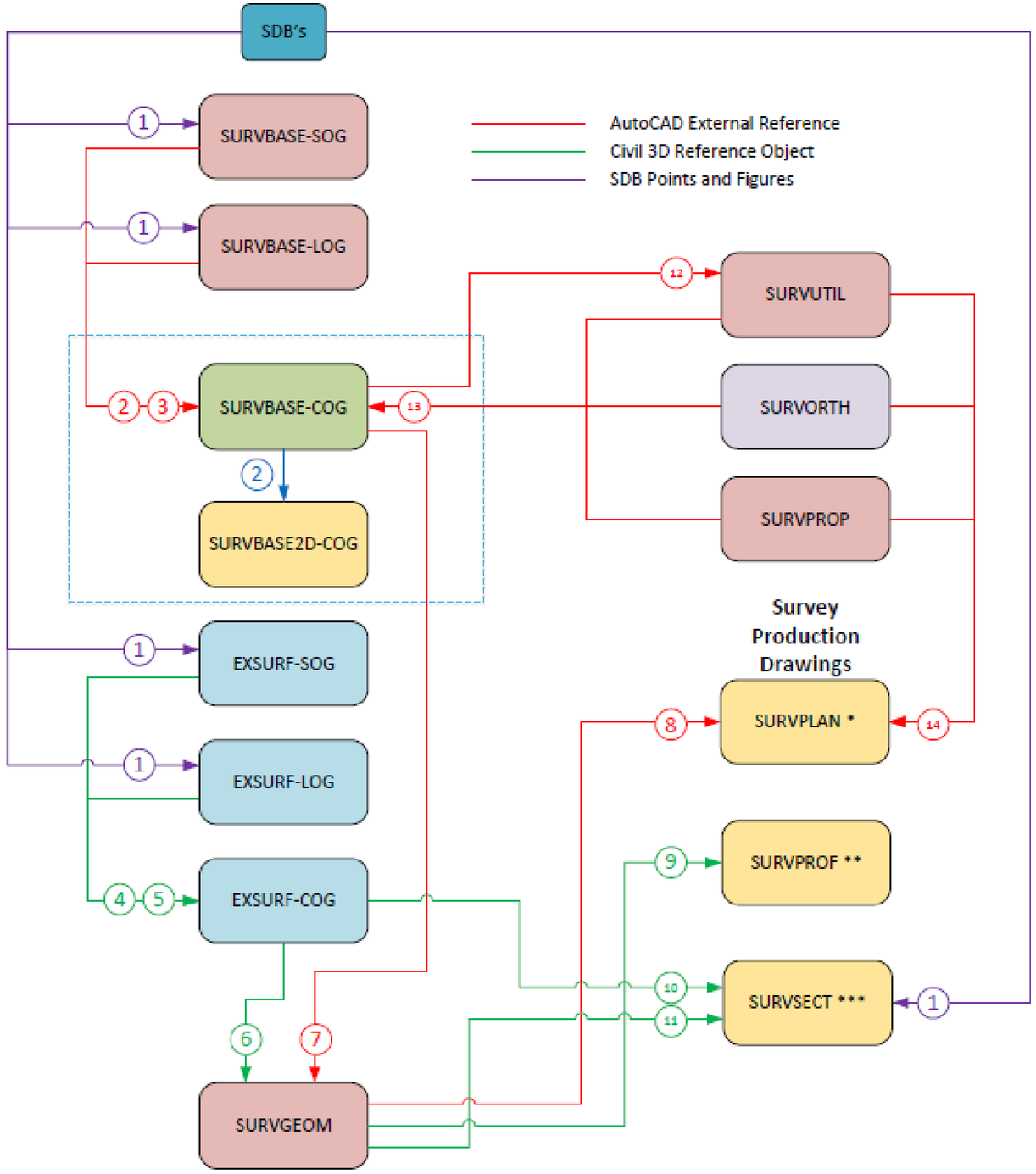
Survey Folders and Drawings



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1. Figures and points inserted from SDB for SURVBASE creation, EXSURF modeling and section view figure projections. Alternatively original ground surface models can be created using survey queries.
2. SURVBASE-COG attaches SURVBASE-SOG as Xref for base plan creation (Xref *attachment*)
3. SURVBASE-COG attaches SURVBASE-LOG as Xref for base plan creation (Xref *attachment*)
4. EXSURF-COG references SOG surface from EXSURF-SOG
5. EXSURF-COG references LOG surface from EXSURF-LOG
6. SURVGEOM references COG surface from EXSURF-COG for existing surface profile creation
7. SURVGEOM attaches SURVBASE-COG as Xref for existing geometry creation
8. SURVPLAN production drawing attaches SURVGEOM as Xref to show existing features and alignments
9. Survey PROFILE production drawing references existing alignments and surface profiles from SURVGEOM
10. Survey SECT production drawing references COG surface from EXSURF-COG
11. Survey SECT production drawing references existing alignments from SURGEOM
12. SURVUTIL attaches SURVBASE-COG as Xref (Xref *overlay*)
13. SURVBASE-COG attaches SURVPROP, SURVUTIL and SURVORTH as Xref (Xref *attachment*, SURVORTH Unloaded) ****
14. SURVPLAN attaches SURVUTIL, SURVORTH and SURVPROP as Xref
15. Create SURVBASE2D 2D drawing from SURVBASE

Survey Data Sharing

Survey Workflow - **Civil 3D Survey Database**

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1. All Feature Data Processed through Civil 3D Survey Database
2. 100% Survey Figure (base plan linework and breaklines) Generation
3. Point Attribution with User Defined Properties (ATT1 through ATT5)
4. DTM Ground Attribute Stored in SDB
5. Managed Survey Archive for Historical Data Access
6. Separate SDB for Ground and Aerial Surveys

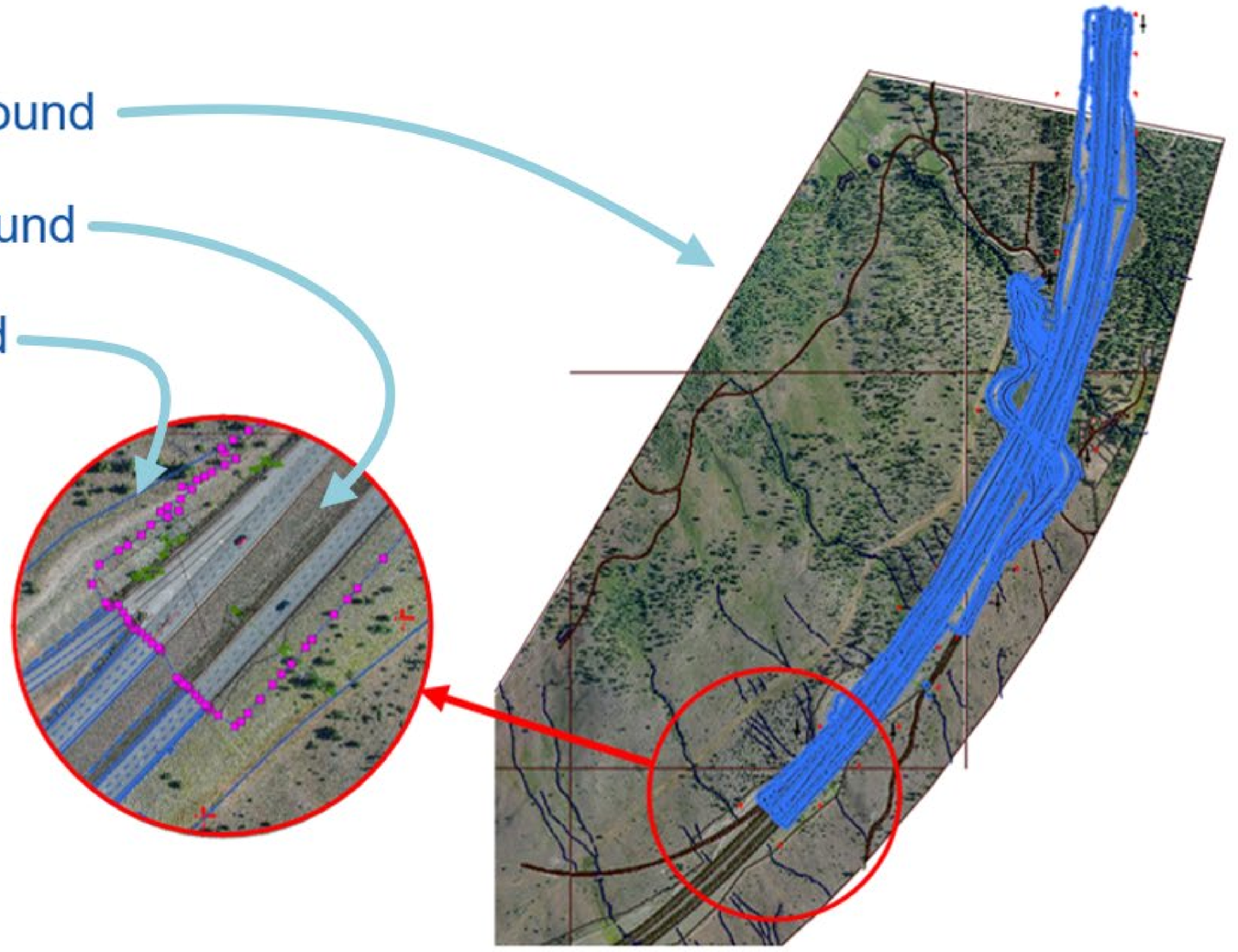
Survey Workflow – **Combining Ground and Aerial Surveys**

Ministry of Transportation and Infrastructure

COG – **C**ombined **O**riginal **G**round

SOG – **S**urveyed **O**riginal **G**round

LOG – **L**iDAR **O**riginal **G**round



Survey Workflow – Combining Ground and Aerial Surveys

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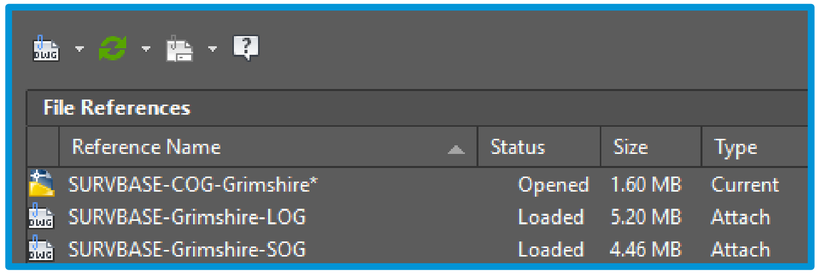
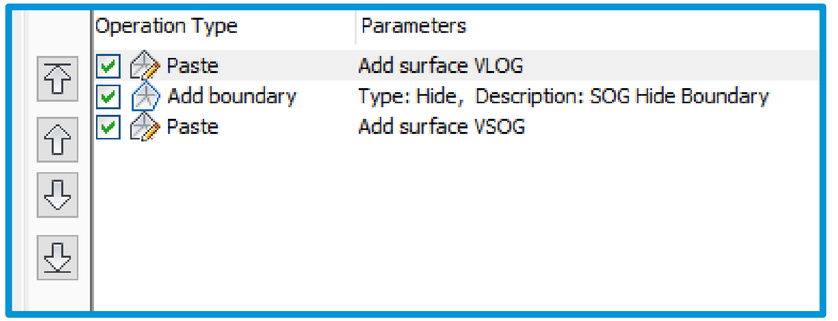
SURVBASE-COG.dwg

- Attaches SURVBASE-SOG as Xref
- Attaches SURVBASE-LOG as Xref
- Xref inverted clipping boundary on SURVBASE-LOG



