Chapter 21

CADD Editing Manual

PRELIMINARY SURVEYS

Table of Contents

21-1 GENERAL

21-1.1 Transmitted Files

AAreadme.docx

Chronological diary of actions taken, and special circumstances encountered during project life.

AAreadme.dgn

3-D file containing notes and descriptions that will be useful for individuals working with the digital version of the data. The data in this drawing is informational only and will not be shown on the final plans. A boundary shall also be included, depicting the absolute survey limits.

081CD_001.dgn

2-D file containing a table of survey point coordinates, alignment data, curve data, and datum information. See section 21-2

CONTROL.dgn

2-D file containing PLSS data, existing ROW markers, reference markers, monuments, property corners, survey centerline and curve data. See section 21-3

TOPOG.dgn

3-D file with the final edited surface features, roadways, buildings, signs, posts, utilities, drains, culverts, water and includes related labeling. See section 21-4

DTM.dgn

3-D file with extractable features that include spot shots, break lines, voids, edge of roadways, concrete surfaces, edges of water, etc. See section 21-5

RR_Profile.dgn

3-D file containing the railroad profile data. This shall include data on top of each track, 1000' each side of the proposed structure. Elevation labels will be placed for the clearance height of the existing structure and for each rail as it intersects the State R/W line.

StreamProfile.dgn

3-D file containing data collected for a hydraulics survey.

Terrain_Exst.dgn

3-D file created from the DTM extraction utilizing graphical filters. It will show a continuous road surface for the primary alignment.

Terrain_Exst_Alt.dgn

3-D file created from the DTM extraction utilizing graphical filters that includes alternate surface data. The alternate surface data typically involves underpass, overpass and/or hydraulic features that would prevent a continuous road surface for the primary alignment.

Optional – No Voids terrains

3-D files. The Terrain_Exst_No_Voids.dgn and Terrain_Exst_Alt_No_Voids.dgn are variations of the terrain files. Obscured and Void graphics are extracted as standard break lines and spot shots. See CADD Manual Section 5.4 for additional details.

21-1.2 Current Resources

There are additional online resources available for assistance with the preliminary surveys CADD editing.

CADD Standards Manual
Preliminary Surveys Manual

21-1.3   Stereo-compilation

The compilation graphics should be translated from State Plane coordinates to the appropriate County ground coordinate system used for the project.

When stereo compilation is part of a survey, there are several features created during stereo compilation that are required to be field located. This includes all utility features for storm, culvert, sanitary, gas, TV, telephone, communications, water, fuel, utility markers, OH line crossing clearance heights, down guy wires, etc. All "undefined…" and post graphics from compilation will need field verified or located as needed. Also needed are the R/W markers, all signs within the R/W, box culverts, and bridge decks.

Check the stereo compiled data for duplicated graphics from the EFB data. All EFB data should be kept once verified and any duplicated stereo compiled data will be deleted.

21-1.4   Level Sets

Most graphical levels within preliminary surveys will have an associated text level with the same name. For instance, the curb line may be placed on the "Curb Line Exst" level while the related annotation will be placed on the "Curb text Exst" level. All the annotations should be placed on the appropriate text level within the level set that the graphic is using.

The level "Pt Control text Exst" is one of the few levels that is used in conjunction with multiple other levels. It contains the annotation for CP, GPS, RTK, and TRI graphics.

21-2 081CD_001 - Curve and Coordinate Data Sheet

21-2.1   General

When creating the coordinate data sheet, the DGN file must be labeled using the naming convention as follows: 081CD_###.dgn. ### indicates the page number. The coordinate data sheet can be created by placing the "PNTSUR" cell into a 2-D file. The PNTSUR cell should not be dropped to its individual elements. It should be maintained as a cell.

NOTE: A sample copy of the 081CD can be found in Chapter 19-13, Consultant Services manual.

The PNTSUR cell uses editable tags to input project information. Only the "titleblock" tags need to be edited as tags. The "titleblock" tag is used to input the project number, sheet section and page number. This is editable by using the Edit Tags tool or by simply double clicking the text.

21-2.2   Border Data

Top Border

The top border title shall include a description of the project after the "PRELIMINARY SURVEY COORDINATE AND CURVE DATA" title, the correct project number, and page numbers should be included in the title block.

Bottom Border

The bottom border includes a simple checklist and data fields that include information about the datum that was used, measurement units, initializing bench mark and coordinate information. All the data should be verified by the surveyor responsible for establishing the coordinate system for the project. The coordinate data fields must include the county, NAD83 reference frame, north or south zone and county combination factor if applicable.

NAD83 Systems include;   2011 (Used with GEOID12B & GEOID18)
                              CORS96 (Used with GEOID09)

21-2.3   Table Data

Text

Text used for table data shall be   Text style: Text 0.07
                                         Color: Shall match its corresponding alignment
                                                  color

All the coordinate values shall include commas. Some of the tools that are used to place coordinates do not allow commas to be added for the thousandth separator. Edits shall be made to ensure the coordinate values are properly formatted.

Horizontal Alignment Data

Horizontal alignment data shall have a heading that includes the alignment description and its feature name. All points used to create the alignment, including PLSS Xings, need to have their northing, easting and station notated.

Many examples are included for standard and unique alignment situations.

The first example shows a PLSS line crossing within the first half of a curve, a station equation, and some standard PLSS line crossings. Notice that within curves, intersecting/crossing alignments are expressed at the centerline of the alignment while PLSS crossings are expressed in the tangent of the curve.

This equation expresses the intersection of two alignments with a change in the back and ahead stationing of the first alignment. The full equation is only documented in the primary alignment (ND 200). When the secondary alignment (ND 8) is documented, it will simply call out that it is intersecting with the other (ND 200) with no station equation expression.

The second example has a PLSS line crossing in the last half of a curve. These are expressed as distance from the PI or to the end of the curve on the Ahd Tan.

The point descriptions in all three examples show the proper text to use for the various PLSS crossing related alignment points. If an alignment point coincides with a PLSS corner, then the description would call out the corner not an Xing. E.g., Rec Sec Cor. The alignment point descriptions should be the same in the 081CD sheet and the Control drawing.

HORIZONTAL ALIGNMENT			
PNT	STATION	NORTHING	EASTING
ND 200 (SCL_200) definition continued from sheet 2			
TS	6073+63.65	616,667.49	1,511,588.17
1/4 line Xing	6074+34.09 (Bk Tan)	616,665.67	1,511,658.58
SC	6077+63.65	616,643.19	1,511,987.23
Station equation ND 200 (SCL_200) and ND 8(SCL_8_N)			
ND 200 Bk	6090+58.44	616,068.44	1,513,119.90
ND 200 Ahd	6090+53.28	616,068.44	1,513,119.90
ND 8	6009+00.96	616,068.44	1,513,119.90
PI	6094+66.38	616,612.98	1,513,690.19
CS	6103+48.06	614,910.44	1,513,641.69
ST	6107+48.06	614,510.68	1,513,647.53
1/4 line Xing	6112+57.66	614,001.18	1,513,637.19
Rge line Xing	6138+94.44	611,364.94	1,513,583.70

PC	6274+59.36	605,8
PI	6279+22.68	605,8
Sec line Xing	6.99' from PI (Ahd Tan)	605,8
PT	6283+85.98	605,8

Curve Data

All curve data in the Coordinate Data sheet should include the same values as the table located in the Control.dgn file.

