Survey Manual

Chapter 9

InRoads Survey
CDOT Best Practices

Colorado Department of Transportation
September, 2010

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Chapter 9 – InRoads Survey CDOT Best Practices

9.1 General

9.1.1 Purpose

The purpose of this chapter is to define the InRoads Survey best practices that shall be followed by CDOT surveyors or contract consultant surveyors. Whenever the term InRoads Survey or InRoads is used in this chapter it refers to the entire InRoads Suite software application.

Any variation from the best practices shall have the prior approval of the Region Survey Coordinator.

This chapter is not intended as a training manual or textbook on InRoads Survey. Rather it provides a reference source for CDOT best practices for InRoads Survey. The InRoads Survey vendor of your choice should be contacted for obtaining any training manuals or textbooks.

9.1.2 Software Selection

In February 2005, as the result of an assessment of all its project development software, CDOT selected MicroStation and InRoads as its standard surveying and engineering software applications.

With CDOT's surveying and engineering functions decentralized it became important to have a standard single surveying and engineering software package to integrate surveying and engineering functions under one software package, to remove the variability involved with operating different software applications, to address workflow issues and to standardize all six of its regions.

9.1.3 Software Replacement

MicroStation and InRoads replaces the following internal and external CDOT software applications:

- AutoCAD
- CDOT COGO
- CDOT PICS
- MX Roads
- Eagle Point
- Various other software

9.1.4 Software Acquisition

MicroStation is a CADD platform that provides the graphic engine for InRoads. InRoads is a commonly used generic term for the InRoads Suite of software offered by Bentley Systems, Inc.

www.Bentley.com

Contract consultants working on a CDOT project should contact the MicroStation and InRoads vendor of their choice for software acquisition.

9.1.5 Software Training and Support

Contract consultants working on a CDOT project should contact the MicroStation and InRoads vendor of their choice for software training and support.

9.2 CDOT MicroStation / InRoads Configuration

9.2.1 Setting InRoads Project Defaults

The most current version of CDOT's MicroStation / InRoads configuration shall be downloaded and used for setting InRoads project defaults from the following:

http://www.coloradodot.info/business/designsupport/cadd

9.2.2 Setting InRoads Default Directories

CDOT has developed a standard Right-of-Way directory (folder) structure for use with ProjectWise and shall be followed for all projects and deliverables that should be used.

9.2.3 Setting MicroStation Level Display

To aid the user with isolating MicroStation levels the level display should be set to the appropriate group.

9.3 InRoads Terrain Modeling Survey System (TMOSS)

9.3.1 General

InRoads TMOSS is a CDOT developed numeric / alpha coding system designed to automate and standardize surveying and aerial mapping. TMOSS coding data is a standard four digit feature code compatible for processing with InRoads software.

TMOSS codes shall be used when any control, topographic, drainage, utility, or aerial survey data is collected for CDOT use (See Chapter 4 – Photogrammetry Surveys and Chapter 5 – Preliminary Surveys for additional information).

9.3.2 TMOSS Code Book

InRoads TMOSS Code books are available through the CDOT region survey office where your project is located.

9.3.3 TMOSS Training

CDOT does not offer InRoads TMOSS code training. Please contact a qualified InRoads vendor of your choice to obtain training.

9.3.4 Survey Data File Format

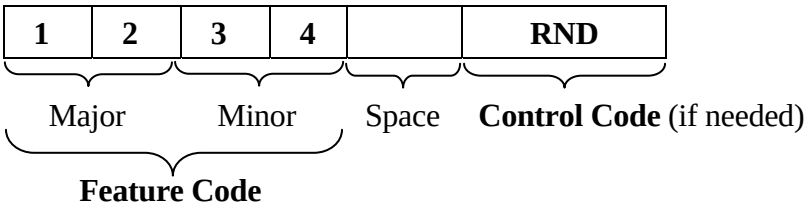
InRoads will except data formats from a wide variety of data collectors and software. Except for data collected by aerial methods, the standard CDOT survey data format for TMOSS codes is the SDR33 file format.

9.3.5 TMOSS Code Structure

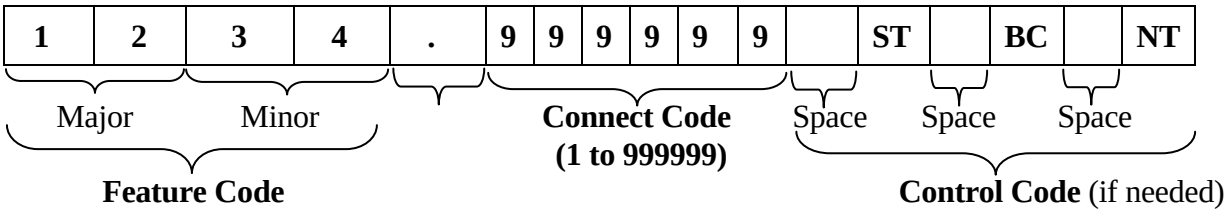
The TMOSS code structure is comprised of several code sub-sets as follows:

- Feature Code
    - Major
    - Minor
- Connect Code
- Control Code

Single Points



Connected Points



9.3.6 Feature Codes

Feature codes are mapped to features. The code is numeric and consist of four digits divided into two parts, the major and the minor. The first two digits define the major classification (*e.g.* culverts, geology, roadway). If the major code is less than 10, then the major code is only one digit (*e.g.* feature code 575).

The second two digits define the minor classification (*i.e.* single point or connected point). Single points, such as a stop sign, are points that represent a single point in the survey. Connected points, such as an edge of oil, are points that are geometrically connected by lines and curves. If the minor code is from 1 to 49 the feature is a connected point, if it is from 50 to 99 the feature is a single point.

9.3.7 Connect Codes

Connect codes are not needed unless the user plans on carrying multiple features at a time. If the user does carry multiple features at the same time the connect codes allows InRoads to track and separate the features from each other.

Connect codes are mapped to groups of points that will be geometrically connected by lines and arcs. The code is numeric. The feature code and connect code are separated by inputting a "." in the fifth digit. Each digit of the connect code is a significant figure and range from 1 to 999,999.

Examples of connect codes:

1320.1
1320.10
1320.100
1320.1000
1320.10000
1320.100000

9.3.8 Control Codes

Control codes are mapped to actions. Control codes are alphabetic and define the geometry of lines and arcs for connected points. It also determines how single and connected points, lines and arcs are used within the Digital Terrain Model (DTM). They can be either upper or lower case characters.

InRoads has defaults for fifteen control codes. CDOT has modified the names of four of these codes and has authorized the following control codes for use on CDOT projects as follows:

CDOT Authorized Control Codes:

Description	InRoads Control Code	CDOT Control Code	CDOT Authorized
Start	**ST**	**ST**	Yes
Close	**CL**	**CL**	Yes
Point of Curve	PC	**BC**	Yes
Point of Tangency	PT	**EC**	Yes
Do Not Contour	DNC	**X**	Yes
Random	**RND**	**RND**	Yes
Rectangle	RECT	**RECT**	Yes
Close Rectangle	CLSRECT	**CLR**	Yes
Nontangent Curve	**NT**	**NT**	Yes
Join Point	**JPT**	**JPT**	Yes
Join Nearest Code	**JNC**	**JNC**	Yes
Distance	**DIST**	**DIST**	Yes
Template	**TMPL**	**TMPL**	Yes
Cross Section	**XS**	**XS**	Yes
Add to Adjustment Set	ADJ		**No**

9.3.9 Attributes

Attributes are mapped to points and describe more detail associated with the point than what is given in the feature or the control code. Attributes are defined as part of the feature, there is no limit to the number of attributes that can be assigned to a feature.

The following CDOT attributes are associated with feature codes:

- Single shot symbol rotations
- Miscellaneous and other feature code note
- Access report
- Drainage report

9.3.10 Feature Code Library

A data collector feature code library containing CDOT's standard feature code definitions and their associated attributes shall be used for inputting of attribute data. Depending on the limits of the data collector, the feature code library can be uploaded into the data collector and whenever a feature code is input the data collector will automatically prompt the users for input of attribute data.

The following feature code libraries are available from CDOT for Trimble data collectors, both of these

files are support and maintained by CDOT and contain all of the standard attributes:

- All CDOT Code.FCL (Feature Code Library created in Trimble Geomatics Office)
- All CDOT Codes.DDF (Data Dictionary File exported from TGO for a Trimble DC)
- CDOT ATT Only.FCL
- CDOT ATT Only.DDF

The following feature code library is available from CDOT for Sokkia SDR data collectors, however it is not being support or maintained by CDOT and may not include all of the standard attributes :

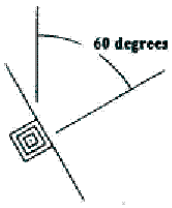
CDOT Feature Code Libraries
http://www.coloradodot.info/business/manuals/survey
The above link provides information and downloading of CDOT feature code libraries.

9.3.11 Single Point Rotation

Single point rotation is a data collector prompted attribute. It is associated with single points that require a rotation input as an azimuth measured clockwise from North with values ranging from 0 to 360.

The following is an example of a single point rotation attribute for a feature code of 5177 and a rotation of 60 degrees measured clockwise from North:

09F1 2501 1017 5.26500000 86.1413888 270.6419445177
13AT ROT 60



9.3.12 Miscellaneous / Other Codes

Miscellaneous and other are data collector prompted attributes. They are associated with feature codes defined as “misc” or “other” that require additional information. Misc feature codes typically have a minor code of 49 or 99.

The following is an example of a misc attribute for a feature code of 5199 having a rotation of 230 and an attribute prompted note containing information about the feature:

08KI 100 10000.00 10000.00 5280.005199
13AT ROT 60
13AT NOT Type I post with illegible 18” x 24” sign

9.3.13 Access Data Code 277

Access 277 data is a data collected prompted attribute. It is associated with the feature code 277. The access data code shall be input as a multiple code in the data collector’s description field immediately after the code for the access feature. Each access feature should have only one access data code 277 collected.

Attribute	Description
USE	Apparent land use 1 = Field; undeveloped, agricultural; 2 = Single family residential; 3 = Multi family, Multi dwelling, apts., condos; 4 = Business; retail, small business, restaurants, gas stations, shopping, centers; 5 = Industrial; trucking, Agribusiness; 6 = Street; subdivision, Co. road, public or private.
VOL	Traffic volume of access 1 = Less than one per day, little or no use. 2 = Less than 50 per day, (single family). 3 = More than 50 per day, less than 12 per hour. 4 = More than I every 5 minutes. 5 = Constant activity, use almost always visible. 6 = Frequent truck or large equipment traffic, > I per hour.
SIZE	Apparent size of property access serves, + 10% 1 = Less than 10,000 sq. ft. 2 = 10,000 sq. ft. to 1 acre. 3 = Ito 5 acres. 4 = 5 to 35 acres. 5 = Greater than, 35 acres. 6 = Undeterminable
ACC	Alternative access 1 = No apparent alternative open or available, landlocked without direct highway access. 2 = Adjacent side street, no current apparent connection, no significant physical limitations visible to achieve side street access. 3 = Adjacent side street, access not constructed, it would be significantly difficult to access side street. 4 = Access to secondary street available and in use.