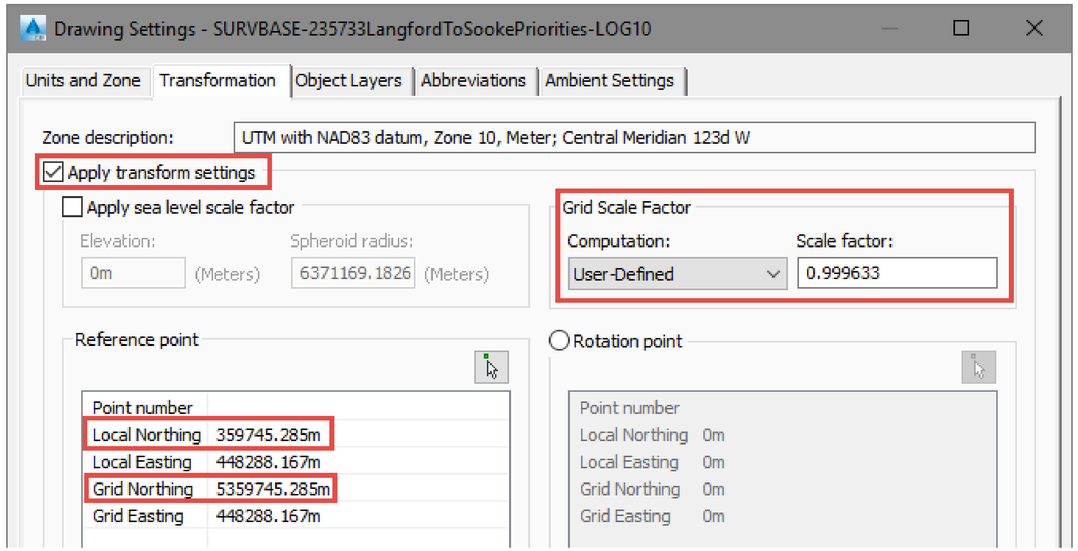
EXSURF-COG.dwg

- Surface reference from EXSURF-SOG
- Surface reference from EXSURF-LOG
- Create EXSURF-COG and paste LOG and SOG
- Hide boundary on EXSURF-COG from SURVBASE-LOG clipping boundary



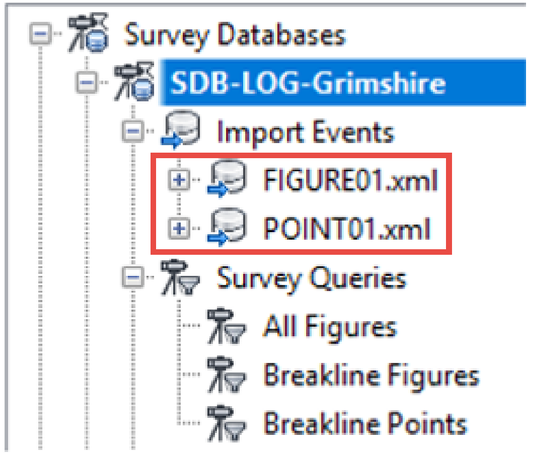
GRID and GROUND Coordinates

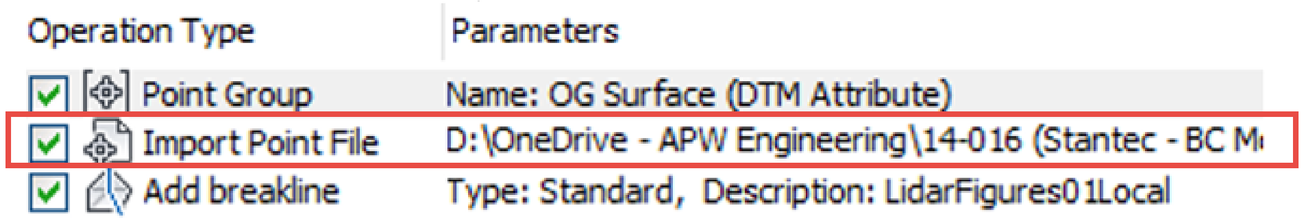
1. COG Drawing – **ground**
2. LOG (LiDAR Original Ground) – **grid**
3. SOG (Survey Original Ground) – **grid or ground**
4. Civil 3D Transformation Settings – **scale factor and translation**



LiDAR Data Management

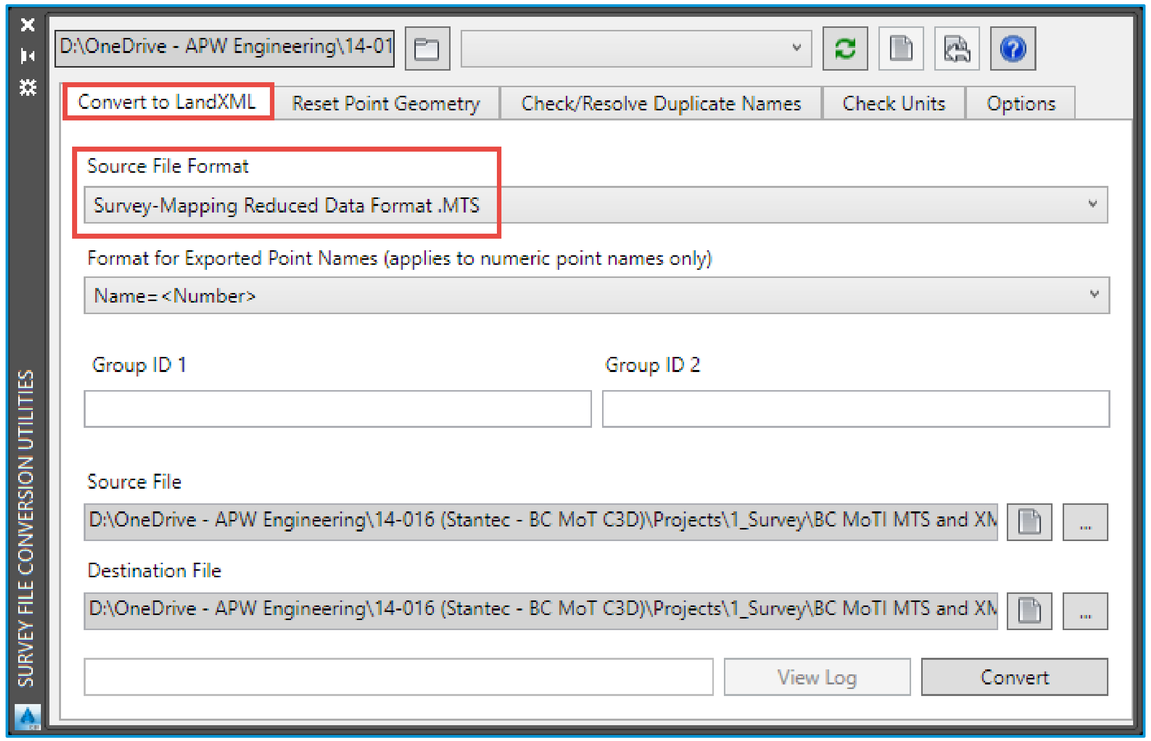
1. Minimize Impact on SDB and DWG
2. Segregated Data / SDB Import Events
   - Feature linework data (pavement markings, edges etc.)
   - Feature point data (power poles, manholes etc.)
   - Ground point data

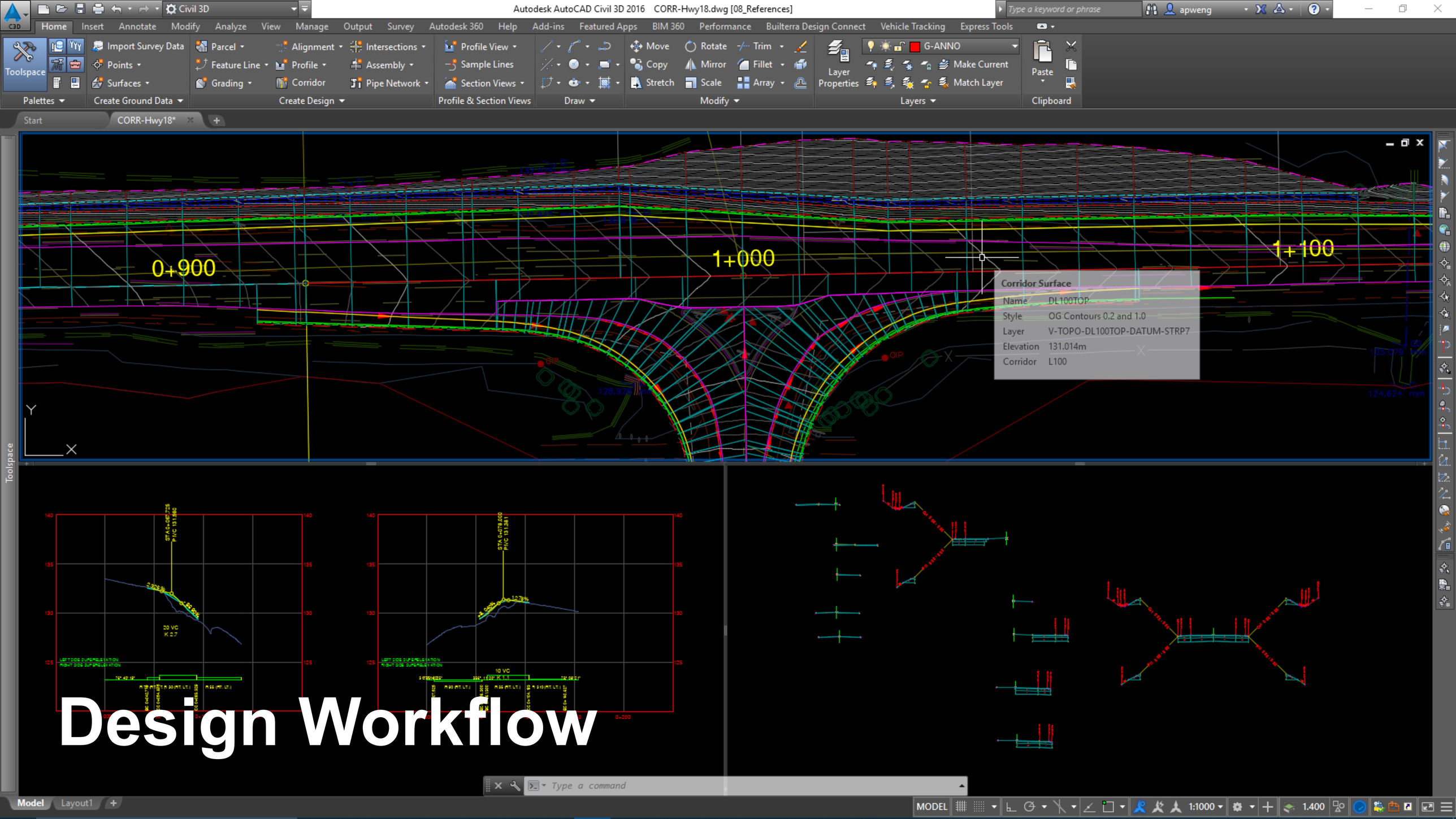




CAiCE Data Migration

1. Export MTS File from CAiCE
2. BC MoTI Convert MTS to Survey XML Utility




Civil 3D
Autodesk AutoCAD Civil 3D 2016 CORR-Hwy18.dwg [08_References]
Home Insert Annotate Modify Analyze View Manage Output Survey Autodesk 360 Help Add-ins Featured Apps BIM 360 Performance Builterra Design Connect Vehicle Tracking Express Tools
Toolspace
Import Survey Data
Points
Surfaces
Parcel
Feature Line
Grading
Alignment
Profile
Corridor
Intersections
Assembly
Pipe Network
Profile View
Sample Lines
Section Views
Move
Copy
Stretch
Rotate
Mirror
Scale
Trim
Fillet
Array
Layer Properties
G-ANNO
Make Current
Match Layer
Paste
Palettes
Create Ground Data
Create Design
Profile & Section Views
Draw
Modify
Layers
Clipboard
Start
CORR-Hwy18*
0+900
1+000
1+100
Corridor Surface
Name DL100TOP
Style OG Contours 0.2 and 1.0
Layer V-TOPO-DL100TOP-DATUM-STRP7
Elevation 131.014m
Corridor L100
Design Workflow
Type a command
Model
Layout1
MODEL
1:1000
1.400