Curves that have an intersecting alignment, which requires the expression of a station equation, should not be documented as compound curves. Curve Combination shows the proper documentation for a typical Spiral-Curve-Spiral. This is the same curve shown in the horizontal alignment definition above.

CURVE DATA	
ARC DEFINITION	
Curve Combination	Curve
PI = 6094+66.38	PI = 6279+22.68
Delta = 89°40'36" (Rt)	Delta = 00°46'20" (Lt)
Da = 02°59'59"	Da = 00°05'00"
R = 1,910.08'	R = 68,754.94'
L = 2,589.57'	T = 463.31'
Ls = 400.00'	L = 926.61
Sc = 05°59'58"	
Ts = 2,102.73'	

Item Types

Populating the item type field within the Control.dgn can accelerate the documentation of the data for the following 3 tables, PLSS Data, Control Points, and Reference Markers. See section 3.22 of the CADD Manual for additional details about Item Types. See the CADD Manual Drawing Production Guidance for 081CD for additional information about using the populated Item Type field to generate reports/tables.

PLSS Data

All the section corner coordinates that are associated with the creation of the alignment and corners that appear in the CONTROL.dgn should be added to the US Public Land Survey Data table. This will potentially include any corners that are within a mile of the project corridor.

The corners should be grouped together by township and range. Within each group, they should be sorted by the PLSS Index Reference Number (IRN). A header for each group shall be added stating the township and range of the group. A blank line shall be included between township groups.

The nature of the PLSS system allows a single corner to have a description that can call out multiple different sections. For instance, the SW corner of Sec 1 can be the NE corner of section 11. It is highly recommended that the description, section, township, range, and IRN match the newest monument record form recorded for each corner.

Abbreviation and capitalization for section corner coordinates shall follow the examples. Commas will be shown for the thousandth separator for the coordinate values.

US PUBLIC LAND SURVEY DATA			
CORNER	IRN	NORTHING	EASTING
T-144-N R-91-W			
SW Cor Sec 6	1-C	605,692.37	1,529,273.26
NE Cor Sec 6	3-A	610,849.39	1,534,566.62
W Qtr Cor Sec 5	3-B	608,261.42	1,534,503.89
NE Cor Sec 7	3-C	605,621.06	1,534,447.42
SE Cor Sec 7	3-E	600,343.95	1,534,335.23
T-144-N R-92-W			
NE Cor Sec 5	5-A	611,502.91	1,508,290.78
E Qtr Cor Sec 5	5-B	608,902.28	1,508,242.57
N Qtr Cor Sec 4	6-A	611,435.11	1,510,948.54
N Qtr Cor Sec 9	6-C	606,188.88	1,510,836.27
S Qtr Cor Sec 9	6-E	600,915.81	1,510,722.42
NE Cor Sec 4	7-A	611,364.94	1,513,583.70

Control Points

Primary and secondary control point data needs to include the northing, easting, elevation, station, and offset. Commas will be shown for the thousandth separator for the coordinate values. Stationing and offsets should be rounded to the nearest foot. If the control point is out of the alignment range, "N/A" shall be put in for the station and offset of the control point.

A description of the monument at the point should be included. E.g., #5 Rebar w/Alum cap stamped – "NDDOT CONTROL".

SURVEY CONTROL POINTS							
PNT	NORTHING	EASTING	ELEV	STATION	OFFSET	ALIGNMENT	MONUMENT
PRIMARY CONTROL							
GPS 9	616,504.72	1,512,176.98	2,133.74	6079+81	101' Rt	SCL_200	#5 Rebar w/ 1 1/2" Alum cap
GPS 117	606,153.80	1,513,378.29	2,192.76	6187+72	647' Rt	SCL_200	1 1/2" Alum cap stamped NDDOT CONTROL
GPS 10	605,793.02	1,529,897.52	2,171.70	6349+51	86' Lt	SCL_200	1 1/2" Alum cap
GPS 123	602,928.26	1,545,015.18	2,005.22	6506+55	92' Rt	SCL_200	1 1/2" Alum cap stamped NDDOT CONTROL
GPS 11	599,992.73	1,558,585.42	2,084.30	N/A	N/A	SCL_200	Rebar
SECONDARY CONTROL							
RTK 20202	616,592.04	1,510,768.70	2,114.01	6065+46	97' Rt	SCL_200	#5 Rebar
RTK 40033	616,614.81	1,514,291.57	2,129.34	6093+09	1252' Lt	SCL_200	RP Cap stamped CONTROL POINT
RTK 40164	605,744.69	1,534,401.96	2,087.47	6394+55	98' Lt	SCL_200	#5 Rebar
CP 30003	602,699.11	1,545,641.23	1,998.71	6513+19	26' Rt	SCL_200	#5 Rebar

Reference Markers

Reference markers shall be documented with a northing, easting, station, offset, and alignment. Stationing and offsets should be rounded to the nearest foot. Commas will be shown for the thousandth separator for the coordinate values.

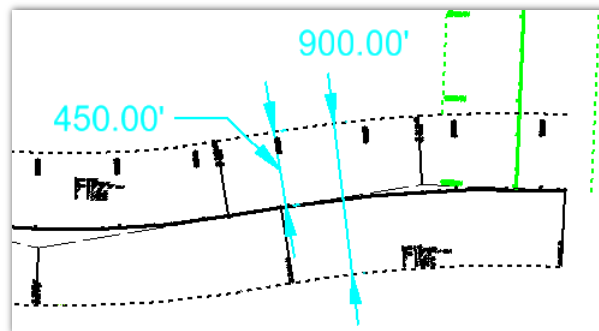| REFERENCE MARKERS				
#	NORTHING	EASTING	STATION	OFFSET	ALIGN
101	627,191.84	1,439,076.72	N/A	N/A	N/A
102	620,904.18	1,443,641.80	5385+69	22' Rt	SCL_200
103	618,487.09	1,448,120.55	5438+19	24' Rt	SCL_200
104	618,270.90	1,453,404.31	5491+07	24' Rt	SCL_200

21-3 Control

21-3.1   General

Design Corridor

The design corridor should be considered the "Plan Sheet" border for orientation of labeling. The Design corridor needs to be established for the project. It will be a 4 ½" strip at final mapping scale, centered on the alignment.

Corridors offset both ways from the alignment:
- 200 scale [Rural]
  - Level – "Corridor Design line Exst" offset 450' from alignment
- 40 scale [Urban]
  - Level – "Corridor Design line Exst" offset 90' from alignment

Rural area in 200 scale

The design corridor should be drawn in for each ramp corresponding symbology for the ramp alignment.

North Arrow

A north arrow shall be set at a minimum of the beginning and end of the topographic limits. Additional north arrows should be included where there is a significant deflection of the alignment and at the CADD editor's discretion.

Labels

There shall be **no labels overlapping** graphical elements or other annotation when the final Control.dgn and Topog.dgn are referenced together. The only exception will be made for the large alignment station values that are automatically generated every 500' or 100' depending on the scale of the project. It is acceptable for these station labels to overlap line work, but not alignment tie lines or other annotation.

Background masking shall not be implemented with any annotation for Preliminary Surveys.