Example of a data collector prompted access data code 277 as a multiple coded observation:

```
09F1      2501      1133    134.825000    90.0152222    451.2741661312.01 ST 277
13ATUSE         4
13ATVOL         2
13ATSIZE        5
13ATACC         1
```

9.3.14 Drainage Data Code 283

Drainage 283 data is a data collected prompted attribute. It is associated with the feature code 283. The drainage data code shall be input as a multiple code in the data collector's description field immediately after the code for the drainage feature. The code shall be collected at both the outlet invert and the inlet invert of the drainage feature.

Attribute	Description
CND	Condition 1 = poor 2 = fair 3 = good
DPTH	Outlet Depth of Silt 1 = none 2 = less than 0.5’ 3 = 0.5 to 1’ 4 = 1’ to 2’ 5 = greater than 2’
ERO	Erosion at Outlet 1 = none 2 = minor 3 = major 4 = severe with undermining
FLOW	Type of Flow 1 = continuous 2 = intermittent 3 = Irrigation without runoff 4 = irrigation with runoff 5 = continuous and stockpass 6 = intermittent and stockpass 7 = stockpass only 8 = other

Example of a data collector prompted drainage data code 283 as a multiple coded point:

```
09F1        2501        1133    259.825000    90.0222222    327.2741662042.01 ST 283
13ATCND          3
13ATDPTH         4
13ATERO          2
13ATFLOW         7
```

9.3.15 Multiple Coded Points

Some field observation can have more than one feature code. Depending on the limits of the data collector and the codes being input, multiple codes can be entered in the data collector’s description field itself. Multiple codes can also be entered as note if the code in the description field is followed by a dash, however editing of data files with multiple codes input as notes is difficult and any feature code library attributes will not be automatically prompted by the data collector for input; therefore multiple codes shall not be input as a note.

InRoads description field is limited to 64 characters; therefore multiple codes shall not exceed 64 characters in length.

Each user should verify the characters limits of their data collector in order not to exceed the data collector’s limits!

In order for the data collector to automatically prompt for feature code attributes and for the attribute to be associated with the correct code, any feature code with prompted attributes shall be input as the last multiple code in the description field.

Input of multiple codes should be tested on each individual data collector before being used to ensure that attributes are prompted, and that codes and attributes are imported into InRoads from the data collector correctly.

Example of a multiple coded point for edge of asphalt, a RCP and a drainage report:
09F1 2501 1133 259.825000 90.0222222 327.2741661310.1 2032.1 ST 283

Example of a multiple coded point for a RCP with an end section:
09F1 2501 1133 259.825000 90.0222222 327.2741662032.1 ST 2056

9.3.16 TMOSS Notes & Sketches

The following information shall be included with the TMOSS code along with descriptive notes and field sketches as necessary to provide additional information not contained in the code:

1. Primary control monuments shall include a detailed description of the physical monument material and cap markings.

2. Secondary control monuments (including boundary monuments) shall include a detailed description of the physical monument material and cap markings.

3. Access Data - Code 277 for county roads, streets, or subdivisions, public or private, driveways, and field approaches, residential, agricultural, or commercial (this must be for an observation taken on the access).

4. Drainage Data – Code 283 for drainage structure (this must be for an observation taken on the drainage structure at the inverts).

5. Advertising Signs - show dimensions, whether lighted or non-lighted, owner, and state highway registration number. Tie down to show skew, placement, etc.

6. Bridges and CBC's - the minimum information that should be collected on all major structures is the feature carried, feature crossed, structure number and structure type. Then collect sufficient information to establish the curb to curb width, curb or sidewalk widths, number of spans, span lengths, wing wall lengths, and angles, skew of abutments and piers, and the utilities present.

7. Special cases will arise in the form of structures to be widened or rehabilitated and in these instances staff bridge or the structure consultant will submit any special requirements at the presurvey conference. Check to see if there is a set of as constructed plans available, these could be of great value in showing what parts are being tied and/or measured.

8. Buildings, Foundations or Basements - show dimensions, and type of construction. Collect shots at all possible corners to show skew.

9. Irrigation Structures - include a detailed drawing of the structure with dimensions and elevations. Show name of ditch and owner of ditch (this may require additional research).

10. Miscellaneous Codes - all shots coded as being a miscellaneous feature will have a description of the feature included in the note field associated with that code.

11. Overhead Power and Telephone Lines - show pole and direction of lines as well as overhead wire elevations when appropriate (observations should be taken at the edge of traveled surface or painted lane lines). Show name of owner and capacity of lines.

12. Sanitary and Storm Sewer Lines - show size, type, and manhole locations. Include invert, and rim elevations and indicate direction of flow. Observations should be connected to each manhole and inlet on the line.

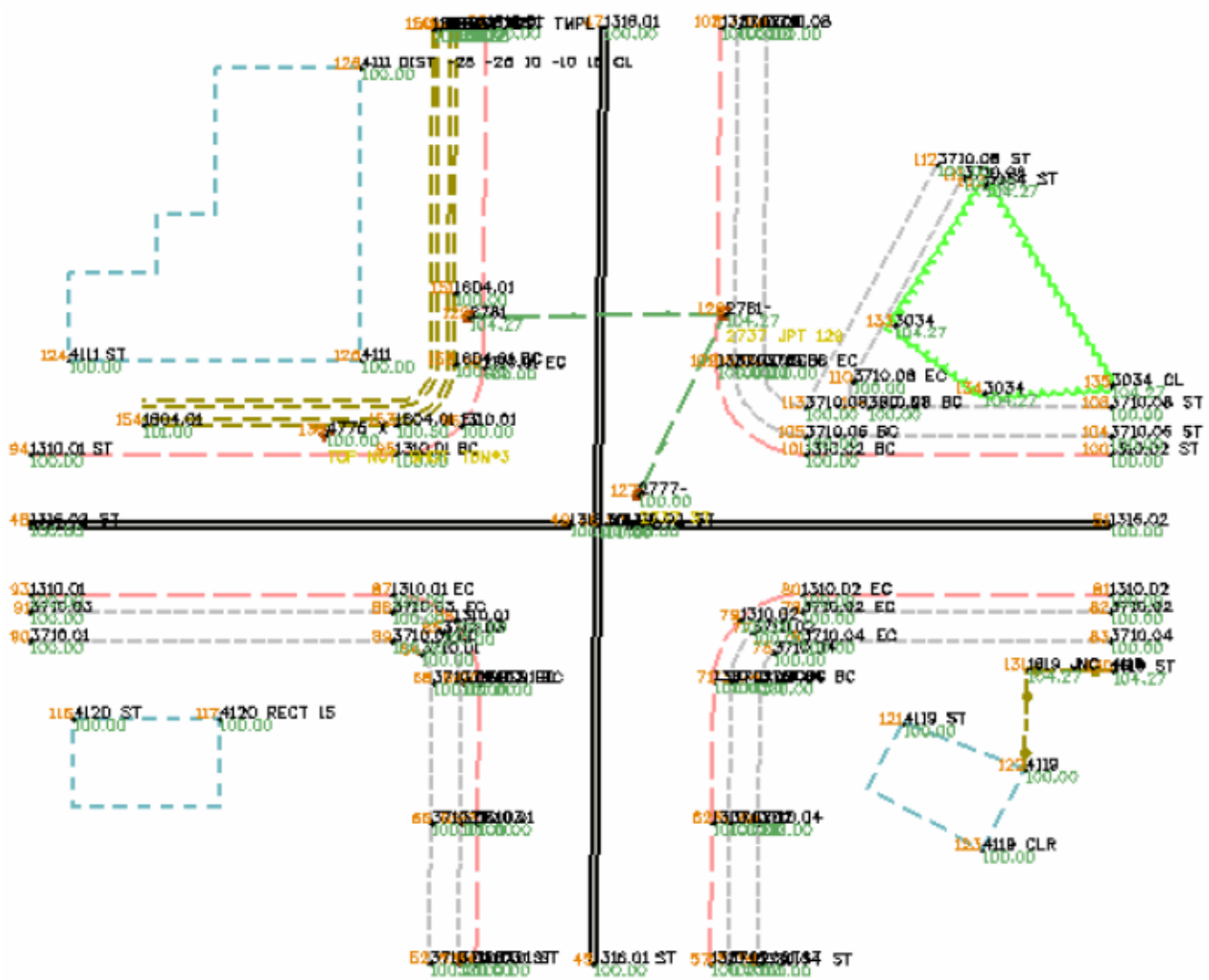
13. Underground Power and Telephone Lines - show locations and direction of lines. Show name of owner.

14. Water and Gas Lines - show size, type of pipe and location of valves. Show name of owner.

15. Wells - show size of well and type of pump.

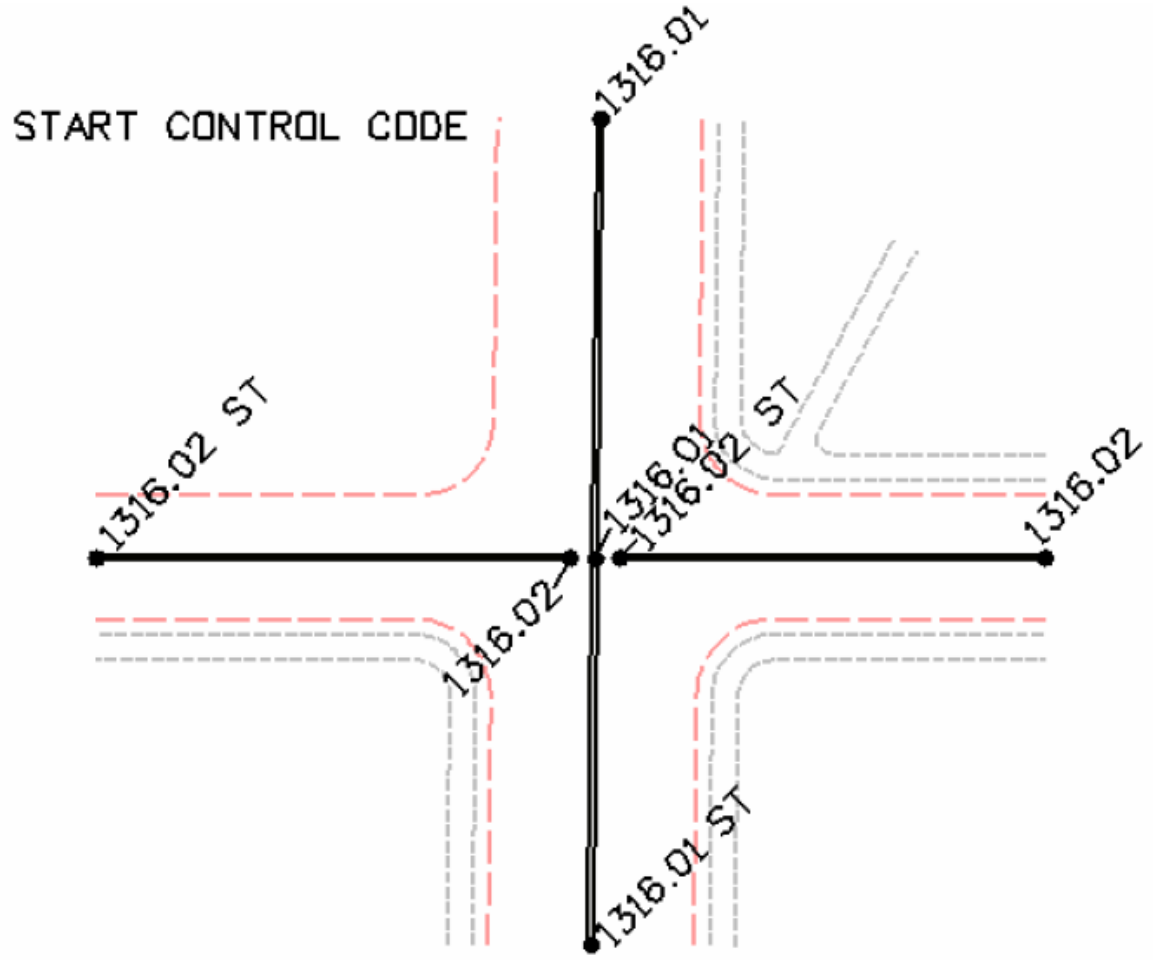
9.4 InRoads TMOSS Code Explanations and Examples

9.4.1 Intersection Example



9.4.2 Control Code ST

The control code Start (ST) begins planimetric lines. There is no code for end, to end a line you need to restart the figure which will discontinue the previous line.