Design Workflow

To provide information upon which construction can be based:

1. Design Model Data
    - Survey original ground surfaces
    - Design corridor surfaces
    - Design stripping, rock, subexcavation surfaces
    - Design Corridor model
2. Design and Construction (Production) Drawings
3. Quantities and Layout Data

Design Workflow – **Technical Highlights**

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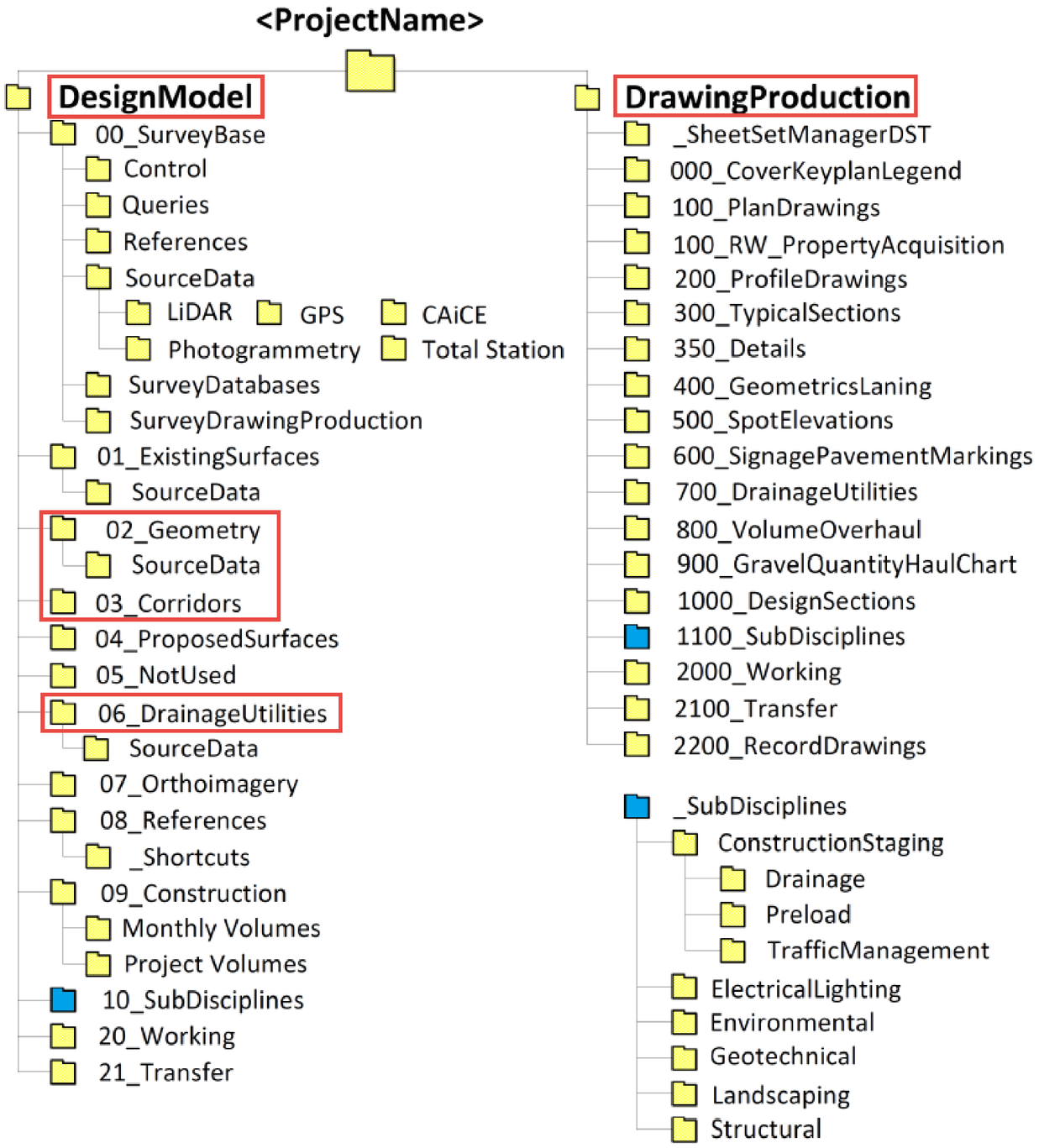
1. 100% Data Sharing (no duplication) and Organization
2. Custom Subassemblies
3. Production Drawings Wholly Representative of Design Model Data
4. Object Naming Conventions



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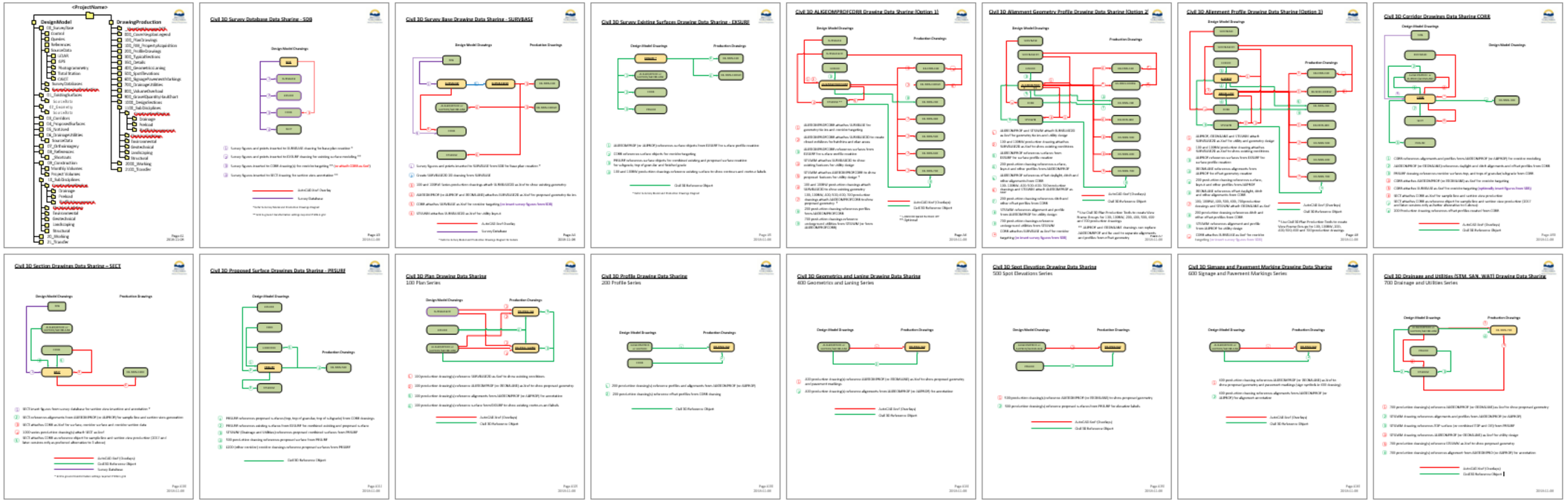
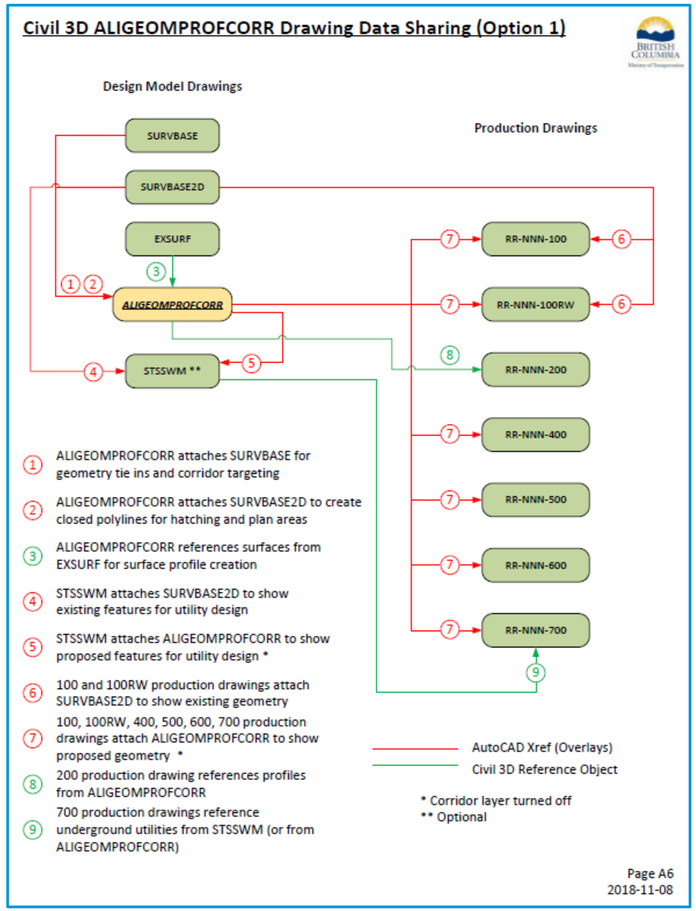
Design Workflow
Project Folder Structure