All features that do not have unique symbology should be labeled. All annotations shall be configured to be read in normal horizontal format, or from the right side of the sheet as printed. Cell annotation should be rotated to match the alignment and line annotation should be rotated to the

corresponding line. Broad coverage labels like City, County, State, Sec Twp Rge labels should be rotated to the alignment.

- Street and highway names should always be annotated if known. The annotation should be placed away from the survey centerline, but within the design corridor. They should be located outside the curb and gutter or edge of roadway surface. All components of the street name should begin with an upper-case letter. EXAMPLES: Hurley Drive, Apple Creek Ln, 3rd St SE, N Everett St, Highland Acres Rd W. Accepted abbreviations for road types are Ave, Blvd, Cir, Ct, Dr, Expy, Hwy, Ln, Lp, Pk, Pl, Rd, Rt, Sq, St, Tr.
- US Highways, State Highways, Interstates and County roads should also be labeled as: US 2, ND 17, I 29 and Co Rd 2. These labels should also be placed close to and outside the edge of the roadway surface, reading from the bottom or right of the plan sheet window.
- Labels that fall inside the primary design corridor are rotated along the primary design corridor. Labels are only rotated to the ramp alignment when they fall inside the ramp alignment corridor alone.
- Municipalities such as Counties and Cities need to be labeled at the beginning and end of the topographic limits. They should also be labeled at any of their borders. For instance, both counties would be labeled at a county line, or the city and county would get a label at a city limits line. Counties, Cities, States and Country names shall be all caps. E.g., BURLEIGH COUNTY, NORTH DAKOTA, CITY OF BISMARCK, etc.

Coordinate System

The correct geographic coordinate system should be set based on the NDDOT Geographic Coordinate System (GCS) library. See CADD Standards manual section 3.21 for additional information.

21-3.2   Alignment Data

POT Labeling

The alignment point description for projects beginning or ending at a POT shall be replaced with "Begin" and "End" followed by the station value. All other items that are visualized as a POT should also be changed to a more appropriate label. Some typical descriptions include PI, Rec Sec Cor, ¼ Line Xing, etc. In rare cases where a POT within the alignment does not have a deflection or is not associated to a PLSS line/corner, then it may remain labeled as a POT.
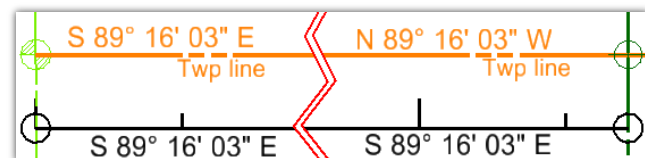
Bearing Labels

Leading zeros shall be used for the minutes and seconds but not for degrees. No decimal places should be shown for the seconds.

The SCL alignments shall be annotated with bearing labels. The bearing for the alignment should be oriented in the same direction as the alignment. E.g., If the alignment was headed in a northwesterly direction, then it may read N 9° 08' 09' W.

PLSS lines that have a valid bearing also require one of these labels. The bearings that are labeled should take on the color of the item they belong to. For example, if you are labeling the bearing for the alignment 1 centerline then the text would be white, if it were for a 1/4 line then it would be light green.
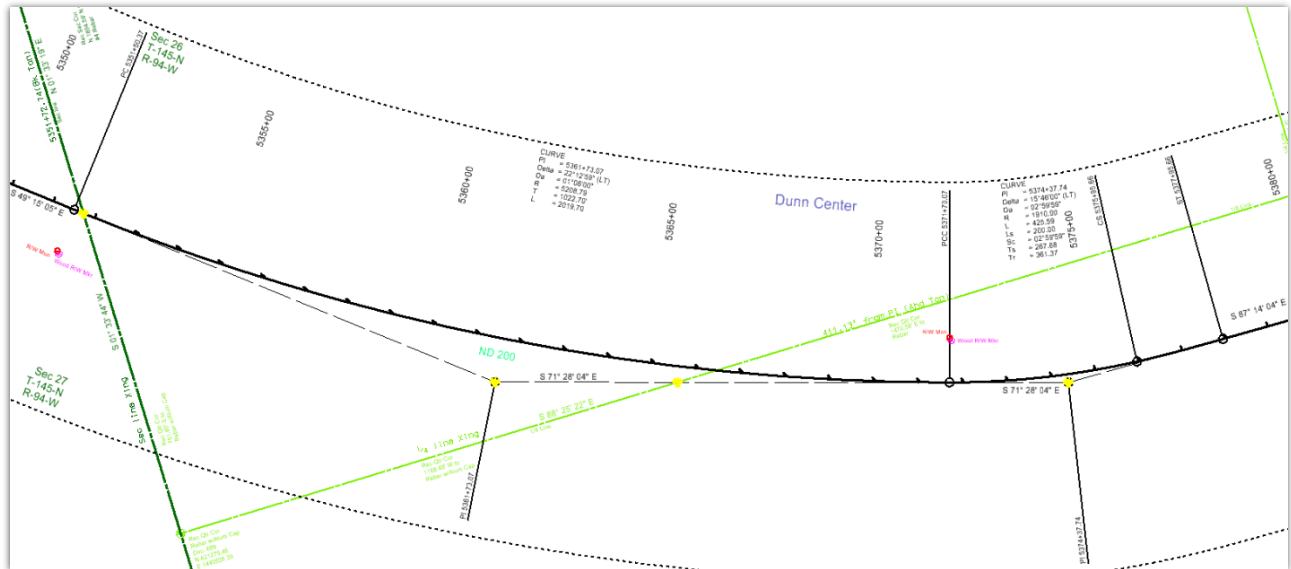
Bearings that are placed on PLSS lines within the design corridor but not crossing the alignment should be oriented in the direction leaving the nearest PLSS corner. On a PLSS line that is parallel with the alignment and offset several feet, each end of the line will have a bearing that denotes opposite directions with the same numeric degree value. In the example the alignment bearings are all SE but the township line bearings change from SE to NW based on their proximity to the nearest corner.

Bearings for PLSS lines that cross the alignment should be labeled in a direction going away from the alignment. See example below.

If there are multiple lines in proximity that require bearing labels, then an additional qualifier should be placed at the end of the bearing. For instance, if the alignment centerline was near a PLSS line then the label would be appended with (Align) and would appear as this; N 9° 08' 09' W(Align). If the alignment is coincident with a PLSS line, the bearing would appear as this; N 9° 08' 09' W (Align & Twp line) and it would take on the color of the PLSS line.