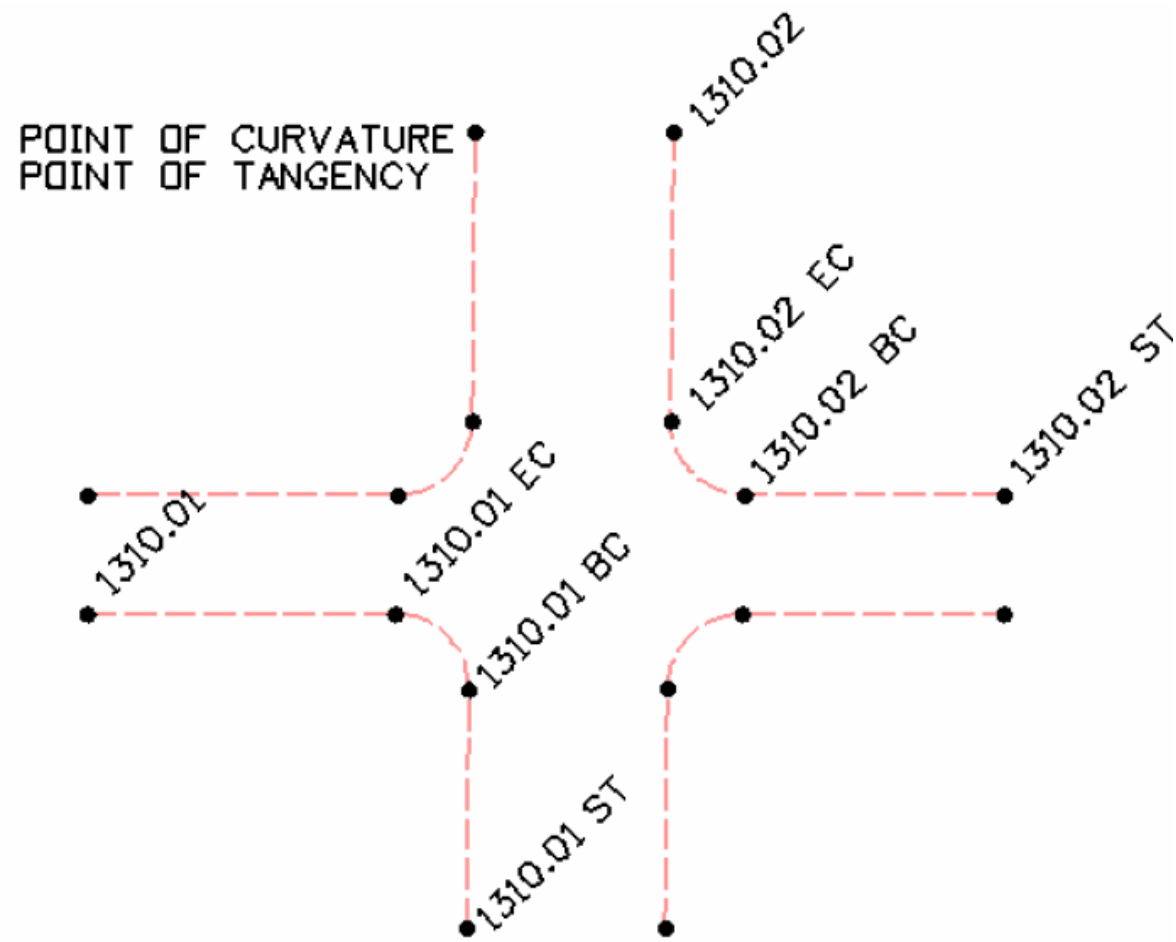


9.4.3 Control Code “BC” & “EC”

The control code Beginning of Curvature (BC) identifies the beginning of the curve while Ending of Curve (EC) identifies the ending of the curve.

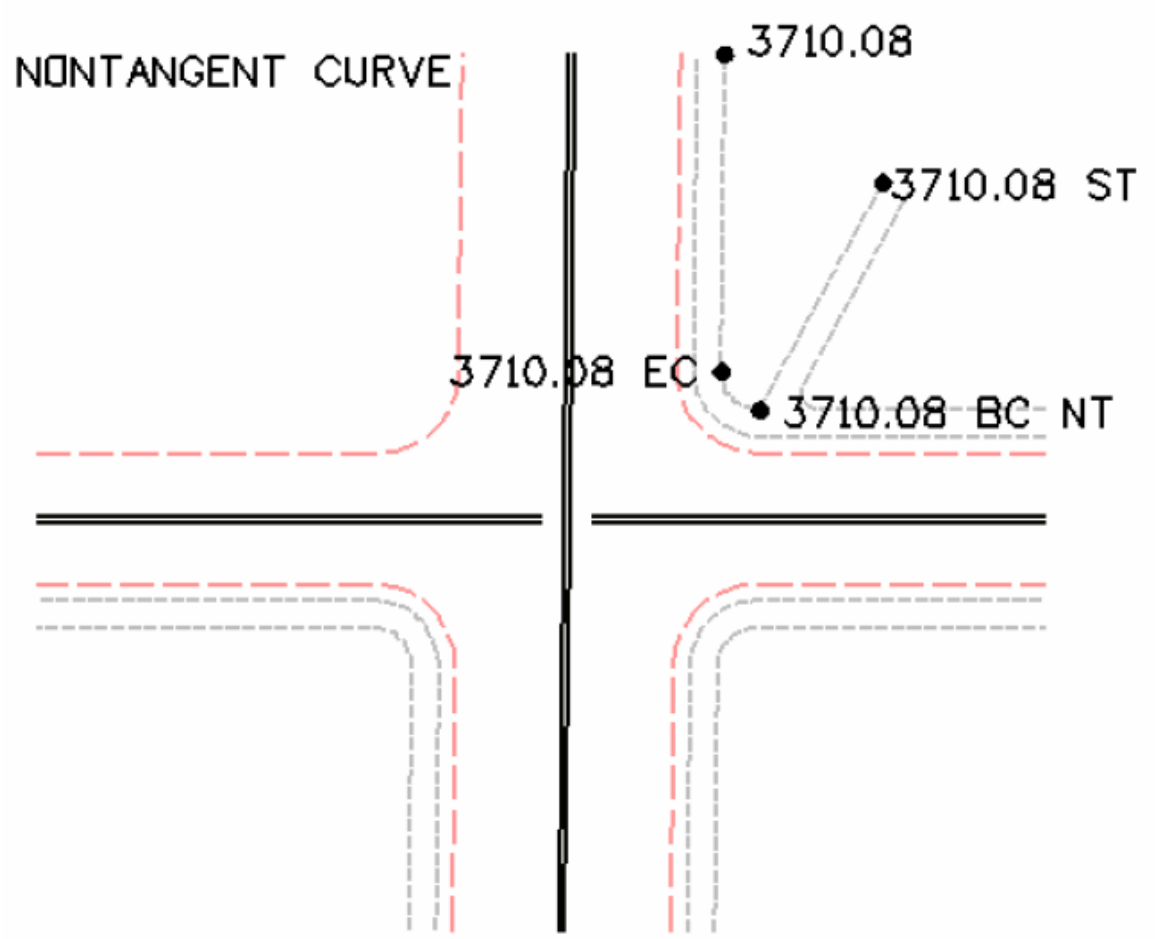
If a single point on arc is taken then the tangent lines are ignored and the curve is generated by the three points PC, POC, and PT.

If more than one point is taken on the arc then the tangent lines are used when calculating the PC and PT of the curve. CDOT has standardized on using the control code NT non-tangent to follow all BC and EC shots. Coding with NT will not add calculated PC’s and PT’s to the linear features. The PC’s and PT’s will be observed points as in the field.



9.4.4 Control Code “NT”

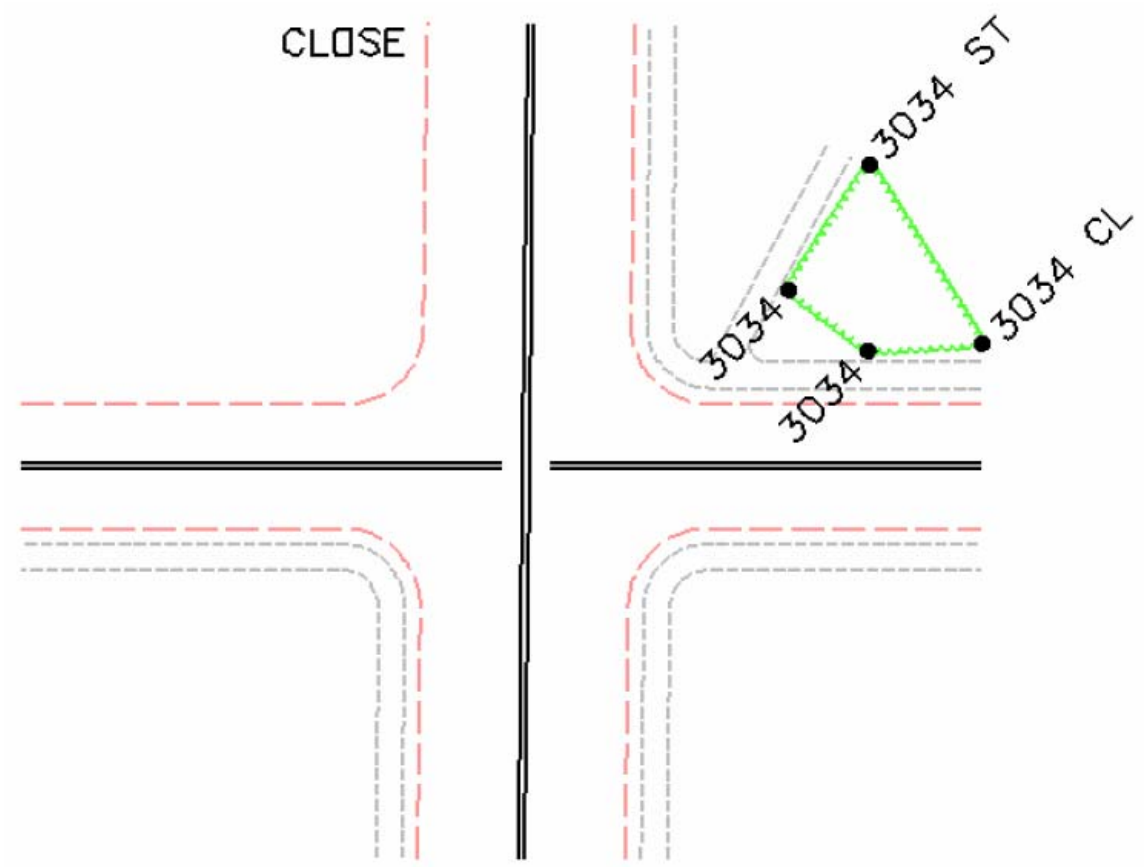
The control code Nontangent Curve (NT) identifies a curve that will be nontangent to either the incoming or outgoing tangent lines. This control code works in conjunction with BC or EC.