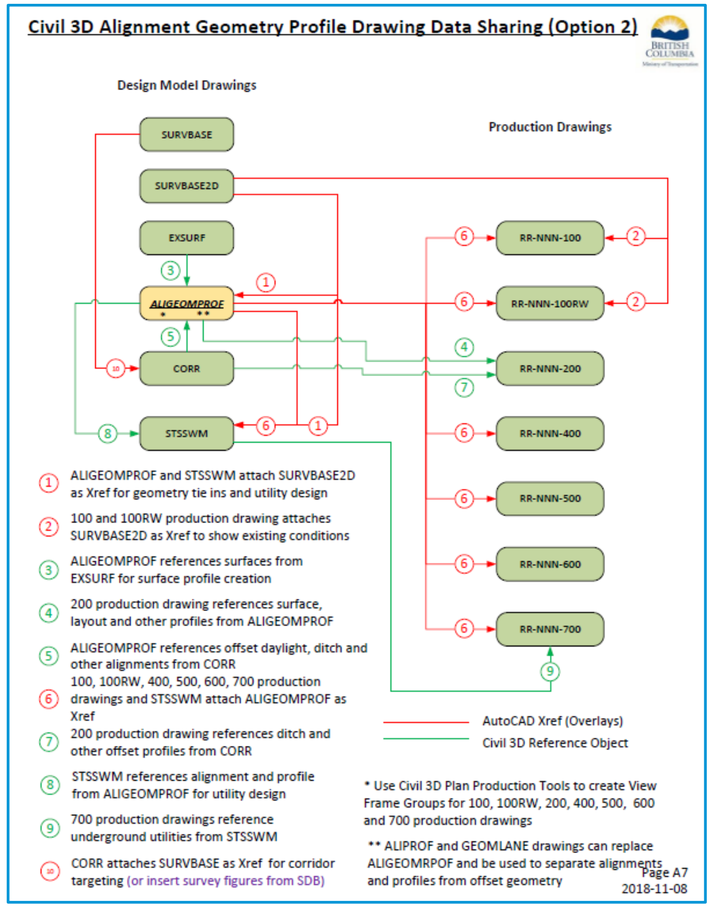
Design Workflow – **Data Sharing**

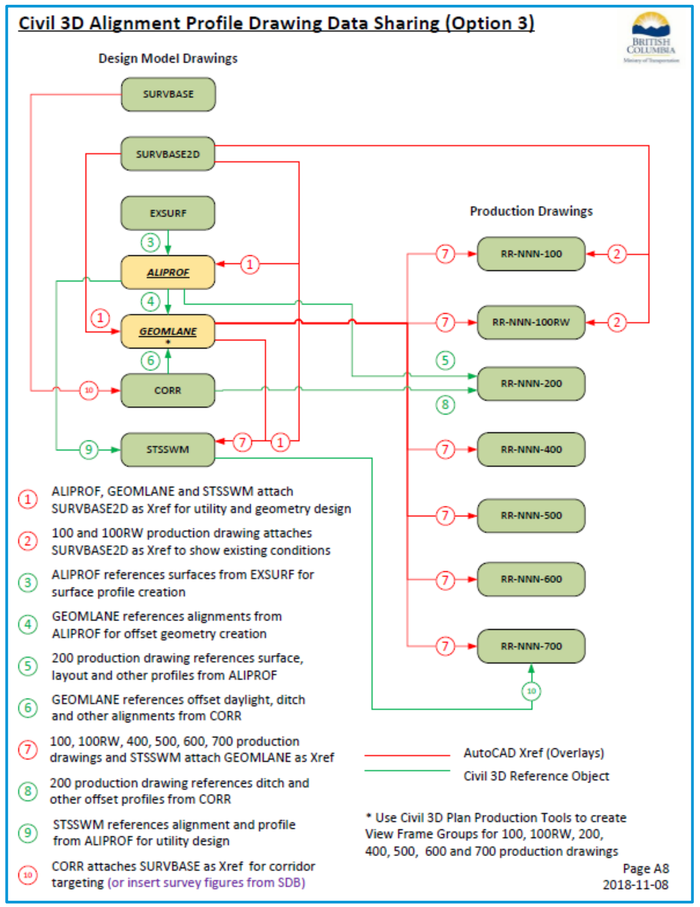
1. AutoCAD External References (Xrefs)
2. Civil 3D Data Shortcuts and Reference Objects
3. Survey Database



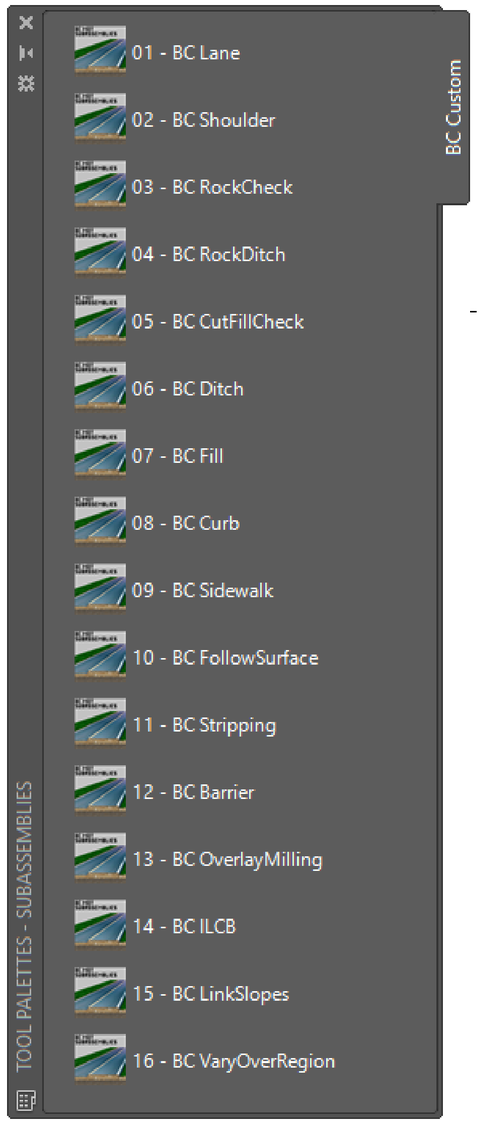
Design Workflow – **Data Sharing**







Design Workflow – **Custom Subassemblies**



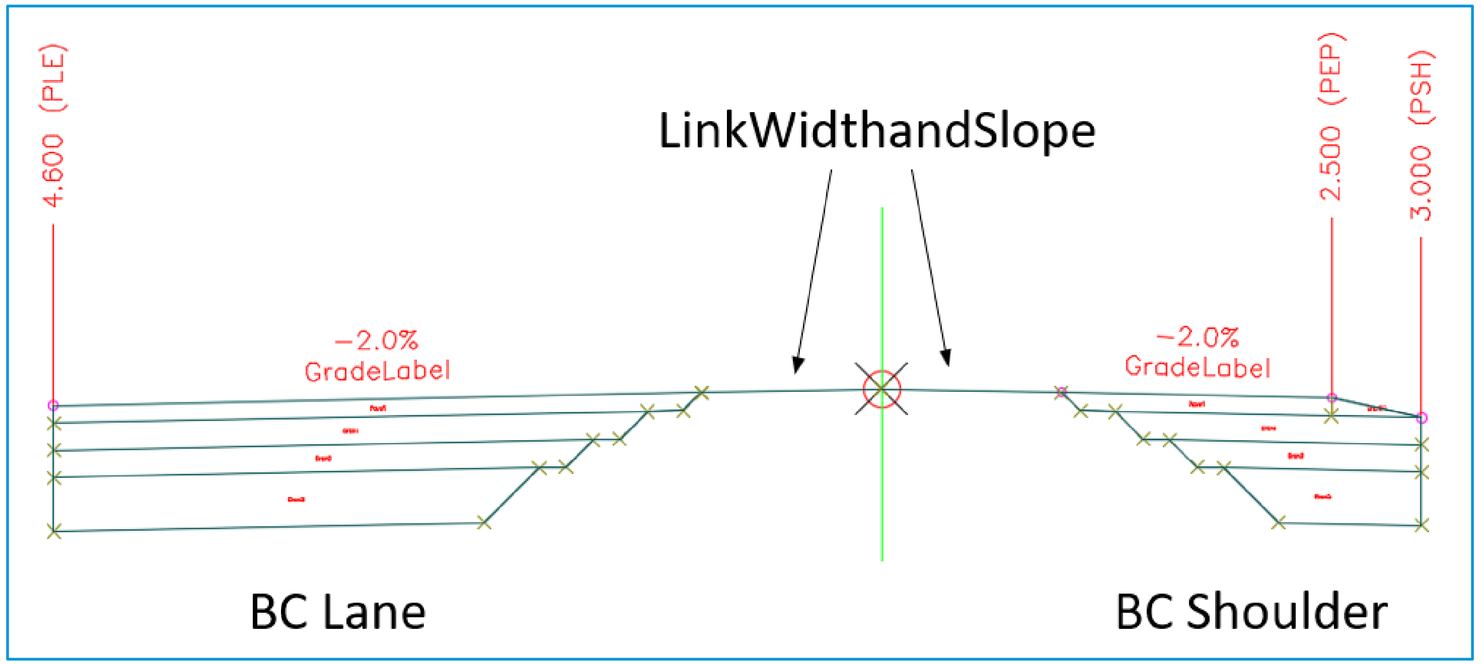
1. Incorporate BC Highway Design Standards
2. Standardized Point, Link and Shape Codes
3. Built in Logic – Cut/Fill Checks, Rock/No Rock Checks

BC Subassemblies

- BC Lane
- BC Shoulder
- BC RockCheck
- BC RockDitch
- BC CutFillCheck
- BC Ditch
- BC Fill
- BC Curb
- BC Sidewalk
- BC FollowSurface
- BC Stripping
- BC Barrier
- BC OverlayMilling
- BC ILCB
- BC Link Slopes
- BC VaryOverRegion

BC Lane and BC Shoulder

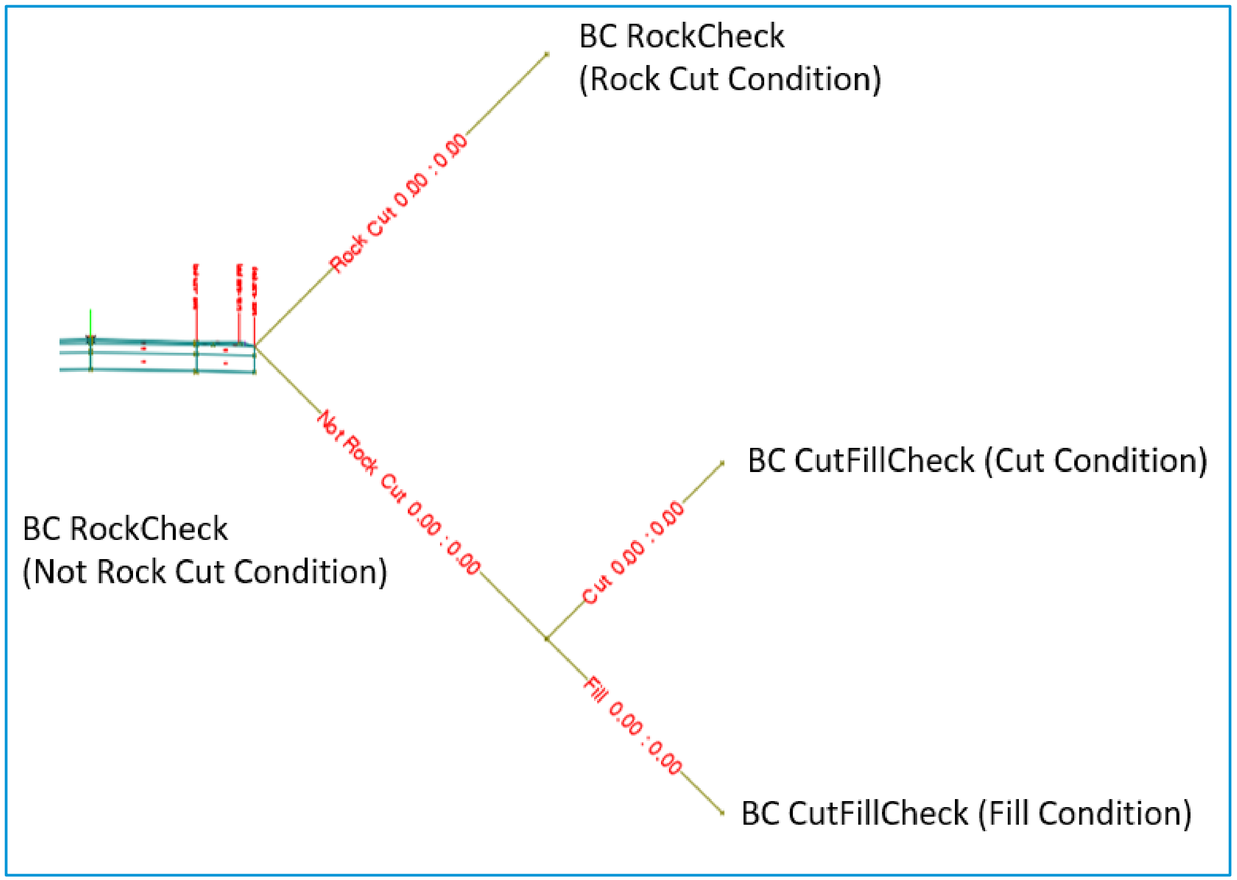
- Inside and Outside Material Offsets
- Independent Subgrade Slope and Superelevation
- Output Parameters
- Custom Point Inside and Outside Point Codes