Curve tangent lines do not require bearing labels unless a unique circumstance is encountered including non-tangential, compound, and reverse curves.
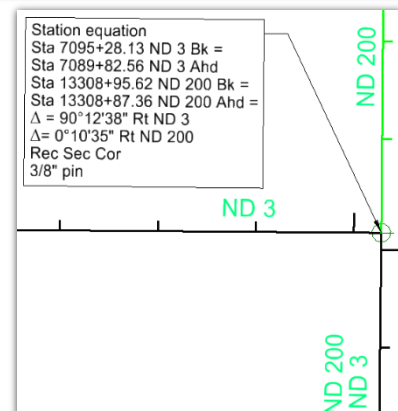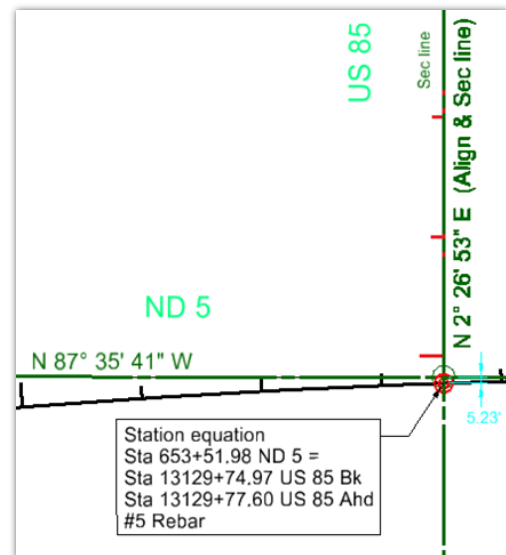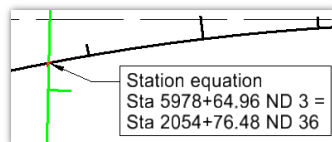

Station Equations

Station equations and Intersections will need to be labeled with a box using a note arrow. This can be done using the appropriate Task or Civil Labeler. The Station equation should be labeled anytime a station equation happens within an alignment or anytime two alignments cross or meet. The formats for the two labels are similar. They are both multiple lines which start with a Station and end with a description. Deflection angles will be included after the station/offset portion appended with the appropriate road name when needed. When there is a monument associated with the point it will be placed as the last line of text. Additional descriptors like "Rec Sec Cor" that would normally be labeled for an alignment point will also be included in the box.

Station equations can represent a station change in an alignment from back to ahead. They can also express a point that is common in two separate alignments.

Interchange ramps will also need station equation labels.

Station equation
105+38.00 45th St=
100+00.00 NW Ramp

Station equation
Sta 653+51.98 ND 5 =
Sta 13129+74.97 US 85 Bk
Sta 13129+77.60 US 85 Ahd
#5 Rebar

Station equation
Sta 7095+28.13 ND 3 Bk =
Sta 7089+82.56 ND 3 Ahd
Sta 13308+95.62 ND 200 Bk =
Sta 13308+87.36 ND 200 Ahd =
Δ = 90°12'38" Rt ND 3
Δ= 0°10'35" Rt ND 200
Rec Sec Cor
3/8" pin

Station equation
Sta 5978+64.96 ND 3 =
Sta 2054+76.48 ND 36

Alignment Points

The Open Roads Designer created alignment point circle should be deleted when it is coincident with an EFB monument cell. E.g., Section Corner, Found Monument, etc. The tie line shall then be extended to the centerline.

The found monument located in the field must be within 0.10' of the true alignment point to be considered coincident. If the monument is not within tolerance, it should not be used at the monument for the point. If the monument is not a PLSS corner, then it should have an independent label. E.g., "Old PI Mon". If the monument is within tolerance, then a monument label shall be placed.

- PLSS related monument labels are on the up-station side of the line and placed on the right side of the alignment if space allows.
- All the other alignment monument labels are placed on the up-station side of the tie line.

Curve PI monuments follow the standard labeling rule. However, found monuments for the start and end of curves should always be labeled as an old monument even if they are within the standard 0.10' tolerance. E.g., Old PC Mon, Old Ts Mon, etc.
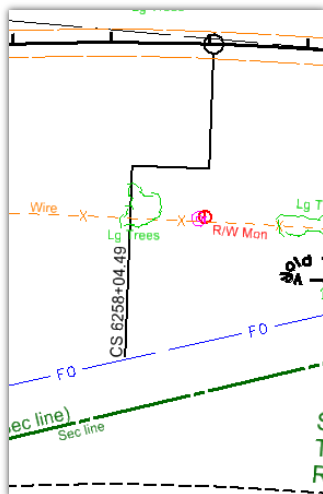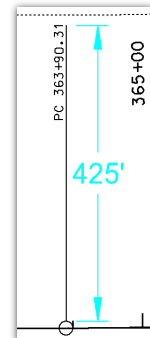
Calculated Points

Calculated point cells should have the same relevance as EFB Locator text or construction elements. The calculated point cell is only meant to be a communication between the surveyor of the project and the individuals producing the right of way plats. The points should be passed along in the Control.dgn but from a CADD editing standpoint, they can be ignored.
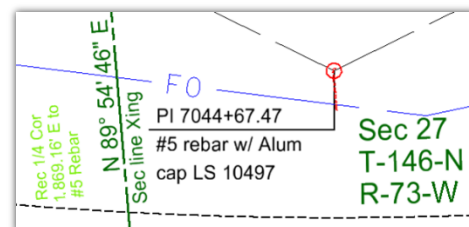
Tie Lines

For 200 scale, tie lines will be extended to 425'. Alignment station labels should be flush with the end of the tie line. The alignment point description and stationing will be shown on the down-station side of the line. A monument description if applicable, will be shown on the up-station side of the line.

When the RW_Bndry.dgn and Topog.dgn are referenced, it may be necessary to alter this typical editing practice. The text may need to be moved closer to the alignment so that it does not overlap with a reference graphic. If this is required, the tie line should be shortened to extend to the end of the text.

Some uncommon situations, involving heavy graphics or the PIs for large curves, will require that the description, station, and monument be placed away from a perpendicular or radial position. In these instances, **which should be a last resort**, the original tie line can be shortened to a minimum length of one-quarter inch as printed (50' at 200 scale). One or more 90° bends can then be introduced in the tie line to allow for more flexibility as to the text placement.

Tangent Lines

Draw individual lines joining tangents to their respective PIs. The tangent line symbology will vary depending on the alignment.

Curve Tables

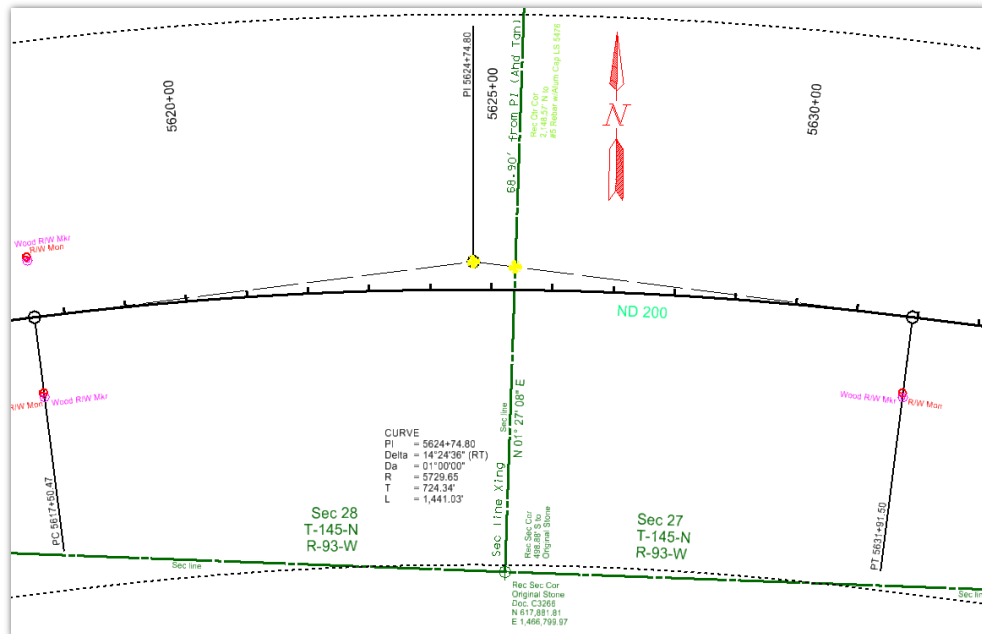Curve tables should include

Simple Curve	Spiral/Combination Curve
Curve	Curve Combination
PI	PI (Combination Data only)
Delta	Delta (Combination Data only)
D_a	D_a
R	R
T	L
L	L_s
	S_c
	T_s