9.4.5 Control Code CL

The control code Close (CL) will create a closed shape from the last shot to the first shot of the feature.

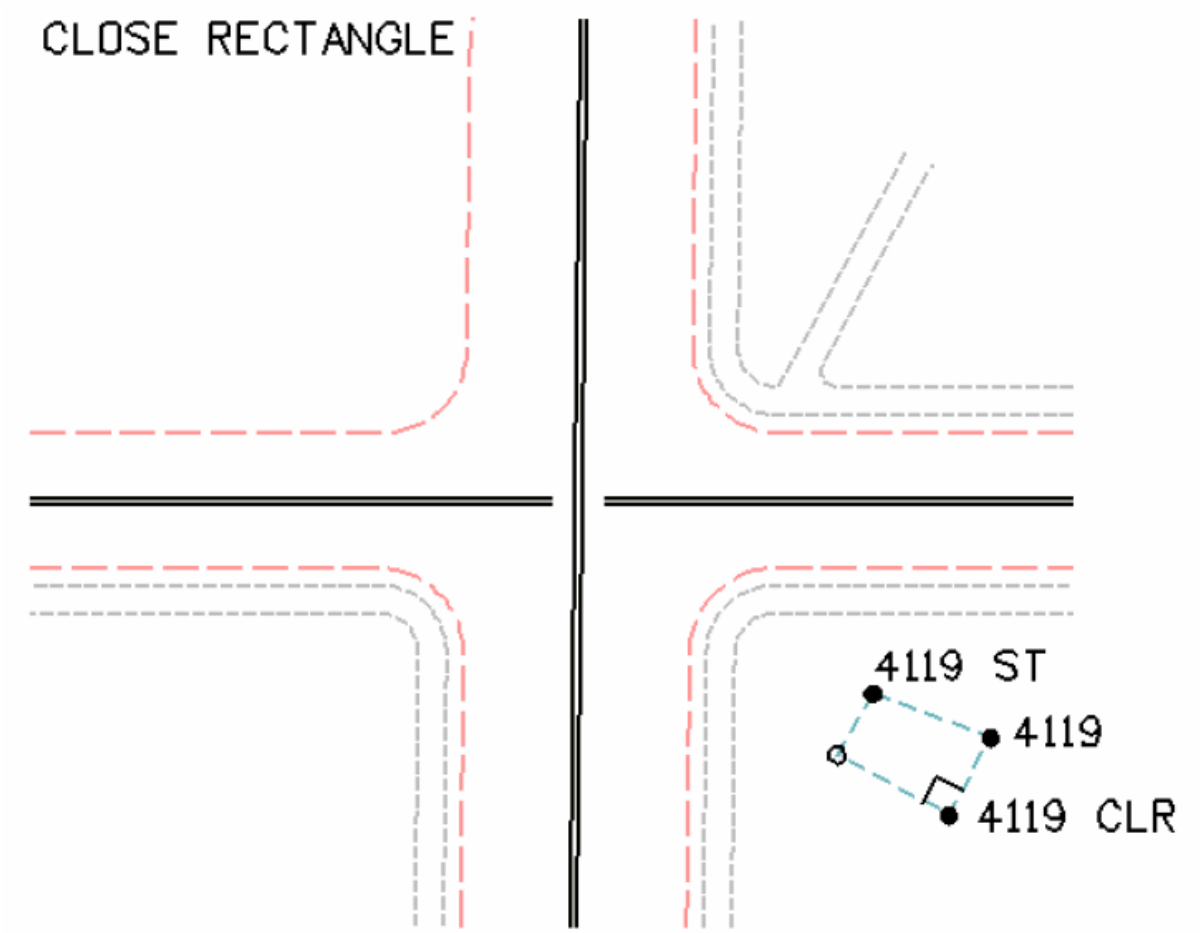
Only a survey feature with a point type Breakline will honor the Close control code when it is pushed to a surface.



9.4.6 Control Code CLR

The control code Close Rectangle (CLR) will draw a trapezoid based on three points shot in the field. The last two points become the baseline and the fourth point generated will be 90 degrees to the baseline.

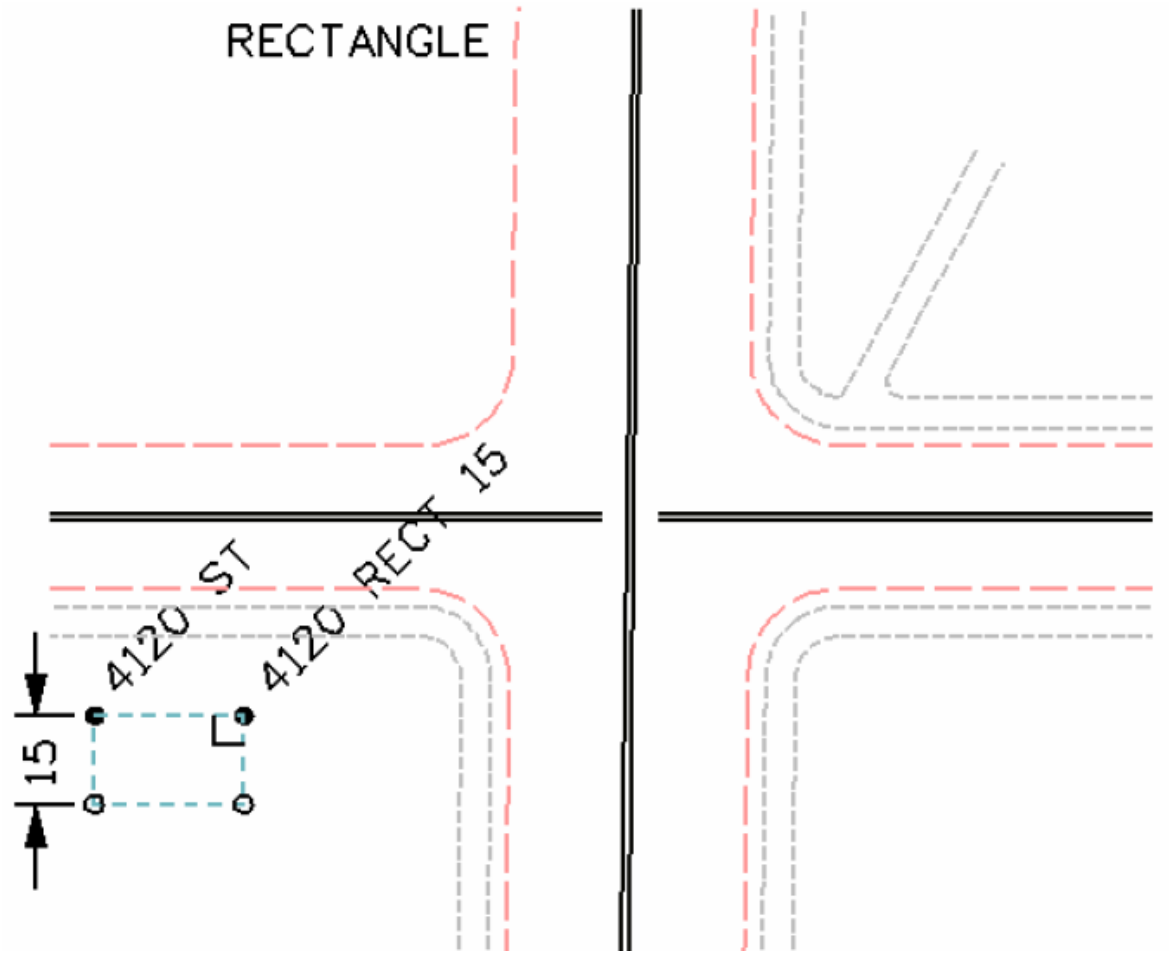
Only a survey feature with a point type Breakline will honor the Close Rectangle control code when it is pushed to a surface.



9.4.7 Control Code RECT

The control code Rectangle (RECT) will draw a rectangle based on two points shot in the field and a measured distance. The two points collected in the filed define the direction of the baseline and the measured distance defines the width. The previous two points collected in the filed define the direction of the baseline. To turn left of the baseline use a negative number (-15) to turn right of the baseline use a positive number (15). Each added point using the Rectangle command will be considered a derived point in Survey.

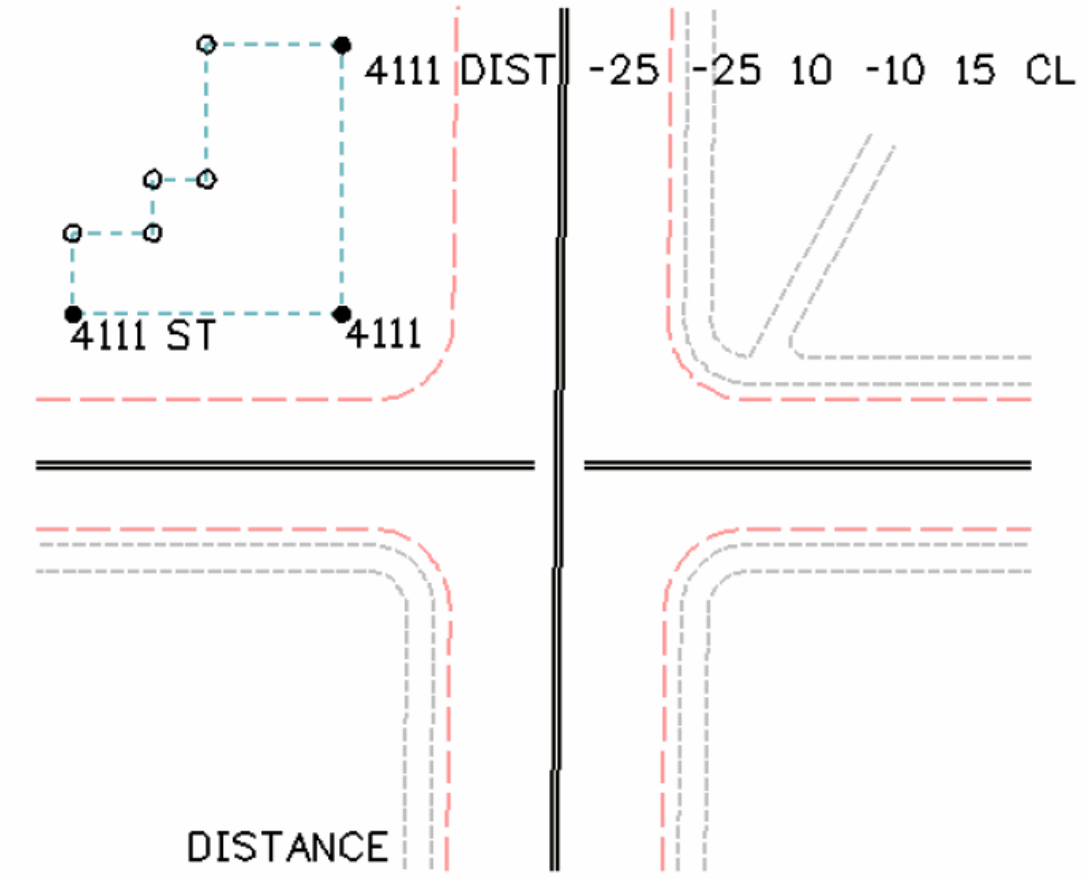
Only a survey feature with a point type Breakline will honor the Rectangle control code when it is pushed to a surface.