Side	Left
Lane Width	3.600m
Lane Crossfall	-2.00%
Depth Pave1	0.100m
Depth Pave2	0.000m
Depth Gran1	0.150m
Depth Gran2	0.150m
Depth Gran3	0.300m
Superelevation	No Superelevation
Slope Direction	Towards Outside
AOR Potential Pivot	No
Grade Label	Top
Point Code Inside	PCL
Point Code Outside	PLE
Point Code Toggles	NY
Subgrade Crossfall	-3.00%
Subgrade Calc	Parallel
Subgrade Super	No Superelevation
Offset Materials	Inside
Offset Pave Slope	1.00:1
Offset Gravel Slope	1.00:1
Offset Opposing Slope	0.00:1
Offset Gran1	0.300m
Offset Gran2	0.600m
Offset Gran3	0.900m

BC RockCheck and BC CutFillCheck

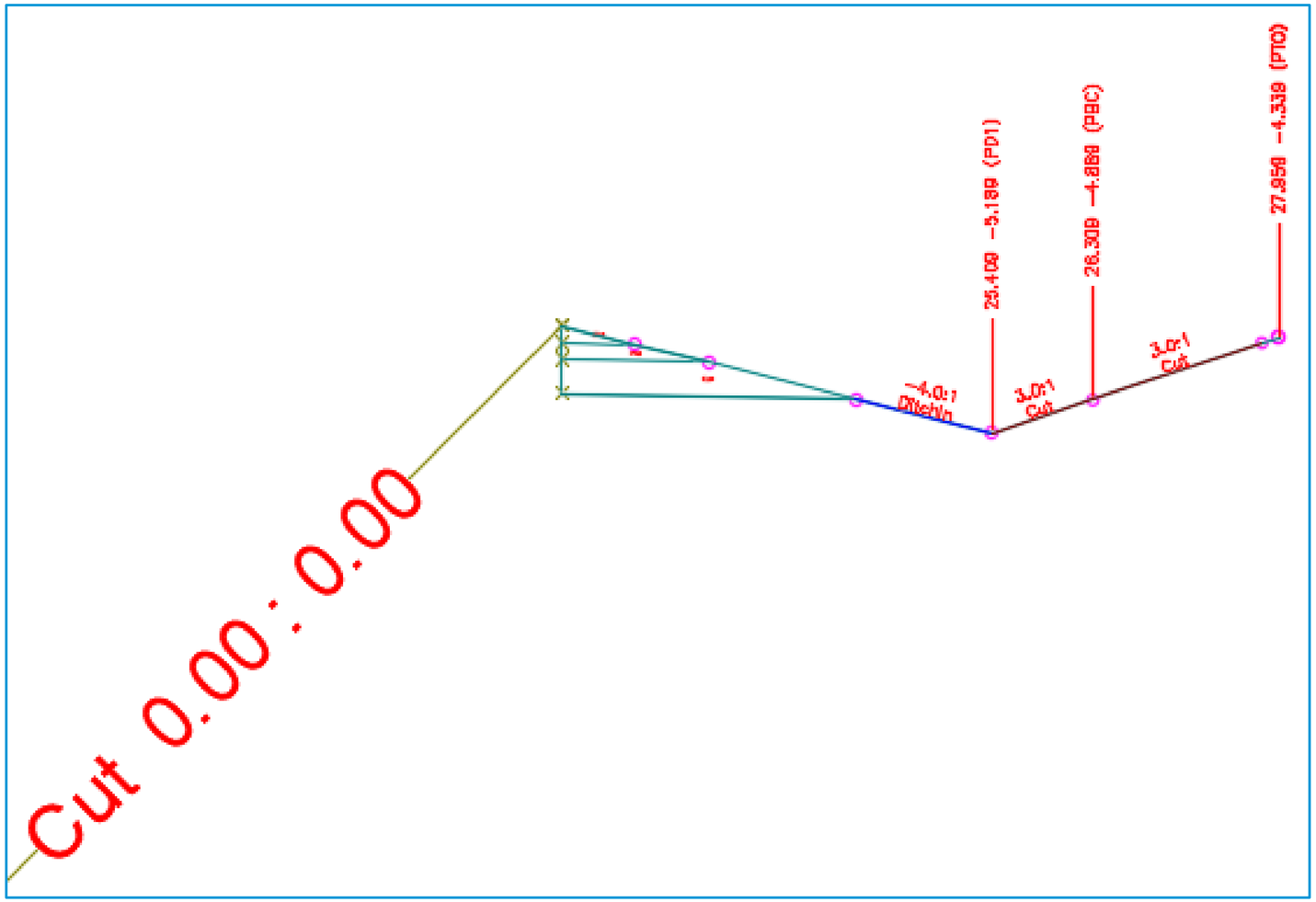
- Conditional SA's
- Checks for Condition at Ditch Location
- Force Situation



Layout Width	6.000m
Layout Grade	1.00:1
Type	Cut
Force Situation	Auto
Foreslope Gravels	4.00:1
Foreslope SGSB	4.00:1
Foreslope Ditch	4.00:1
Ditch Depth	0.300m
Ditch Type	One-Point
Ditch Width Inside	1.000m
Ditch Width Outside	1.000m
Ditch Slope Inside	20.00:1
Ditch Slope Outside	3.00:1
Gravels Crossfall	-2.00%
Depth Gran1	0.150m
Depth Gran2	0.150m
Depth Gran3	0.300m
Superelevation	No Superelevation
Slope Direction	Towards Outside
Subgrade Crossfall	-3.00%
Subgrade Calc	Parallel
Subgrade Super	No Superelevation
Version	1.00

BC Ditch

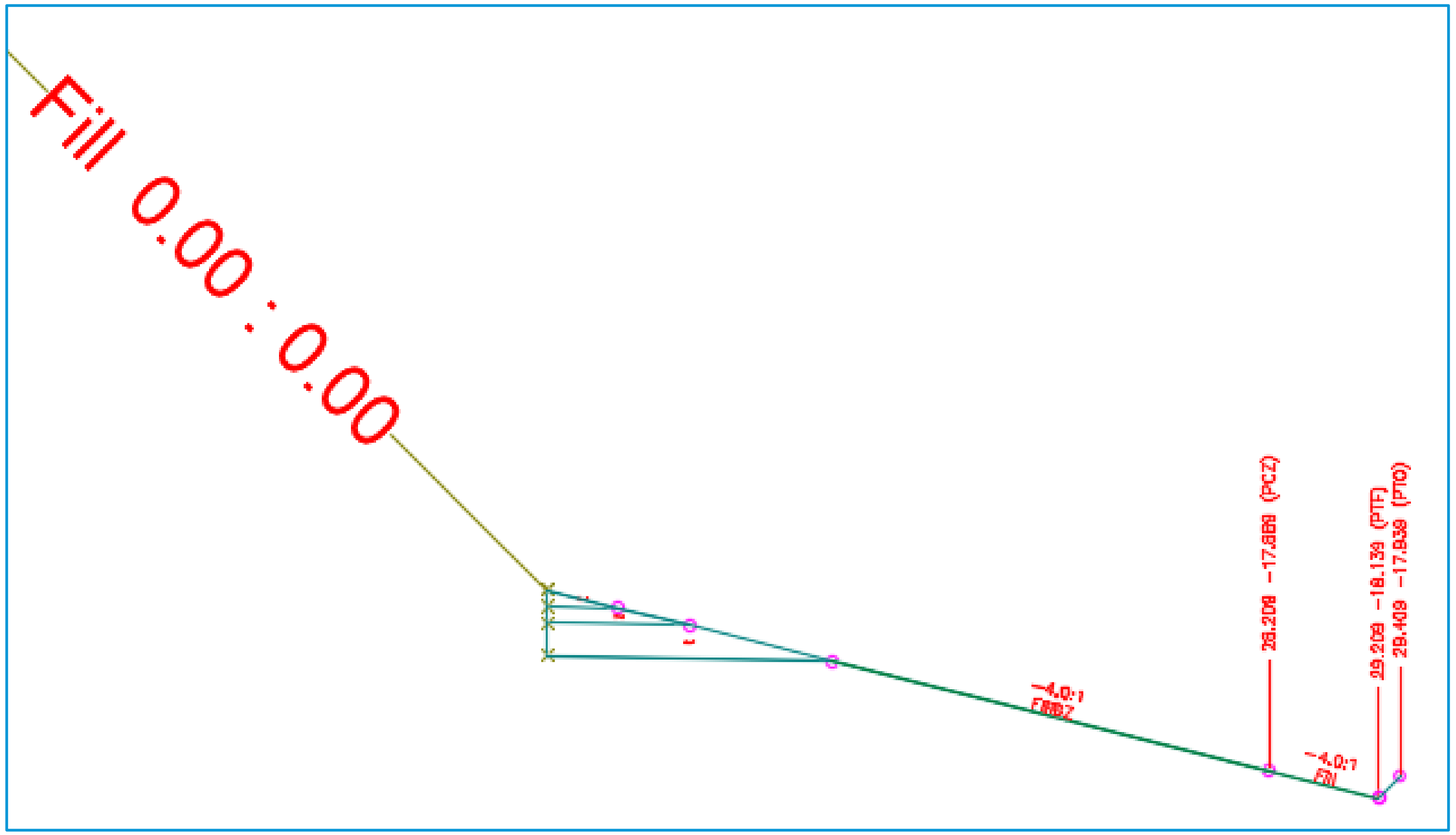
- BC Ditch (Stripping and OG Surface Targets)



Side	Right
Foreslope Gravels	4.00:1
Foreslope SGSB	4.00:1
Foreslope Ditch	4.00:1
Ditch Depth	0.300m
Ditch Type	One-Point
Ditch Width Inside	1.000m
Ditch Width Outside	1.000m
Ditch Slope Inside	20.00:1
Ditch Slope Outside	3.00:1
Backslope Mode	Backslope On
Backslope Slope	3.00:1
Close Slope	3.00:1
Gravels Crossfall	-2.00%
Depth Gran1	0.150m
Depth Gran2	0.150m
Depth Gran3	0.300m
Superelevation	No Superelevation
Slope Direction	Towards Outside
Point Code Toggles	NNYNYNYYYYYYY
Subgrade Crossfall	-3.00%
Subgrade Calc	Parallel
Subgrade Super	No Superelevation
Version	1.10