Place the curve table as close to the middle of the inside of the curve as possible, near the design corridor edge, and rotate to alignment. Delta, D_a and S_c shall have the decimals removed and rounded to the nearest second.
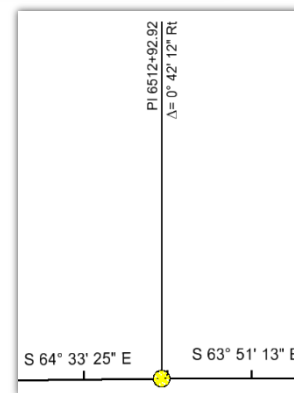
For spiral/combination curves, only the total combination curve data for PI and Delta should be kept in the table. Delete the PI and Delta Simple Curve information. Keep the length and delete the "simple curve" label if it appears behind it. The location of the PI alignment cell, tie line and station should be moved to the combined curve PI location. The station value shown shall be combined curve PI station. Xc and Yc values shall not be included in the curve table. "Simple Curve" and "Total Combination" text is also deleted.

Deflection angles

Most POTs visualized on the alignment will be at a deflection of the alignment. These deflections need to be labeled using the same symbology used for the station label for the point. The deflection label will be placed near the station value on the up-station side of the line. The label will contain the delta symbol, an = sign, the deflection angle at that point and the direction of the deflection, either left or right. Leading zeros should be included for the minutes and seconds. E.g., Δ = 0° 42' 12" Rt

POTs that do not have a deflection should also be labeled. In the place of deflection angle the word "None" will be used. E.g., Δ = None
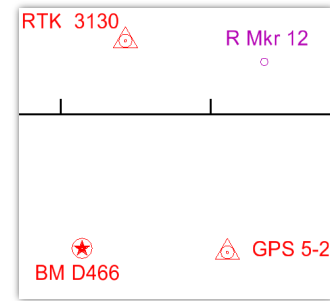
21-3.3 Control Data
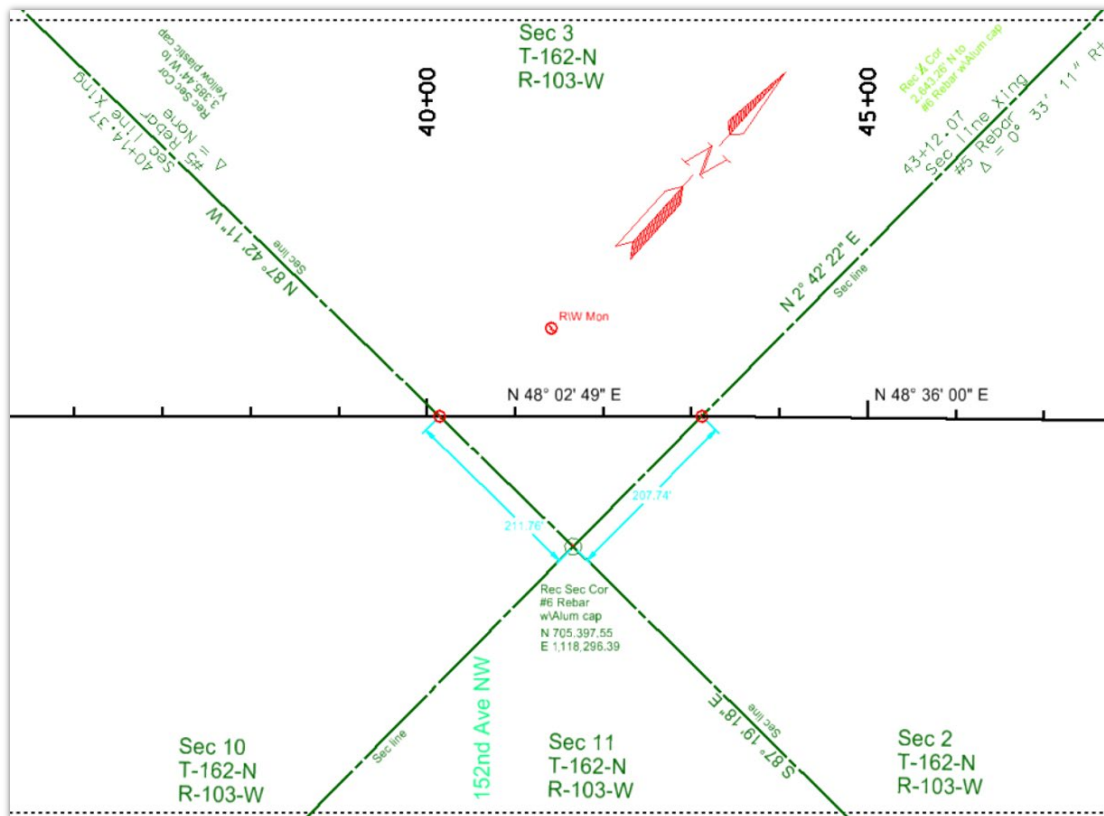
Survey Control Points

The primary control, secondary control and reference markers will all be labeled with the following abbreviations:

- Primary Control
  - Global Positioning System – GPS #
- Secondary Control
  - Real-Time Kinematic – RTK #
  - Control Point – CP #
  - Bench Mark – BM #
- Reference Marker – R Mkr #