9.4.8 Control Code DIST

The control code Distance (DIST) will continue to draw lines based on measured distances and direction. The previous two points collected in the filed will define the direction the next point will be calculated from. The angle will always be a 90 degree deflection angle, turned looking forward from the last point collected or calculated. To turn left of the baseline use a negative number (-25) to turn right of the baseline use a positive number (10). Each point using the Distance command will be considered a derived point in Survey and will also be used in calculation of a DTM surfaces and ALG geometry alignments.

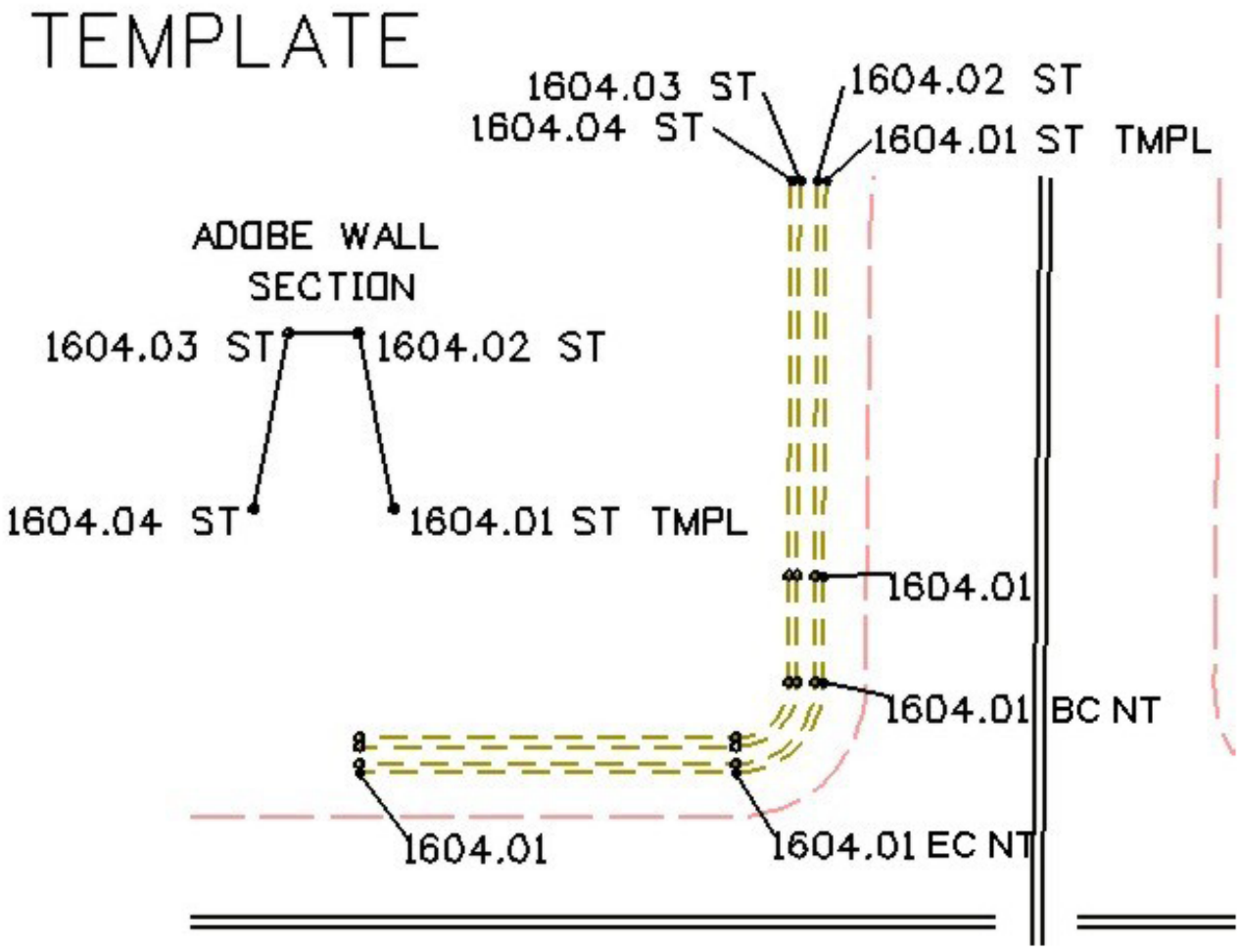
Only a survey feature with a point type Breakline will honor the Distance control code when it is pushed to a surface.



9.4.9 Control Code TMPL

The control code Template (TMPL) defines multiple survey features that are uniform in distance and elevation from a baseline.

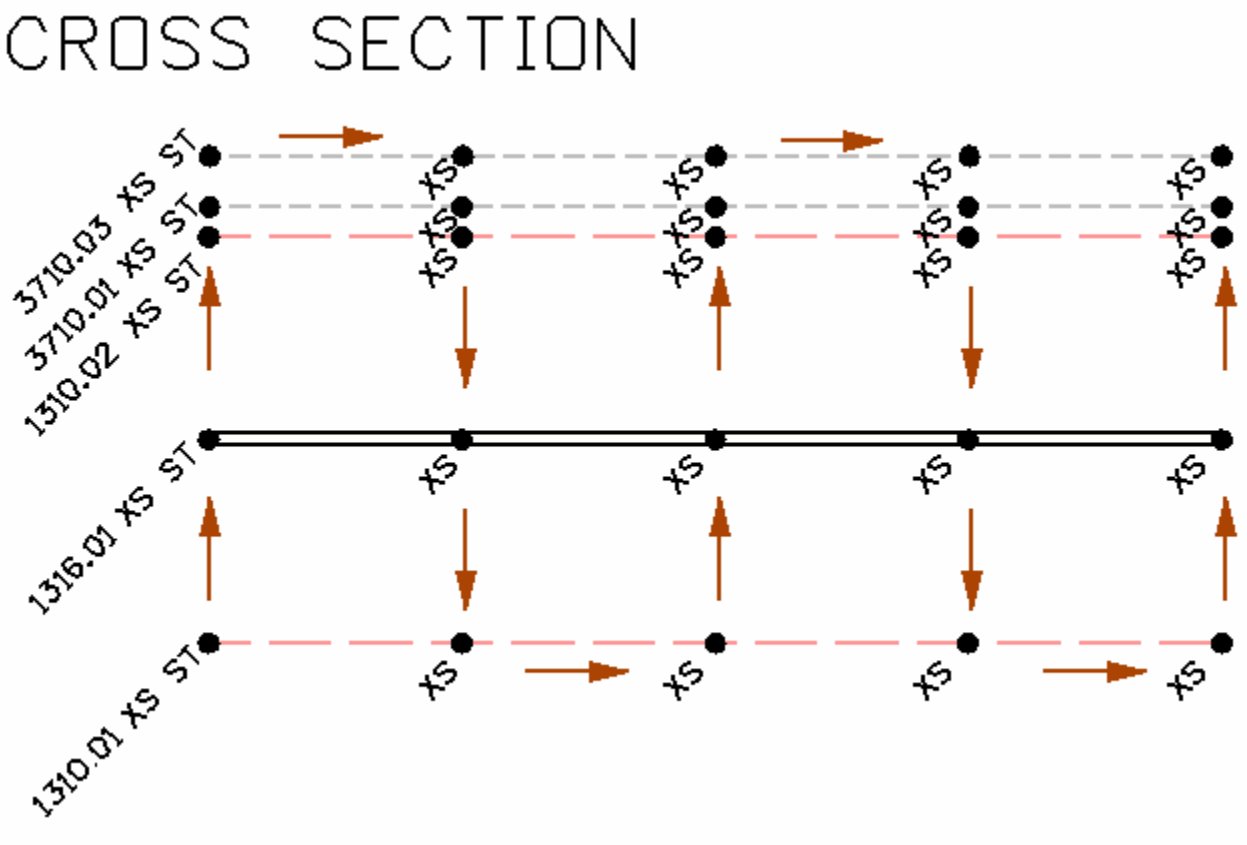
This code should be used only when approved in advanced by the Region Survey Coordinator.



9.4.10 Control Code XS

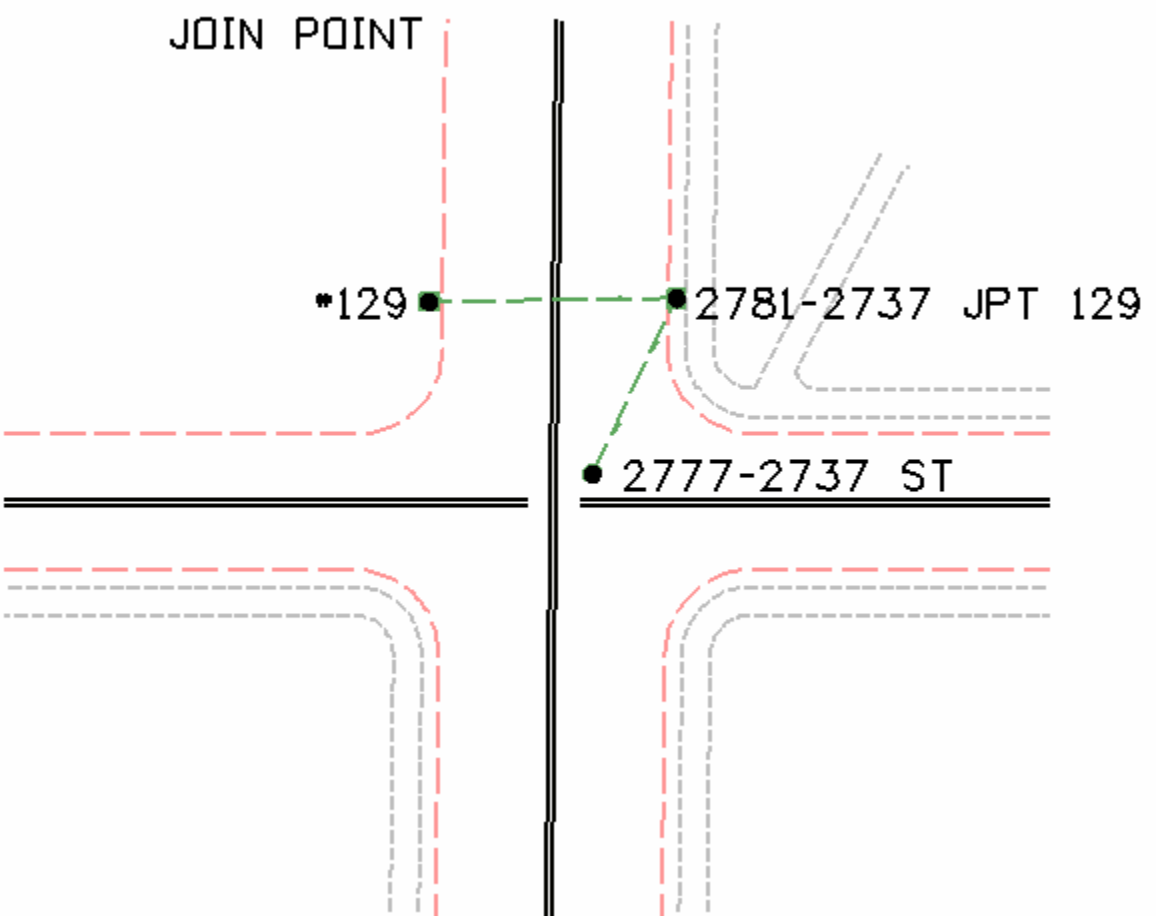
The control code Cross Section (XS) allows any uniform set of corridor shots to be collected efficiently. Start by collecting the start of each new feature, and then continue to collect the shots in a crossing pattern. When the raw data is imported into the field book it will convert the code XS to the correct feature code.