BC Fill

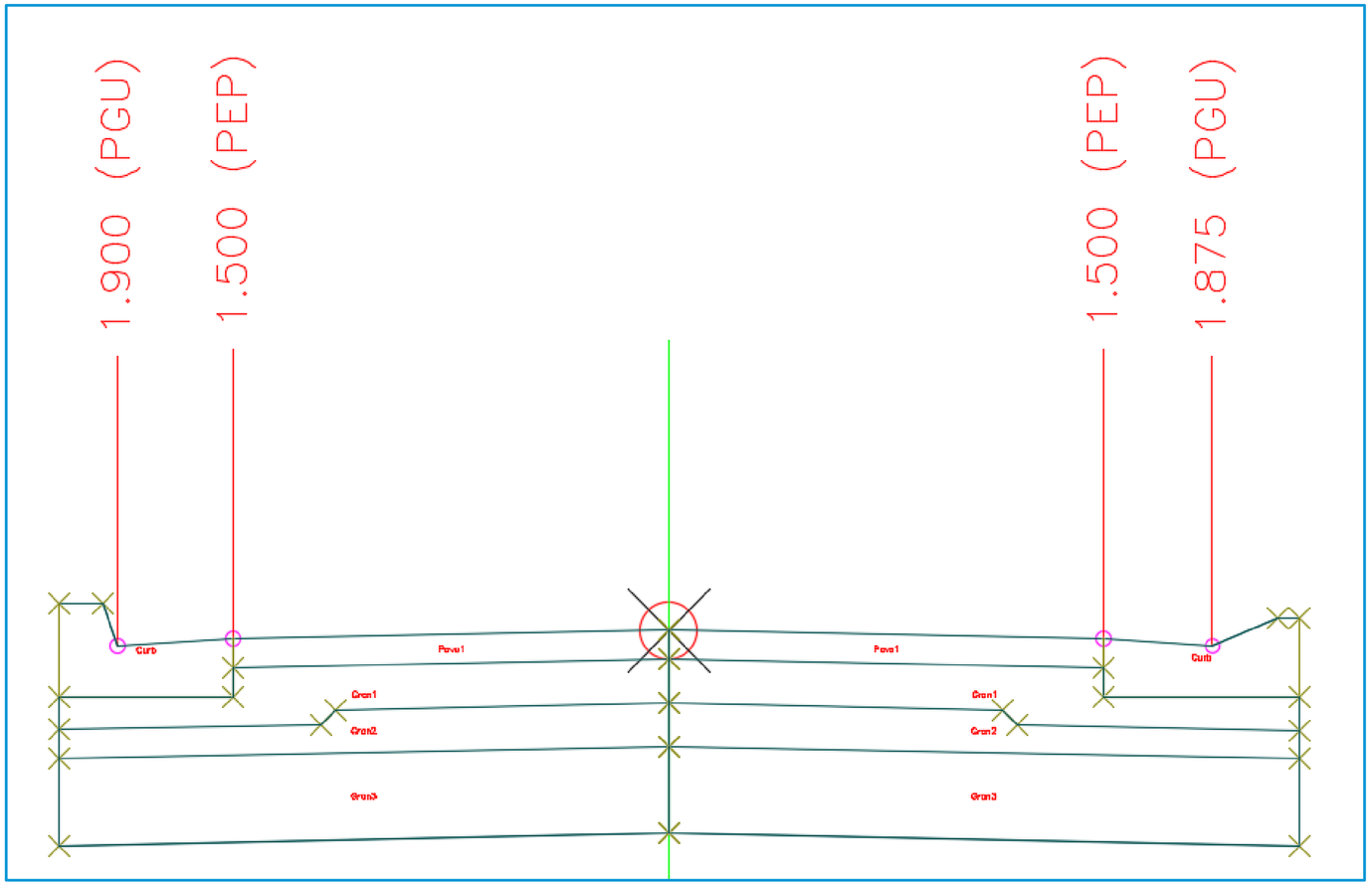
- BC Fill (Stripping and OG Surface Targets, Clear Zone)



Side	Right
Foreslope Gravels	4.00:1
Foreslope SGSB	4.00:1
Daylight Mode	Clear Zone and Daylight
Daylight Slope	4.00:1
Clear Zone Start	3.600m
Clear Zone Width	9.000m
Clear Zone Slope	4.00:1
Close Slope	1.00:1
Gravels Crossfall	-2.00%
Depth Gran1	0.150m
Depth Gran2	0.150m
Depth Gran3	0.300m
Superelevation	No Superelevation
Slope Direction	Towards Outside
Point Code Toggles	NNYNYNYYYYY
Subgrade Crossfall	-3.00%
Subgrade Calc	Parallel
Subgrade Super	No Superelevation
Version	1.10

BC Curb

- Several Curb Configurations
- Pavement Depths Passed to BC Sidewalk

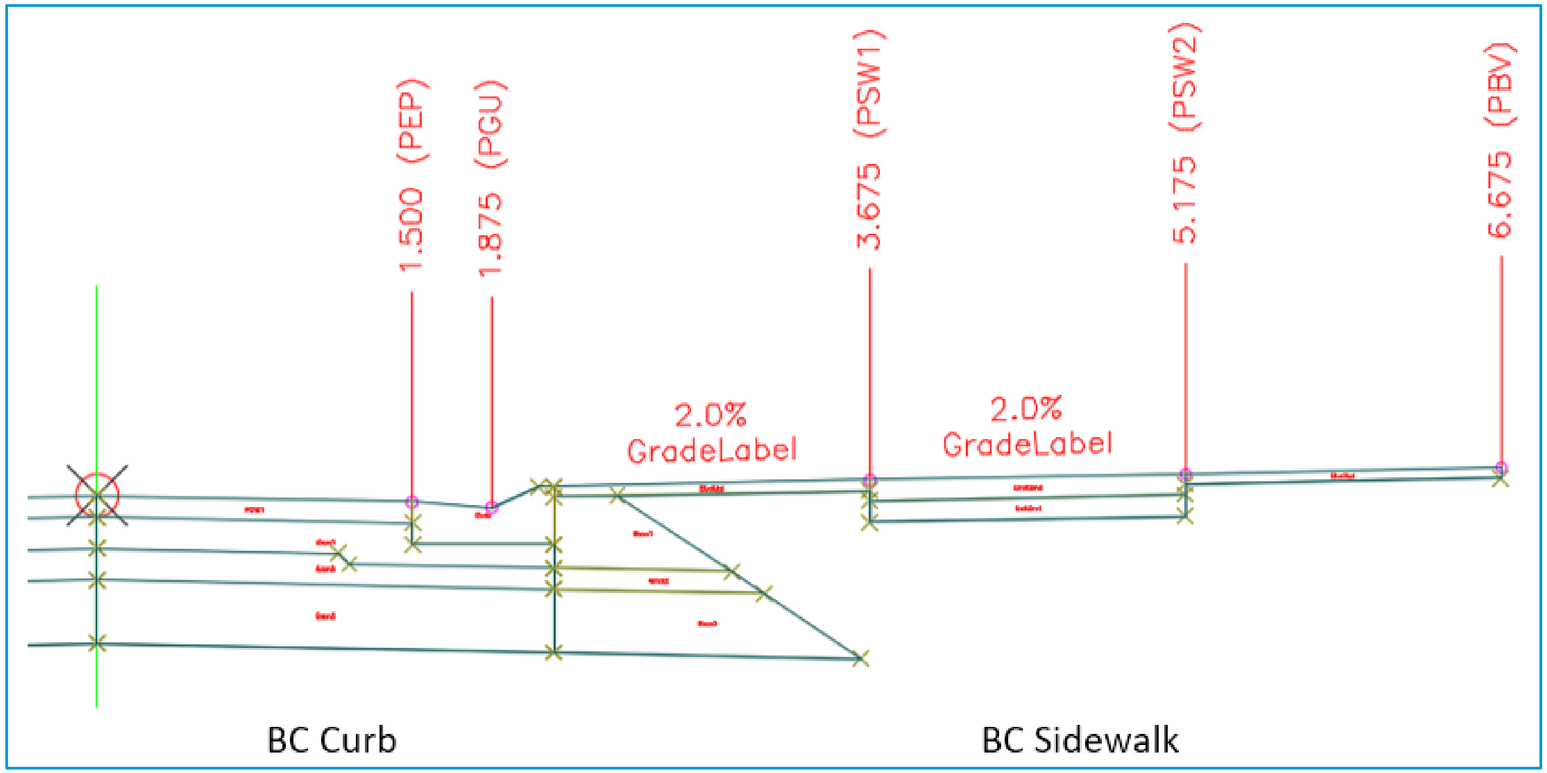


BC Mountable
BC Combined
BC Drop
BC Mountable
BC Roundabout
BC Valley
MMCD Narrow
MMCD Wide
MMCD Rollover
Custom

Side	Right
Curb Type	BC Mountable
Curb Insertion	Normal Slope
Curb Gravels	Extend Gravels
Paved Width	1.500m
Bedding Width	0.300m
Bedding Depth	0.100m
Shoulder Crossfall	-2.00%
Depth Pave1	0.100m
Depth Pave2	0.000m
Depth Gran1	0.150m
Depth Gran2	0.150m
Depth Gran3	0.300m
Superelevation	No Superelevation
Slope Direction	Towards Outside
Point Code Inside	PLE
Point Code Outside	PEP
Custom Curb	0,400,50,150,0,0,150,-2...
Point Code Toggles	NYY
Subgrade Crossfall	-3.00%
Subgrade Calc	Parallel
Subgrade Super	No Superelevation
Version	1.00
SuperAOR	Supported
Paved Width	1.500
Gravels Crossfall	-0.020
Last Depth	0.000
Subgrade Crossfall	-0.020

BC Sidewalk

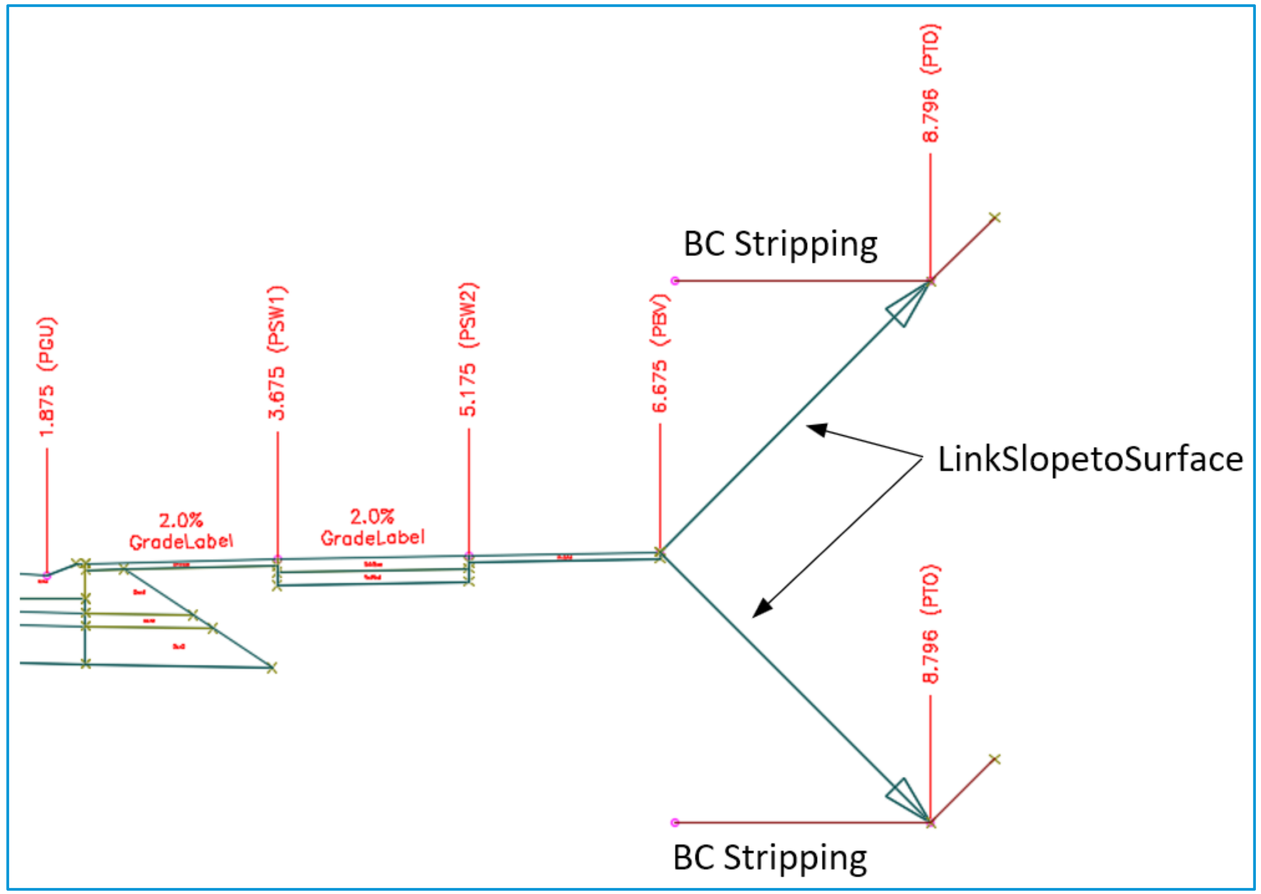
- Pavement Depths Passed from BC Curb
- Gravel Slopes Adjust for Cut and Fill