See the Item Type section above for additional information about adding intelligence to these items for use within the 081CD.
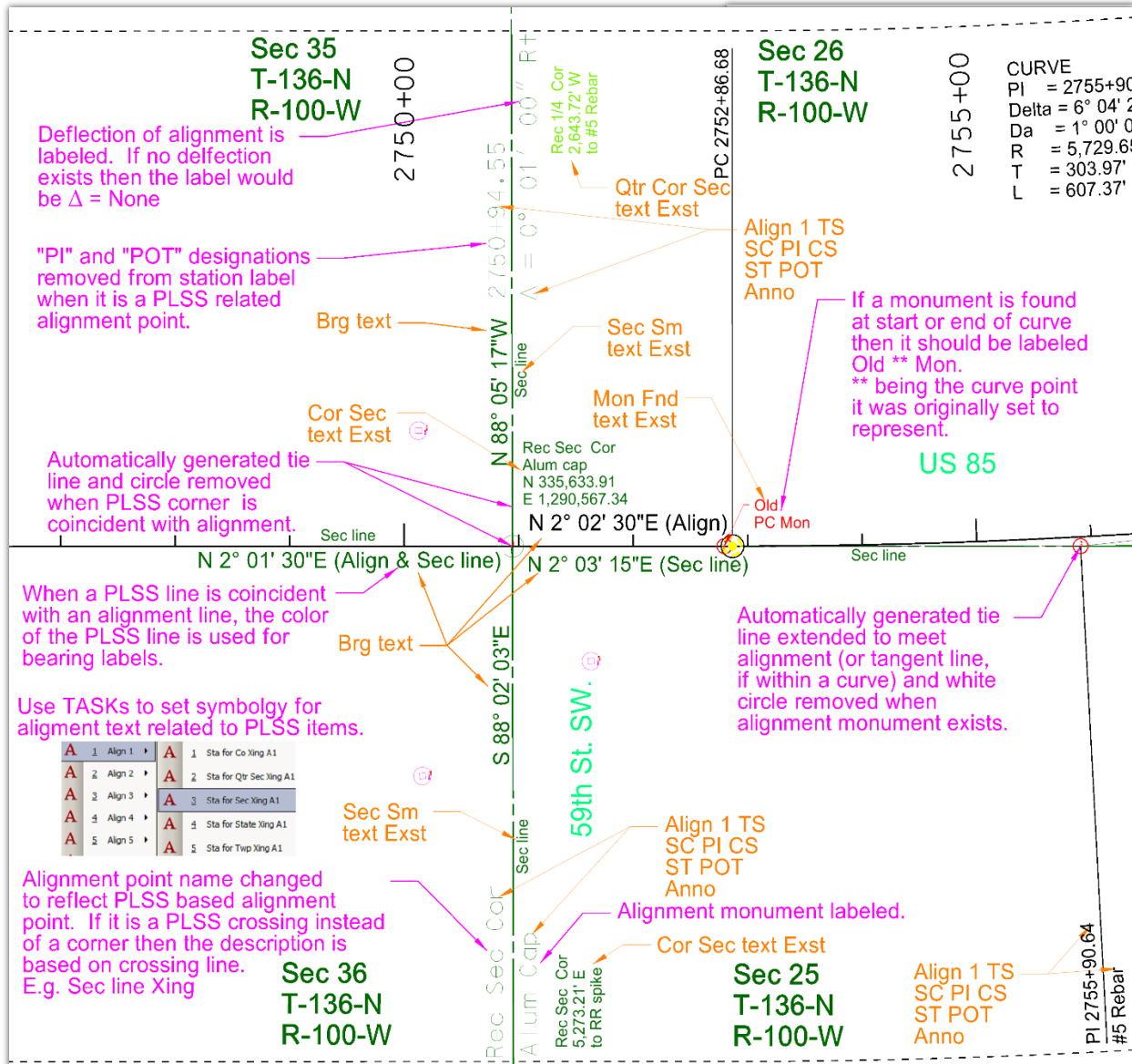
PLSS Lines

All PLSS lines need a label. E.g., Twp line. In cases where the PLSS line crosses the alignment, the PLSS line must also be labeled showing that it is in fact a PLSS crossing on the right side of the alignment. E.g., Twp line Xing. Up-station from the PLSS Xing label and PLSS line, the description of the Xing monument must also be included. E.g., #5 rebar. On the left side of the alignment, the PLSS Xing station will be labeled down-station of the PLSS line, and the deflection angle will be labeled up-station of the PLSS line on the left side as well.

The example above shows an exception to these placement rules. All labels are left of the alignment since there is not enough room between the crossing and the corner to place the labels.

In cases where the alignment point is defined as a PLSS corner, then the corner will be called out. E.g., Rec Sec Cor, Rec ¼ Cor, etc. A PLSS label will still be required. E.g., Twp line, Sec Line, ¼ Line, etc. PLSS line labels shall be placed about halfway between labeled PLSS corners and the design corridor. If the PLSS corners are within the design corridor, additional line labels will need to be placed on each side of the PLSS corner.

Any assumed section line or quarter line that is drawn onto the plans with only a single corroborating corner location to establish the drawn line shall be known to be a "constructed line" since there will be no labels stating, "distance to nearest corner" or "distance from alignment." PLSS lines shall not be drawn without at least a single corroborating corner.

These lines shall only be labeled as a "Sec Line" or "1/4 Line" even if they cross the alignment. No "Assumed" labels will be placed on PLSS lines. Other section lines and quarter lines that cross the alignment and do have monumentation will be labeled appropriately.
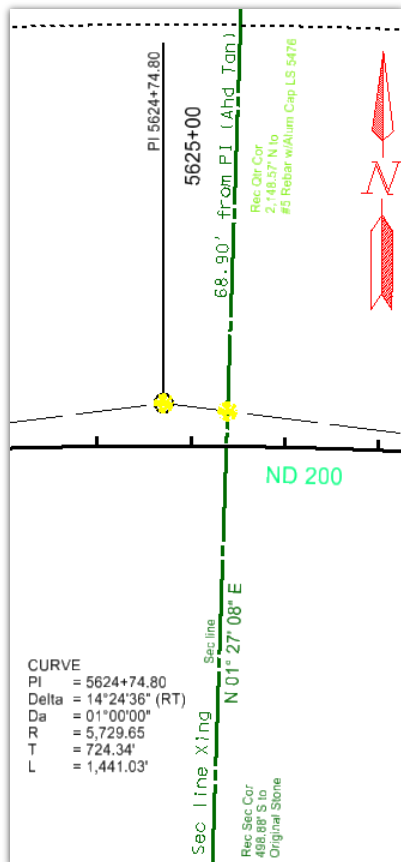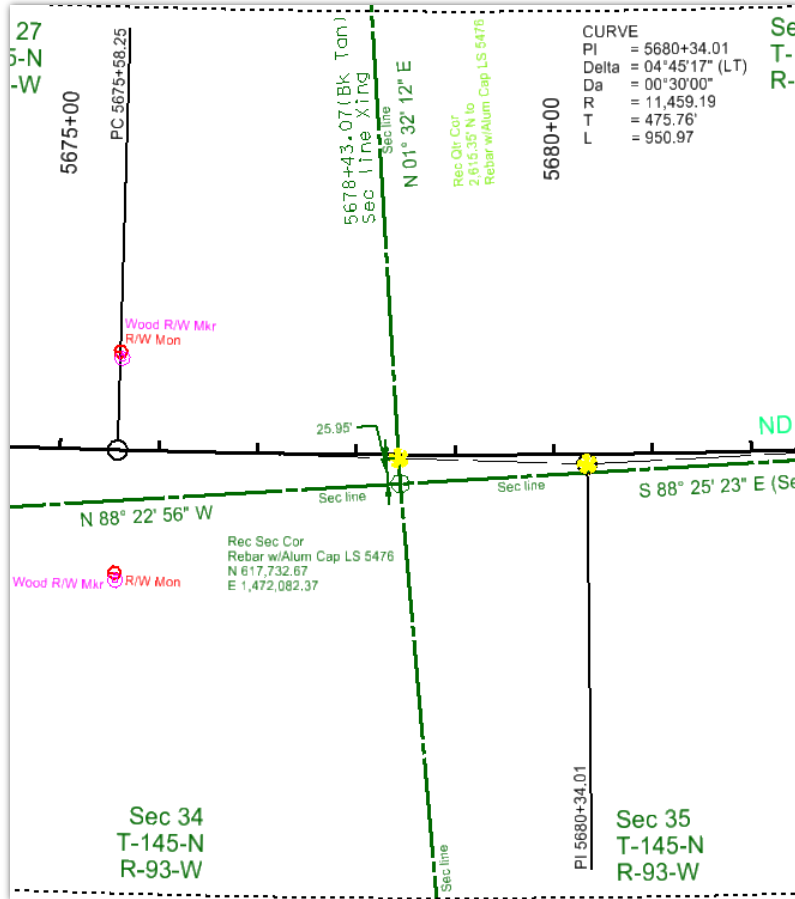
Bearing Labels

PLSS lines that have a PLSS corner on each end require a bearing label. PLSS lines with only one corner anchoring them do not. Refer to Bearing Labels in section 21-3.2 for more information.