This code should be used only when approved in advanced by the Region Survey Coordinator.



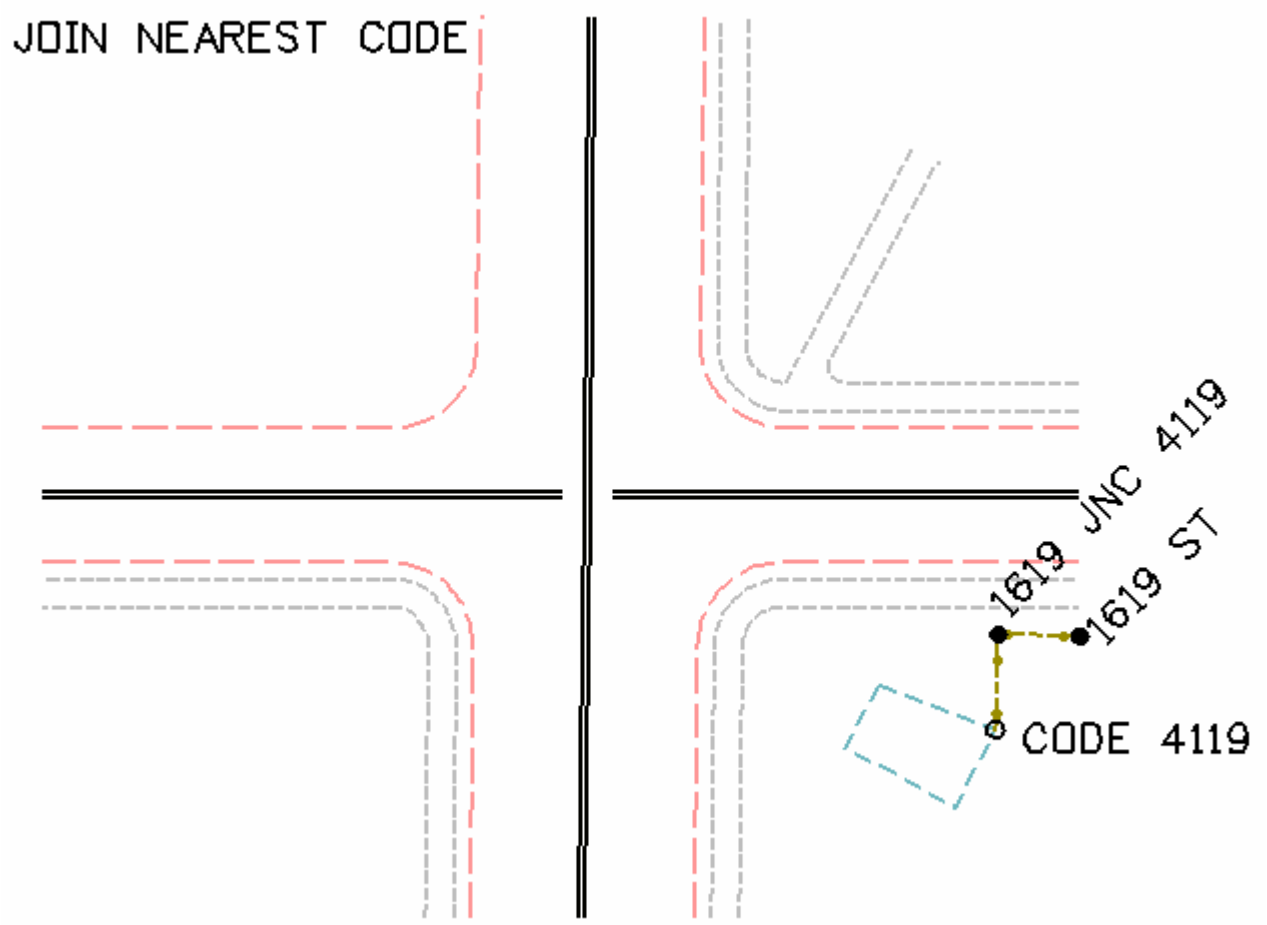
9.4.11 Control Code JPT

The control code Join Point (JPT) will draw a connecting line to the specified point number in the fieldbook using the current feature style.



9.4.12 Control Code JNC

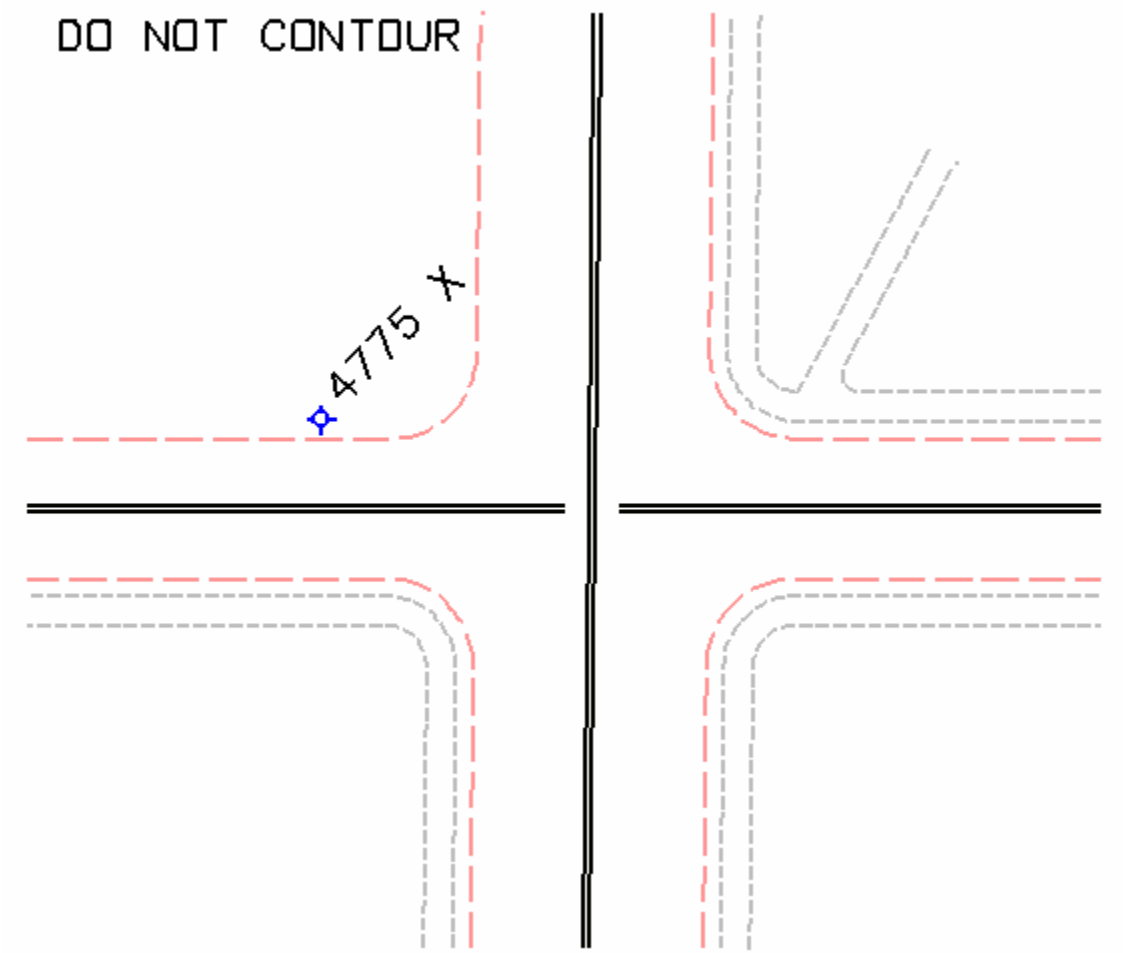
The control code Join Nearest Code (JNC) will locate the closest code specified and draw a connecting line using the current feature style.



9.4.13 Control Code X

The control code Exclude from Triangulation (X) (a.k.a. Do not Contour DNC) overwrites the TMOSS codes having a Breakline (B) or Random (RND) default setting and excludes it from the DTM for those points that should not be used to generate surface contours.

Points that are coded with "**X**" could include such items as fire hydrants, manhole inverts, benchmarks and control points, valve boxes and similar features.



9.4.14 Control Code RND

The control code Random (RND) overwrites the TMOSS codes having a Breakline (B) default setting and makes the point a random DTM point for those points that should not be used as a breakline to generate surface contours.

9.5 Translator

9.5.1 General

In order to ease the transition from the old Project Item Coding System (PICS) TMOSS to the new InRoads TMOSS a translator application was created by CDOT that translates survey codes from PICS TMOSS to InRoads TMOSS.