Side	Right
Configuration	Boulevard Sidewalk Bo..
Gravels	Extend Gravels
Width IB	1.500m
Width SW	1.500m
Width OB	1.500m
Width IAG	0.000m
Width OAG	0.000m
Width Gran	0.300m
Depth IB	0.050m
Depth IBG	0.000m
Depth SW	0.100m
Depth SWG	0.100m
Depth OB	0.050m
Depth OBG	0.000m
Slope IB	2.00%
Slope SW	2.00%
Slope OB	2.00%
Cut Slope	0.00:1
Fill Slope	1.50:1
Force Situation	Auto
Point Code Toggles	NYYYYYY
Version	1.00

BC Stripping

- Generates Stripping Links (for Surface)
- Multiple Targetable Offsets with Variable Depths

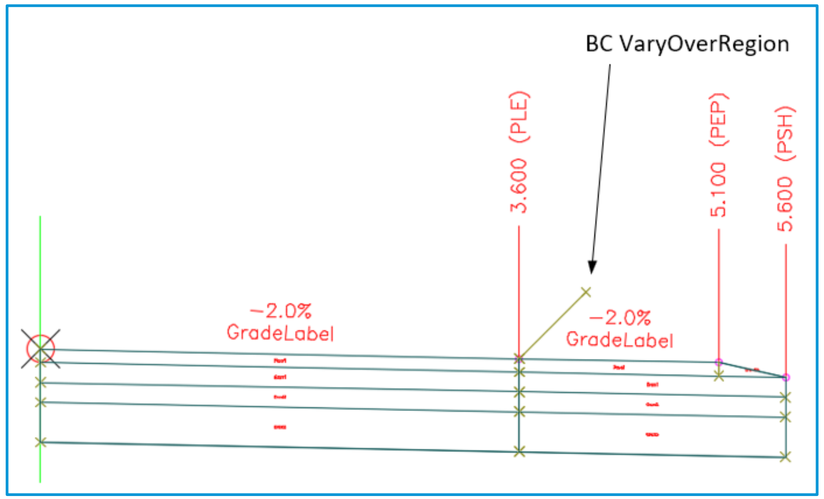


Side	Right
Configuration	Boulevard Sidewalk Bo..
Gravels	Extend Gravels
Width IB	1.500m
Width SW	1.500m
Width OB	1.500m
Width IAG	0.000m
Width OAG	0.000m
Width Gran	0.300m
Depth IB	0.050m
Depth IBG	0.000m
Depth SW	0.100m
Depth SWG	0.100m
Depth OB	0.050m
Depth OBG	0.000m
Slope IB	2.00%
Slope SW	2.00%
Slope OB	2.00%
Cut Slope	0.00:1
Fill Slope	1.50:1
Force Situation	Auto
Point Code Toggles	NYYYYYY
Version	1.00

BC VaryOverRegion

- Outputs any Parameters Over Station Range

Side	Right
Station Start	10000.000m
Station Finish	10100.000m
Value A Start	0.500
Value A Finish	1.000
Value B Start	1.000
Value B Finish	1.000
Value C Start	1.000
Value C Finish	1.000
Value D Start	1.000
Value D Finish	1.000
Value E Start	1.000
Value E Finish	1.000
Value F Start	1.000
Value F Finish	1.000
Station Table	None
Version	1.00
OutputA	0.500
OutputB	1.000
OutputC	1.000
OutputD	1.000
OutputE	1.000
OutputF	1.000



Item:

- Baseline
  - Right
    - 01 - BC LaneRight
    - 16 - BC VaryOverRegionRight
    - 02 - BC ShoulderRight

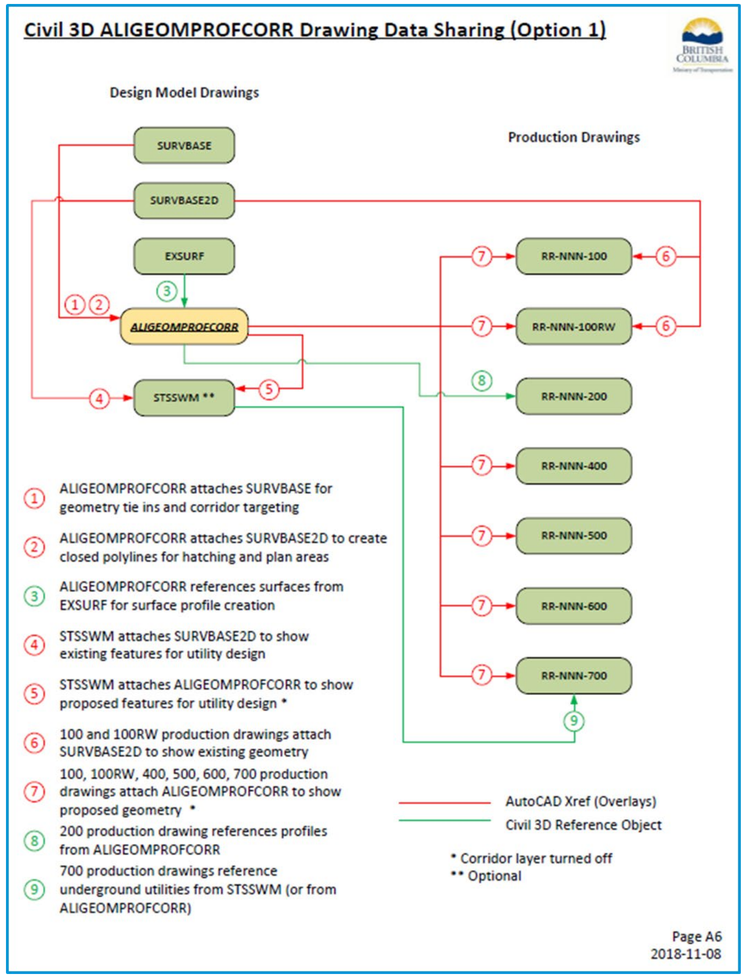
Input values:

Value Name	Default Input Value	Parameter Reference Use	Parameter Reference Get Value From
Side	Right	☐	<None>
Width Paved Shoulder	1.500m	☐	<None>
Width Gravel Shoulder	0.500m	☑	<None>
Width Asphalt Limit	0.600m	☐	
Shoulder Crossfall	-2.00%	☐	
Depth Pave1	0.100m	☐	
Depth Pave2	0.000m	☐	
Depth Gran1	0.150m	☐	
Depth Gran2	0.150m	☐	
Depth Gran3	0.300m	☐	
Superelevation	No Superelevation	☐	
Slope Direction	Towards Outside	☐	
Grade Label	Top	☐	
Point Code Inside	PLE	☐	<None>

<None>
16 - BC VaryOverRegionRight.OutputA
16 - BC VaryOverRegionRight.OutputB
16 - BC VaryOverRegionRight.OutputC
16 - BC VaryOverRegionRight.OutputD
16 - BC VaryOverRegionRight.OutputE
16 - BC VaryOverRegionRight.OutputF
01 - BC LaneRight.Lane Crossfall
01 - BC LaneRight.Lane Offset
01 - BC LaneRight.Lane Width
01 - BC LaneRight.Last Depth
01 - BC LaneRight.Subgrade Crossfall

Production Drawings = Design Model Data

- Flexibility in Styles for Production Annotation



Get profile view drawing from VJ

Mentioned conversation with Kamloops FS re: checking CAiCE archive against drawings

Object Naming Conventions

1. Existing and Proposed Surfaces
2. Horizontal and Vertical Alignments
3. Corridors
4. Point (Feature Line) and Shape Codes
5. Materials

Construction Workflow

Construction Workflow

To Measure, Calculate and Record Construction Volumes for Contractor Compensation and Dispute Resolution

1. Monthly surveys and volume calculations
2. Comparisons against neat lines (design)
3. Design corridor model copied and run against construction horizons
4. Practitioners require a broad knowledge of Civil 3D

Construction Workflow – **Technical Highlights**

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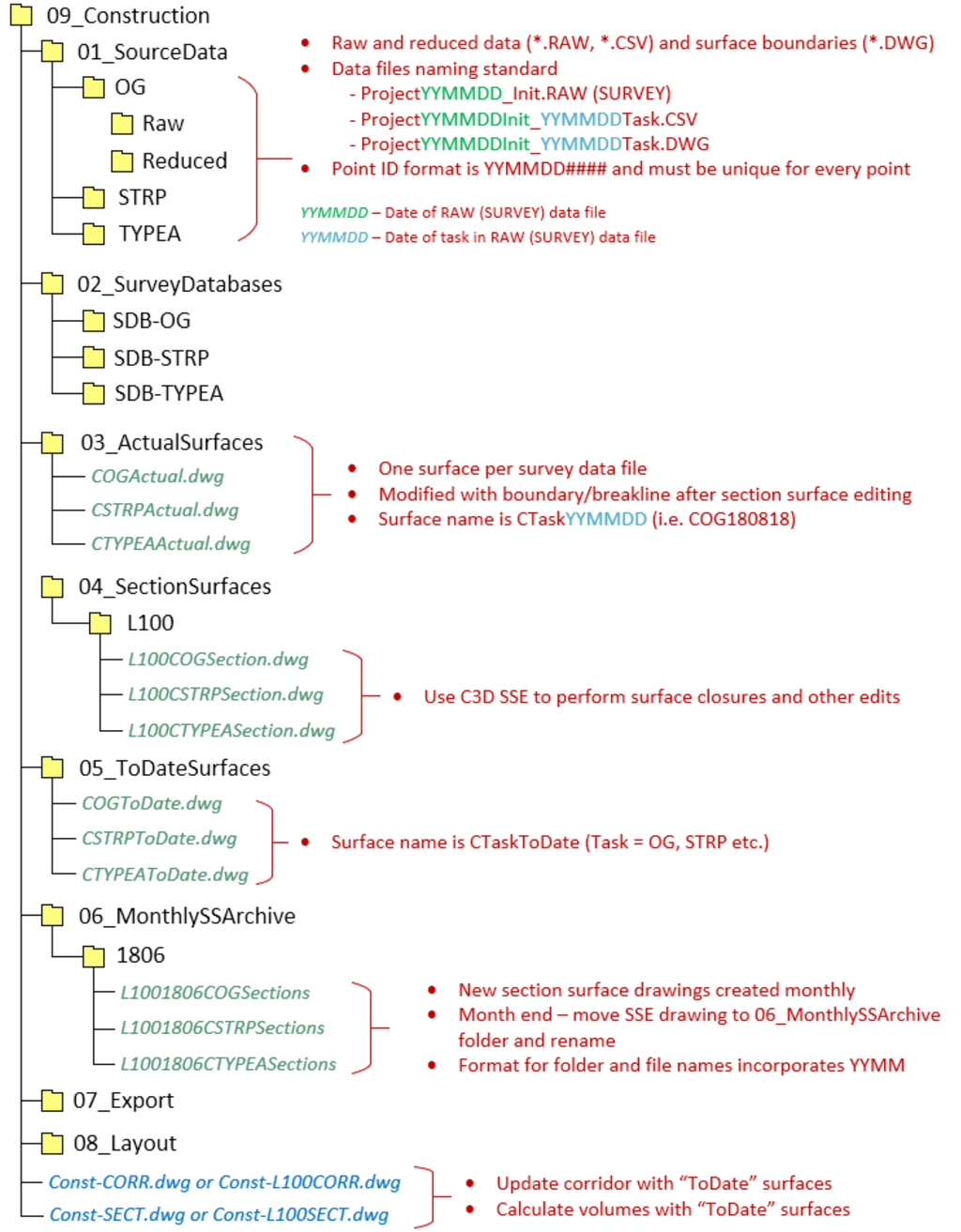
1. Data Sharing – Civil 3D Data Shortcuts and Reference Objects
2. Section Surface Editor
3. Design Corridor Updates to Reference Construction Horizons
4. Monthly Archives and Records