Intersection Angles

At the intersection of two alignments or an alignment and a side road, there shall be a dimension angle placed to the nearest second. The dimension should have the leading zeros for the minutes and seconds. The quadrant or quadrants in which the intersection dimension angles are placed should be at the CADD editor's discretion to give the most beneficial information. See 21-3.5 example.

Tangent Lines

If a section line crosses the alignment within the back tangent of a curve, the crossing point is defined by the station of the Back Tangent. The Back Tangent station is defined by adding the station of the PC point to the distance from the PC point to the intersection point E.g. if Sta. PC = 5675+58.25 and distance = 284.79', then Bk Tan Sta = [5675+58.25] + [284.79] = [5678+43.07].There is no deflection angle label required in this case because there cannot be a deflection in the Back Tangent.

If a section line crosses the alignment within the forward tangent of a curve, the crossing point is defined by a distance to the PI or PT and not a stationing expression. No deflection angle label would be needed.

If an intersecting alignment meets the primary alignment on any tangent of a curve, the expression for the station equation shall be the station value **on the curve**, at the point of intersection … **not** an expression relating to the forward or back tangent. See Station Equations in section 21-3.2.

Appropriate dimension angles and lengths should also be added. The PLSS lines shall have a label for the back tangent e.g., 5678+43.07 (Bk Tan) and for the ahead tangent e.g., 68.90' from PI (Ahd Tan). This text shall be on the "Align # Line Anno" level and the color shall match the PLSS lines color.

PLSS Corners

All PLSS corners should show a dimension to the alignment unless they are located on the alignment or are outside of the design corridor.

PLSS corner labels shall include:

- If the corner is recorded it will receive the prefix of "Rec"
- Designation – Quarter, section, or township corner
- Distance and direction offset from alignment.
  - distance is from point on alignment or tangent line.
  - distances are from the alignment centerline/tangent line and not from the monument cells.
  - denote (nearest hundredths) distance from alignment to section corners.
- Description of monument
- Ties to corners that fall outside the design corridor will have a format like the following:

Rec ¼ Cor 2158.62' W to	Rec ¼ Cor
#5 Rebar w/Alum cap LS 1139	2158.62' W to
	#5 Rebar
	w/Alum cap LS 1139

- Corners within the Design corridor will additionally have their northing and easting labeled. They will also include their proximity to grade. E.g., If the monument is 0.4' below the ground, then they will include the label 0.4' BG on the same line as the monument. The color of the label should match the corner type. Possible formats for labeling the corner include:

Rec ¼ Cor	Rec ¼ Cor
#5 Rebar w/Alum cap LS 1139 0.4' BG	#5 Rebar w/Alum
N 123,456.78 E 1,234,567.89	Cap LS 1139 0.4' BG
	N 123,456.78
	E 1,234,567.89

NOTE: The "LS 1139" is the LS# stamped on the monument. No other information that is stamped on the cap will be included.

The section corner ties will be labeled for all PLSS corners that define a PLSS line which intersects or crosses the alignment. The exception to this rule is for corners that define the alignment. The distance and direction are not required in a separate label. The Corner type, monument, and coordinates are still required.

See the Item Type section above for additional information about adding intelligence to PLSS corner cells for use within the 081CD.

Sections

Sections shall be labeled and rotated to the alignment. Sections shall include the section number, township, and range.

Label the "Section, Township and Range" at township/section lines and the beginning and end of the project. From there, just place "Section" labels every ¼ mile for 100 scale or less (60, 40, 20, etc.) and every ½ mile for 200 scale.

Sec 2
T-162-N
R-103-W

Sec 2

R/W Markers

R/W markers have a unique symbology. If they are constructed of concrete or yellow plastic and in acceptable condition, then do not need to be labeled. If a R/W marker is damaged or made from a different material like wood, then the cell requires an accompanying label. E.g., Wood R/W Mkr, R/W Mkr broken, etc.

21-3.4   Uncommon PLSS Corners, Monuments and Points

Witness Corners

Scenario 1: *A witness corner exists on a preliminary survey. The PLSS corner that is witnessed by said witness corner DOES NOT exist or is calculated.*

The witness corner for CADD editing purposes will be treated like a common PLSS corner. If necessary, the distance tie from the alignment will be labeled.

> e.g.   Rec WC
> 102.56' S to
> #5 Rebar

- The witness corner itself will be labeled "Rec WC".

Scenario 2: *A witness corner exists on a preliminary survey. The PLSS corner that is witnessed by said witness corner DOES exist.*

- A dimension will be placed on the plans showing the distance between the witness corner and the PLSS corner.
- If an acceptable monument recordation form is provided, then the corner will be labeled "Rec WC".
- If an acceptable monument recordation form is not available, then the witness corner will be labeled simply as "WC" with no reference to its current recordation status.
- The distance from the alignment to the PLSS corner still needs to be labeled. Do not assume that a witness corner means that there is no existing corner.

Calculated Corners

In certain situations, it is impossible for a PLSS corner to be set due to the topographic conditions. In these circumstances a calculated PLSS corner cell may be utilized.

Scenario: *A corner used for the preliminary survey is calculated and will not be monumented or recorded. (e.g., a section corner in a lake that has a witness corner)*

- A cell will be placed in the DGN file representing this corner.
- The point will not receive the "Rec" prefix e.g., "Sec Cor"
- A distance tie from the alignment to the calculated corner will be labeled.

> e.g.   ¼ Cor
> 253.89' S

Closing Corners

If the distance from the alignment to the closing corner is less than or equal to 0.10' then the alignment point will be labeled as a "Rec closing Cor". If the closing corner is more than 0.10' away from the alignment (north or south of) then the alignment point will be labeled as a "Closing line Intscn".

In the case of a closing line intersection, the closing corner would be called out like any other adjacent PLSS corner. E.g.
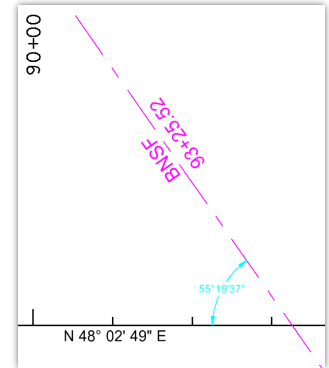
> Rec closing Cor
> 0.64' N to a
> #5 Rebar

Only Section and Township lines will bear the "Closing line Intscn" label. Subdivisions thereof (1/4 line, 1/16 line, etc.) will not receive this note. If there are any other PLSS monuments (1/16, 1/32, government lot, etc.) on a standard parallel, that belongs to the closing section, then it will get a label, Rec ¼ Cor, Rec 1/16 Cor, etc. plus the accompanying coordinate and monument label. Note that the term "Closing" was omitted from the label.