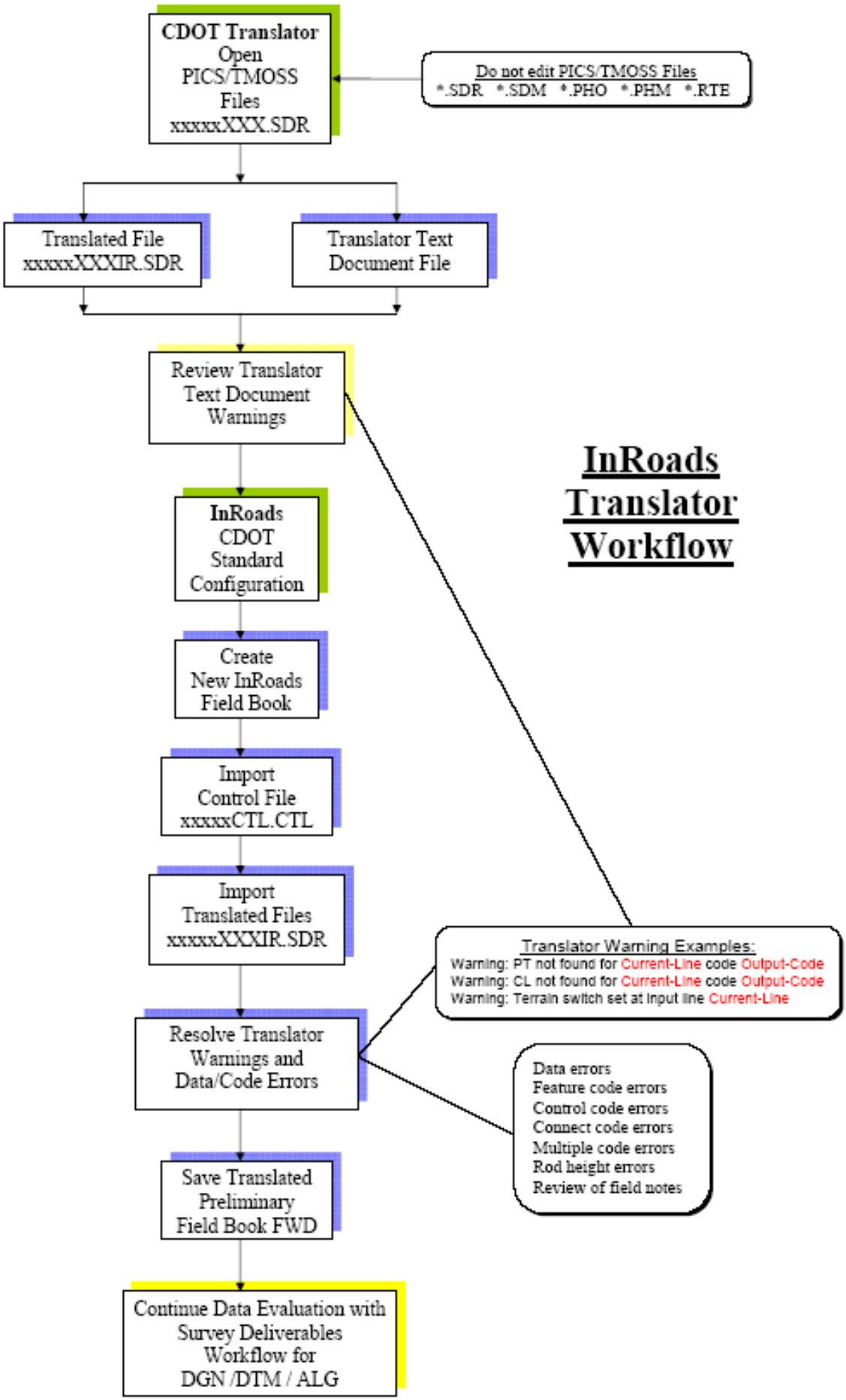
The intention of the translator is not to continue collecting PICS TMOSS and translating the codes into InRoads TMOSS, rather the intention of the translator is to ensure uninterrupted project delivery during the software transition for those projects already undertaken. Once CDOT determines that the translator is no longer needed support for it will be discontinued.

9.5.2 Translator Program

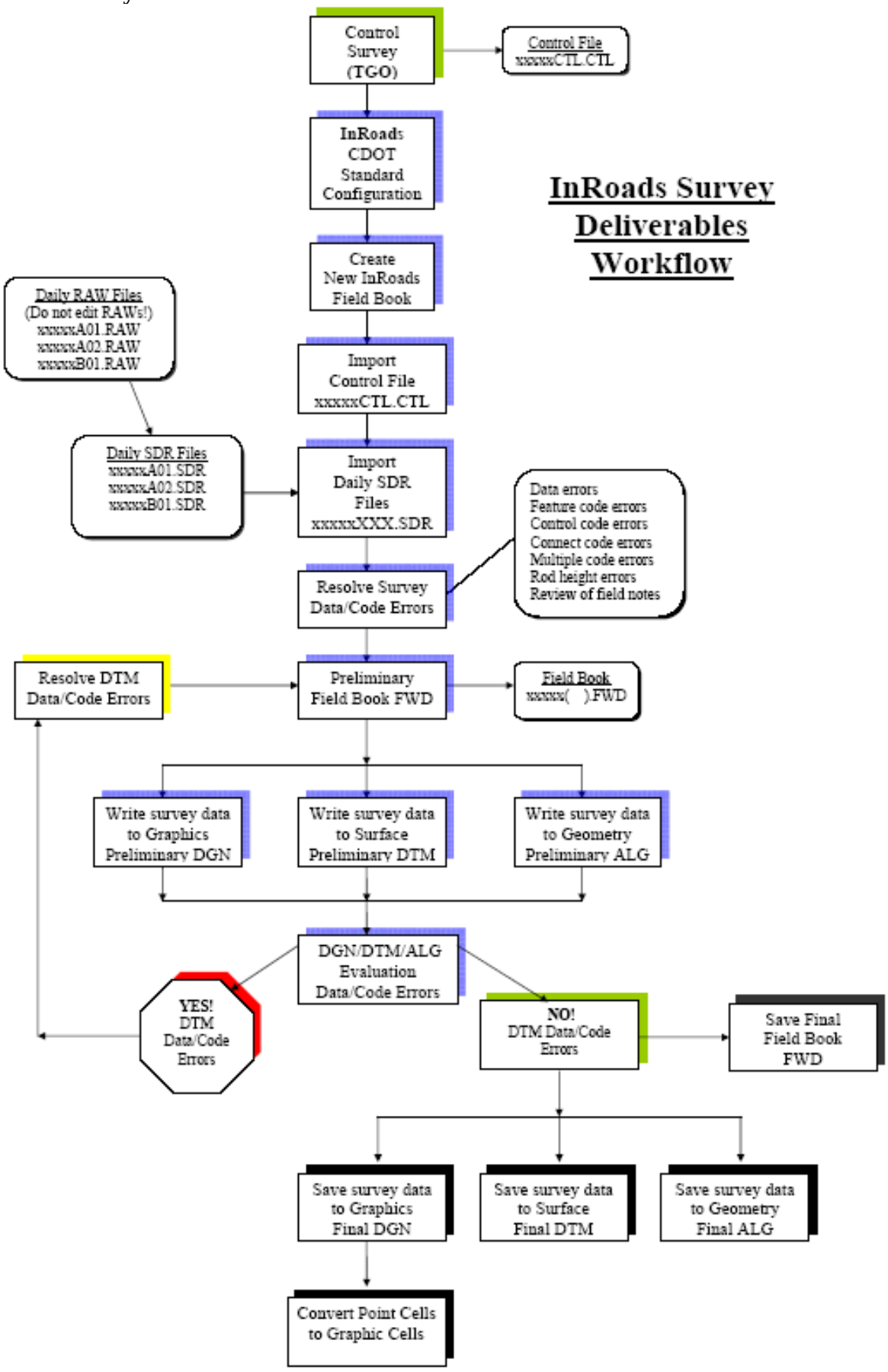
The most current version of the translator (2.2.1) shall be used for translating any PICS TMOSS. The approval of the Region Survey Coordinator shall be obtained prior to translating any PICS TMOSS codes.

Contact the region survey office in which your project is located to obtain a copy of the translator program and user manual.

9.5.3 Translator Workflow


CDOT Translator
Open
PICS/TMOSS
Files
xxxxxXXX.SDR
Do not edit PICS/TMOSS Files
*.SDR *.SDM *.PHO *.PHM *.RTE
Translated File
xxxxxXXXIR.SDR
Translator Text
Document File
Review Translator
Text Document
Warnings
InRoads
CDOT
Standard
Configuration
Create
New InRoads
Field Book
Import
Control File
xxxxxCTL.CTL
Import
Translated Files
xxxxxXXXIR.SDR
Resolve Translator
Warnings and
Data/Code Errors
Save Translated
Preliminary
Field Book FWD
Continue Data Evaluation with
Survey Deliverables
Workflow for
DGN /DTM / ALG
InRoads
Translator
Workflow
Translator Warning Examples:
Warning: PT not found for Current-Line code Output-Code
Warning: CL not found for Current-Line code Output-Code
Warning: Terrain switch set at Input line Current-Line
Data errors
Feature code errors
Control code errors
Connect code errors
Multiple code errors
Rod height errors
Review of field notes

9.5.4 Survey Data Reduction Workflow



9.5.5 General

InRoads Survey is a software application used for processing of survey and aerial data. The software processes raw data in the form of MicroStation graphics, surface models, and geometry in the form of coordinate geometry (COGO) points. InRoads Survey offers limited commands available in InRoads Suite.

Whenever the term InRoads Survey or InRoads is used in this chapter it refers to the entire InRoads Suite software application.

InRoads is the standard survey and civil engineering software application for CDOT.

9.5.6 Survey Options

The survey options dialog settings are automatically set by the standard configuration. The settings establish additional controls that are needed to ensure correct processing and tacking of fieldbook data and edits as follows:

- General
- Units

9.5.7 Audit Trail

If required, the InRoads fieldbook audit trail should be checked on and set under the InRoads survey options. The audit trail creates a file for saving during a single session. The file includes point numbers and the current and previous data before and after the edits.

Contract consultants should verify with the Region Survey Coordinator whether the audit trial should be set and provided as part of the deliverables.

9.5.8 Resolve and Log Code Errors

Resolve and log code errors shall be checked on under the InRoads survey options.

Resolve code errors will open the resolve code error dialog alerting the users of errors when importing fieldbooks and allows the users to resolve code errors.

Log code errors will open the results dialog and displays each point error and error type at the end of importing fieldbooks and allows the user to save code errors to a file.

9.5.9 Custom Operations and Cells

Use custom operations and cells shall be checked on under the InRoads survey options.

Use custom operations allows for all standard custom operations from the survey feature table to be used.

Use cells allows for all standard cells from the survey feature table to be used.

9.5.10 Default Tags and Attribute Tags

Attach default tags and attribute tags shall be checked on under the InRoads survey options.

Default tags define and attach an InRoads default tag to the MicroStation graphic when saved to a design file.

Attribute tags attach a tag with attribute information along with its values to the MicroStation graphic when saved to a design file.

9.5.11 Units

The units setting defines the linear and angular units that are used to process imported, exported and saved data. Once a file is imported the units can be changed and the data will be updated to reflect the change.

Typical units should be set as follows:

- Linear format
  - Units: US Feet for English units or Meters for metric units
    Note: International feet shall not be used
  - Precision: One hundredth of a foot

- Angular format
  - Units: Degrees
    Note: Degrees represents decimal degrees
  - Precision: One second of arc

- Angle orientation
  - Azimuth: North
  - Face: Right (depending on observational data *e.g.* angle right or left)
  - Vertical observation: Zenith (depending on observational data *e.g.* zenith or horizon angle)

9.5.12 Exporting Survey Data

InRoads can export fieldbooks in various formats. These formats create a basemap that will be used as a reference by survey, civil engineering design and ROW plans as follows:

Export Option	Export Command	Delivered to and Referenced by
DGN	Survey data to graphics	Survey, Civil Design, ROW
DTM	Survey data to surface	Design
ALG	Survey data to alignment	Survey, Civil Design, ROW

9.6 Data Management

9.6.1 Point Numbering

Point number grouping shall be used to avoid duplicate point numbers of survey data collected in the field or by aerial methods. This will aid the users while performing data edits and queries within InRoads.