BC MoTI – Construction Supervision Workflow Data Structure



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Construction Workflow
Data Sharing

Construction Workflow - **Section Surface Editor**

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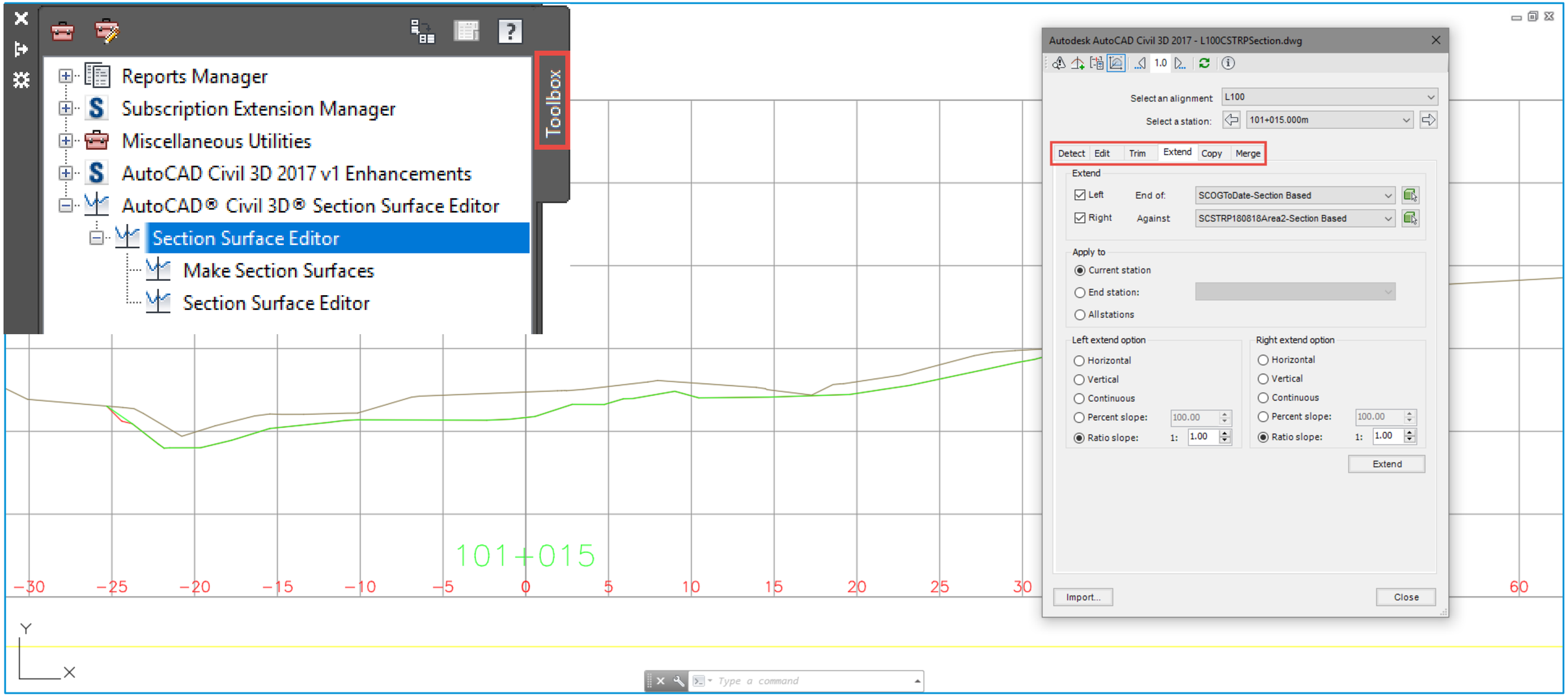

Construction Workflow – **Design Corridor Updates**

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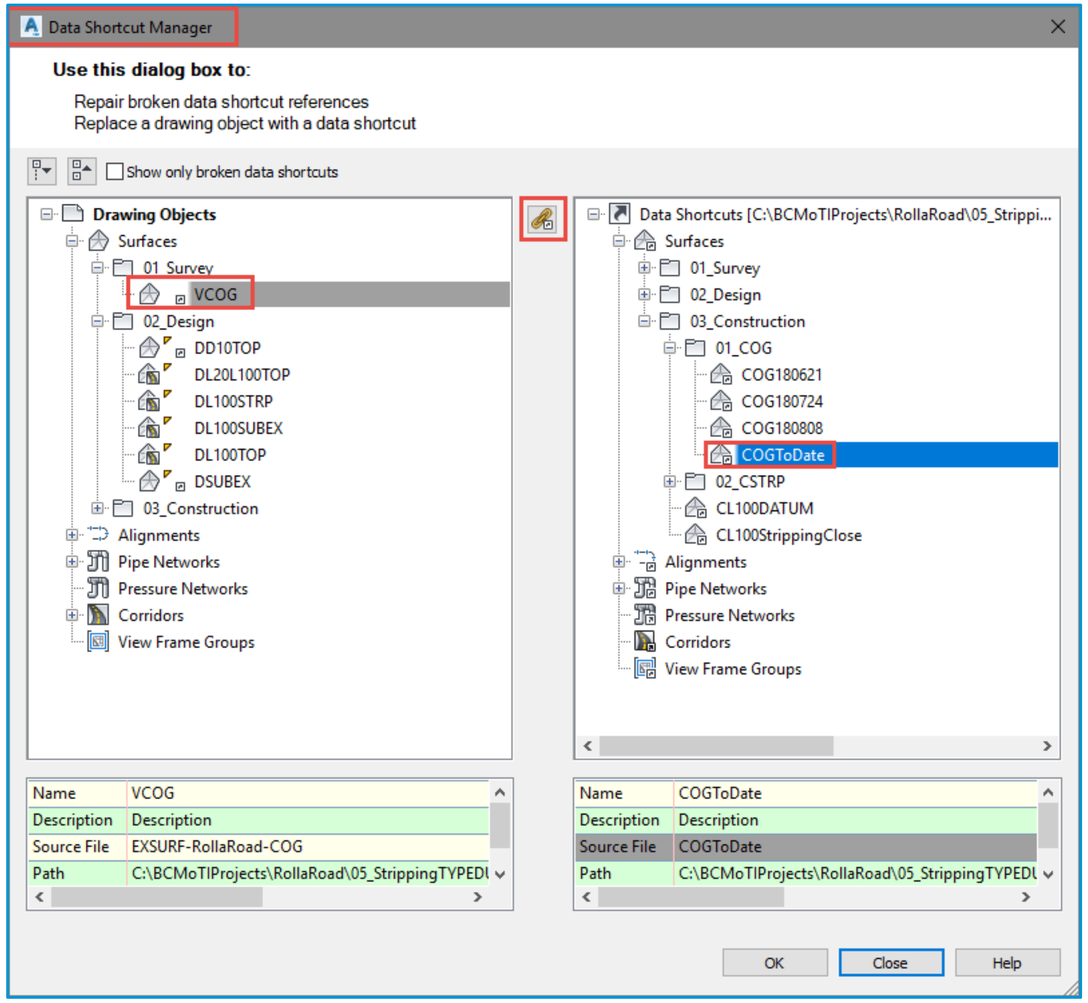

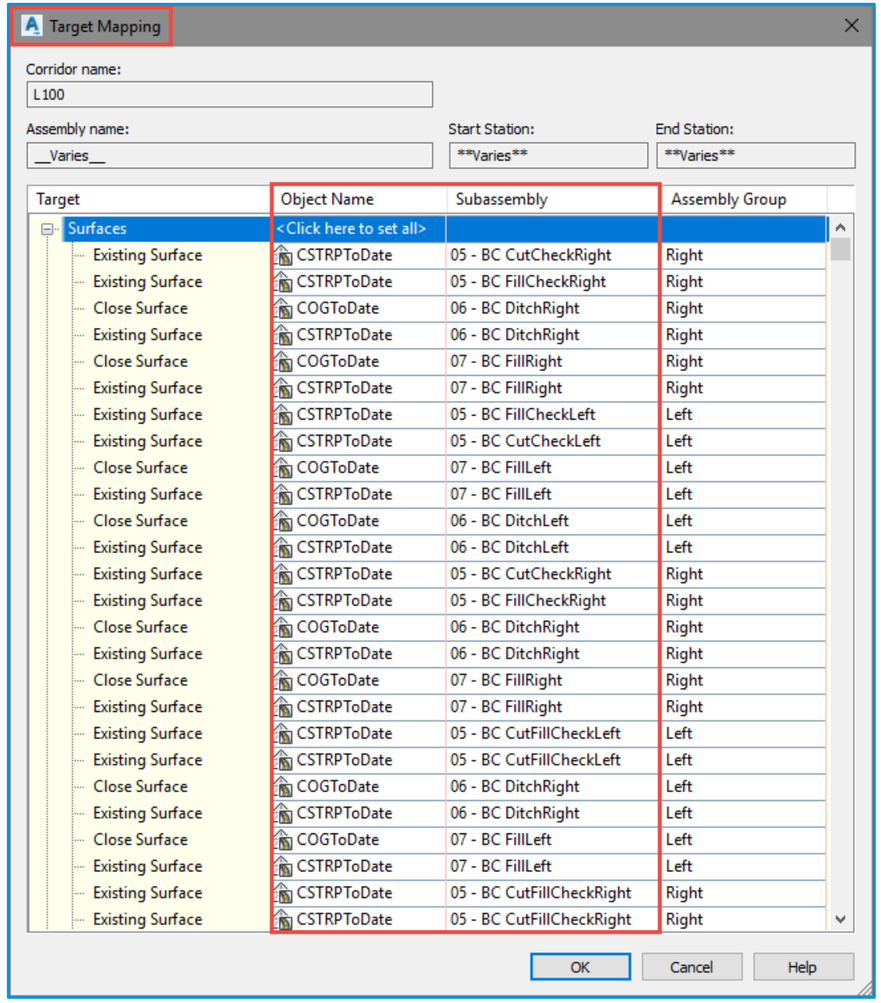

Implementation and Communication

Implementation and Communication

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1. Retrieve kApps

2. Surveyor and Designer Technical Meetings
3. Collaboration and Communication with Ministry and Consultant Staff
4. Training
5. Workflow Development

Thank you!

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