9.6.2 Control Data File

Control data shall be imported and processed separately from ROW or TMOSS data with the software application appropriate for processing the control. This may or may not be InRoads. An example of this is primary control established by GPS static methods should be processed with Trimble Geomatics Office, once adjusted and accepted a final control file should be saved from of TGO and imported into InRoads prior to importing any fieldbooks (See Chapter 3 – GPS Surveys and Chapter 5 – Preliminary Survey for additional information).

Prior to importing any fieldbooks a control file shall be imported into the InRoads fieldbook. This allows InRoads to use the control data in the control file rather than control data from the imported fieldbooks. If the control data is updated the updated data shall be changed in the control file itself and then the ROW or TMOSS files shall be re-imported into the InRoads fieldbook for processing with the updated control data.

The control file shall be named with the CDOT five digit project code number followed by CTL and the extension of CTL to indicate the file is a control file for importing into the InRoads fieldbook. Only one control file shall be created for an entire InRoads project.

Example of a control file name for importing into an InRoads fieldbook:

12345CTL.CTL

9.6.3 Daily Unedited Files

In order to minimize errors and shorten the time it takes to edit and resolve errors, all TMOSS collected data shall be downloaded and saved at the end of every day as a daily file. The original downloaded daily files shall be named with the CDOT five digit project code number, the daily alphabetic/numeric code and the extension RAW indicating that they are raw downloaded and unedited files and shall be saved as a legal record of the survey field work for that day. If more then 99 daily files are created, the alphabetic portion of the daily file code shall increment alphabetically to the next letter.

No edits shall be made to any RAW files!

Examples of unedited daily file names:

First day:	12345A01.RAW
Second day:	12345A02.RAW
Third day:	12345A03.RAW
Ninty-nith day:	12345A99.RAW….
One-hundredth day:	12345B01.RAW

If multiple filed crews are collecting data on the same day the file name shall be incremented to the next daily file name.

Once downloaded the copies of the RAW files shall be made and the file extensions changed to SDR indicating that they are SDR files for importing into InRoads.

Examples of daily file names for importing into InRoads:

First day:	12345A01.SDR
Second day:	12345A02.SDR
Third day:	12345A03.SDR
Ninty-nith day:	12345A99.SDR….
One-hundredth day:	12345B01.SDR

9.6.4 Edited Daily InRoads Fieldbooks

Unedited daily SDR files shall be imported into an InRoads fieldbook, checked, edited and then saved as an InRoads fieldbook (FWD). The fieldbook shall be named with the CDOT five digit project code number followed by any other identifying characters and the extension FWD to indicate the file is a InRoads edited fieldbook edited and saved from InRoads.

In order to maintain security and control over survey collected data, the InRoads fieldbook shall remain in the possession of the surveyors and shall not be shared or included as part of the deliverables from survey to design, ROW or other disciplines.

9.6.5 Survey Deliverables

MicroStation Drawing (DGN)

Only after all survey data and code errors have been resolved and the fieldbook saved, InRoads “Survey Data to Graphics” shall be used to create a DGN representing the survey data contained within the fieldbook.

The DGN shall be used for sharing and delivering to design, ROW and other disciplines in need of the data.

If after being delivered changes are made to the original DGN by other disciplines, the user must be aware that the DGN no longer represents the data contained in the fieldbook and the surveyor accepts no responsibility for the changes made.

If after being delivered the user determines that the original DGN contains errors the user shall notify the surveyor immediately and the fieldbook shall be rechecked and any errors corrected, a new DGN shall then be created from the corrected fieldbook and shall be delivered to the user. All other users shall then be notified of the creation of a new DGN.

Digital Terrain Model (DTM)

Only after all survey data and code errors have been resolved and the fieldbook saved, InRoads “Survey Data to Surface” shall be used to create a DTM representing the survey data contained within the fieldbook.

The DTM shall be used for sharing and delivering to design, ROW and other disciplines in need of the data.

If after being delivered changes are made to the original DTM by other disciplines, the user must be aware that the DTM no longer represents the data contained in the fieldbook and the surveyor accepts no responsibility for the changes made.

If after being delivered the user determines that the original DTM contains errors the user shall notify the surveyor immediately and the fieldbook shall be rechecked and any errors corrected, a new DGN shall then be created from the corrected fieldbook and shall be delivered to the user. All other users shall then be notified of the creation of a new DGN.

Geometry (ALG)

Only after all survey data and code errors have been resolved and the fieldbook saved, InRoads "Survey Data to Geometry" shall be used to create a ALG representing the survey data contained within the fieldbook.

The ALG shall be used for sharing and delivering to design, ROW and other disciplines in need of the data.

If after being delivered changes are made to the original ALG by other disciplines, the user must be aware that the ALG no longer represents the data contained in the fieldbook and the surveyor accepts no responsibility for the changes made.

If after being delivered the user determines that the original ALG contains errors the user shall notify the surveyor immediately and the fieldbook shall be rechecked and any errors corrected, a new ALG shall then be created from the corrected fieldbook and shall be delivered to the user. All other users shall then be notified of the creation of a new ALG.

9.6.6 Aerial Mapping Data

Aerial mapping data files shall consist of a simple positional space or comma delimited ASCII text file with point number, northing, easting, elevation, and the InRoads TMOSS code for the point including any associated attributes or notes. (See Chapter 4 – Aerial Surveys for additional information).

Aerial mapping data file names shall be consistent with daily file naming conventions with the extension SDR.

9.6.7 Data Files from Other Sources

Observational data files from other sources shall consist of a SDR33 format with the point number, observational data and the InRoads TMOSS code for the point including any associated attributes or notes. The files shall have the extension SDR.

Positional data files shall consist of a simple space or comma delimited ASCII text file with the point number, northing, easting, elevation, and the InRoads TMOSS code for the point including any associated attributes or notes. The files shall have the extension SDR.

9.7 Survey Data to Graphics (DGN)

9.7.1 General

In order to maintain security and control over survey collected data, the InRoads fieldbook shall remain in the possession of the surveyors and shall not be shared or included as part of the deliverables from survey to design, ROW or other disciplines in need of the data (See Section ____). Writing survey data to graphics shall be the responsibility of the surveyor for delivering a DGN that represents the data contained within the InRoads fieldbook.

Writing survey data to graphics creates a static MicroStation basemap and the link between InRoads and MicroStation no longer exist. If there are edits made to the InRoads fieldbooks or changes are needed to the MicroStation basemap the survey data will have to be rewritten to graphics.

Due to this fact writing survey data to graphics shall be done as a final step before the following:

- Delivering a DGN to design, ROW and any other disciplines in need of the data
- Preparing final Project Control or Land Survey Control Diagrams
- Preparing final ROW plan sheets

9.8 Survey Data to Surface (DTM)

9.8.1 General

In order to maintain security and control over survey collected data, the InRoads fieldbook shall remain in the possession of the surveyors and shall not be shared or included as part of the deliverables from survey to design, ROW or other disciplines in need of the data (See Section _____). Writing survey data to surface shall be the responsibility of the surveyor for delivering a DTM that represents the data contained within the InRoads fieldbook.

The DTM triangulation is based on each feature's point type as defined in the survey feature style. Not all of the feature codes survey intelligence will be written to the DTM, therefore there may be inconsistency between the graphics displayed from survey and the graphics displayed from the DTM. For example only those survey features with a point type of breakline will carry over the control code when writing graphics to surface.

The following examples are some of the inconsistencies between survey graphics and surface graphics:

- Attributes
    - Rotation of cells
    - Access Report Code 277
    - Drainage Report Code 283
    - NOT attributes

- Control codes
    - RND
    - X
    - CL
    - CLR
    - JPT
    - JNC
    - DIST

Due to this fact writing survey data to surface should be done as a final step before delivering a DTM to design, ROW and any other disciplines in need of the data

9.8.2 DTM Settings

Description dialog set to **Use Attributes**
Curve stoking set to **Horizontal Only**

9.8.3 DTM Evaluation Workflow

1. View Surface Properties
    a. Data Range
    b. Surface Description
    c. Surface Preference
    d. Cross Section Preference
    e. Profile Preference

2. View Crossing Segments
    a. Mismatched Elevations

b. Crossing Breaklines

3. View Surface Triangles
    a. Set Exterior Boundary
    b. Look for spikes in the triangles
    c. Look for holes in the triangles
    d. Triangles that cross breaklines

4. View Surface Contours
    a. Look for spikes in the contours
    b. Look for holes in the contours
    c. Look for zigzag contours
    d. Look for vertical walls
    e. Look for contours that are not consistent

5. Cut Profiles
    a. On Center line
    b. On Ditch line
    c. View Surface
    d. View Features – Above and Below ground
    e. etc.

6. Cut Cross Sections
    a. On Center line
    b. View Surface
    c. View Features– Above and Below ground

9.9 Survey Data to Geometry (ALG)

9.9.1 General

In order to maintain security and control over survey collected data, the InRoads fieldbook shall remain in the possession of the surveyors and shall not be shared or included as part of the deliverables from survey to design, ROW or other disciplines in need of the data. Writing survey data to geometry shall be the responsibility of the surveyor for delivering a ALG that represents the data contained within the InRoads fieldbook.

Writing survey data to geometry creates a geometry project that consist of multiple horizontal and vertical alignments from any connected point feature. Single points such as control, ROW, and property monuments may also be written to the project and placed in the coordinate geometry buffer.

9.10 Deliverables

InRoads can export fieldbooks in various formats. These formats create a basemap that will be used as a reference by survey, civil design and ROW plans as follows:

9.10.1 Survey

- DGN (Used for planimetric drawings)
- DTM (Used for topographic mapping)
- ALG (Used for survey calculations)
- Coordinate point list
    - Primary and secondary control
    - ROW

9.10.2 Civil Engineering

Currently, all features and points shall be written to and delivered as follows:

- DGN (Used for planimetric drawings)
- DTM (Used for civil engineering design)
- ALG (Used for civil engineering design)
- Drainage report
- Access report
- Coordinate point list
    - Primary control

9.10.3 ROW

Currently, all features and points shall be written to and delivered as follows:

- DGN (Used for planimetric drawings)
- ALG (Used for ROW calculations)
- Access report
- Coordinate point list
    - Primary and secondary control
    - ROW

9.11 MicroStation

9.11.1 General

MicroStation is a software application used to graphically display InRoads data. InRoads does not posses a graphics display application, MicroStation or AutoCAD is needed to display the InRoads data.

MicroStation is the standard computer aided drafting software application for CDOT.

References

CDOT Survey Manual – CDOT, 1992

CDOT TMOSS Training Manual –

CDOT TMOSS Code Book – CDOT April 1, 1998

CDOT Translator Manual – CDOT

InRoads Survey – Bohannan Huston, 2005

InRoads Survey Location and Topographical Surveying – Bentely, 2004

Trimble Geomatics Office Feature Code and Attribute Editor – Help Topics, 2003