There should be no instance (or extremely rare) where these other PLSS corners are part of the alignment. This means that even if they fall within 0.10' of the alignment, they will NOT get stationed.

21-3.5   Railroads

Railroad centerlines that cross the alignment shall be drawn in the Control.dgn (CL RR line Exst) and have a dimension angle at the intersection with the station labeled along the railroad centerline. If the railroad centerline crosses the alignment within a curve, then refer to Section 21-3.3 – Tangent Lines for instructions.

21-4 Topog

21-4.1   General

The TOPOG file is the location of physical features such as roadway surface feature lines, trees, culverts, and utilities. Most of these features without unique symbology will need to be labeled. The CADD Standards Manual is a useful labeling resource.

Coordinate System

The correct geographic coordinate system should be set based on the NDDOT Geographic Coordinate System (GCS) library. See CADD Standards manual section 3.21 for additional information.
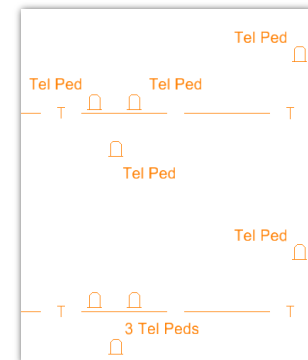
21-4.2   Annotation

There shall be **no labels overlapping** graphical elements or other annotation when the final Control.dgn and Topog.dgn are referenced together. There are only two exceptions for overlapping annotation. The first will be made for the Control.dgn large alignment station values that are automatically generated every 500' or 100', depending on the scale of the project. It is acceptable for these station labels to overlap line work, but not other annotation. The second is for the Exst Grnd Void feature. See below for additional details. Background masking shall not be implemented with any annotation.

All features with nonspecific symbology should be annotated. If there are numerous examples of the same feature, the annotation should be adjusted to cover all features.

Not Like this:

Like this:

Text Size

Annotation should be placed away from the survey centerline; to leave the project corridor clear of clutter. Some features such as manholes will need to be labeled at their location. Arrows can be used to move the annotation to a clearer part of the sheet.

Abbreviations

The use of abbreviations, to save space is recommended. However, if there is sufficient space on the sheet, the full worded description should be used. If a descriptive sentence is used incorporating several abbreviations, the use of capital letters should be used for each abbreviation e.g., "Conc Fdn with 7 FLS". This reads "Concrete foundation with seven fuel leak sensors". The capitalization "FLS" is used because there are three separate words described in the abbreviation. Upper and lowercase annotation is used in its correct grammatical form for unabbreviated words. The correct form of annotation would read "Br deck 44' wide" for "Bridge deck 44 feet wide" or "Sq Conc post" for "Square concrete post". The same rules apply for culvert ties.

Justification

The default text justification in our standards is Top Left. Text justification can be altered if required. Multi-line text items should remain Left justified. An example of when it would be beneficial to adjust the justification is if the data will be used at multiple scales. In the previous Tel Ped graphic, the text could be justified so that the origin was set to the point closest to the item it was describing. If the scale of the drawing changed then the annotation would expand away from its item as opposed to overlapping it. In the "Like this:" part of the graphic the "3 Tel Peds" would stay top left justified but the single "Tel Ped" label could be set to bottom right if the drawing needs to take advantage of being at multiple scales.

Questionable Features

During preliminary surveys there can be items from time to time that defy definition. Some of these may derive from items seen by the aerial stereo compiler or it may be a vertical 4" PVC pipe with no markings sticking 5' out of the ground identified by the field crew. All effort should be made to define all the graphics contained in the preliminary survey drawings. If an item remains questionable then the ⟨?⟩ symbol should be used in its label.

⟨?⟩ indicates a feature that has an unknown characteristic, potentially based on: Lack of description, location accuracy or purpose. One example of this might be a culvert where only one end could be found. Another example may be an item beyond the project corridor that was seen in the aerial photos but will not be field verified, like a utility box. This item may be labeled "Util box ⟨?⟩"

21-4.3   Cells

Many TOPOG features are represented by Cells. They are unique symbols used to represent commonly observed objects (e.g., highway signs, power poles, and utility pedestals, etc.) When labeling cells, the label should be oriented to match the alignment.

Threshold spot shots do not receive a descriptive label but instead an elevation label.

21-4.4   Line Styles

Many TOPOG features are represented by lines. The Line Style describes the shape of the line, e.g., dashed, dotted, or wavy. While features have their own line level, many still share line styles and colors so labeling is used for identification.

Some features have unique line styles, but a label might still be necessary to identify additional information e.g., a barbed wire fence is labeled "Wire" to identify the type and railroad tracks would be labeled "BNSF" to identify the owner as Burlington Northern Santa Fe. All utility lines should also have a label identifying the owner, type, and size. NDDOT Utility Abbreviations can be found in the CADD Standards Appendix F. Note that utility owner labels are always labeled in all caps.

Some line styles are direction specific e.g., curb and gutter lines or tree boundaries. These line styles should be checked and may need to be reoriented to correctly represent data.

Labels should be oriented to match the rotation of the line features and be readable when viewed from either the top or the right of a sheet as it would be printed.

Upon completion of the Terrain, the voids for the primary Terrain will be visualized in the Topog file using the Exst Grnd Void feature. Any of the void lines that represent a structure should be omitted from this process. In almost everything that is edited it is necessary to ensure that items are as legible as possible and overlapping text is addressed. The Exst Grnd Void feature line does not require this. It is acceptable for items to overlap it even if that makes them illegible.
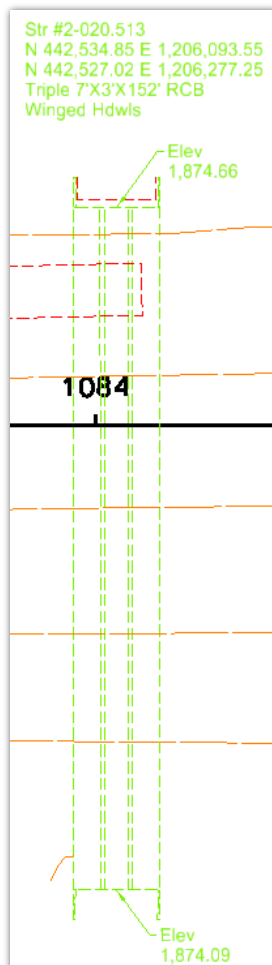
21-4.5　　　Structures

Labels for structures, such as bridges or box culverts, consist of the structure number, northing, easting, and a description. In addition, wing walls require labels for box culverts. The structure number and description can be found in the North Dakota Department of Transportation Bridge Listing.

The structure number will be listed first and abbreviated. The structure number will be labeled without any leading zeros. Hence the first line of a box culvert label with the reference point of 0018-207.031 will read Str #18-207.031.

The northing and easting coordinates for the beginning and ending of the structure will be extracted from the center of the total structure width on each end. The coordinates will be preceded by an "N" or an "E" and rounded off to the nearest hundredth. The second and third line of the label would read N 500,932.02 E 1,320,809.12. Note: The coordinates for bridges should be on the top of the road surface at the bridge deck, not the approach slab. The coordinates for box culverts should be the top, center, outside edge.

The structure description is found in the Bridge Listing book. The fourth line of the label would read Quad 8'x7.5'x269' RCB.

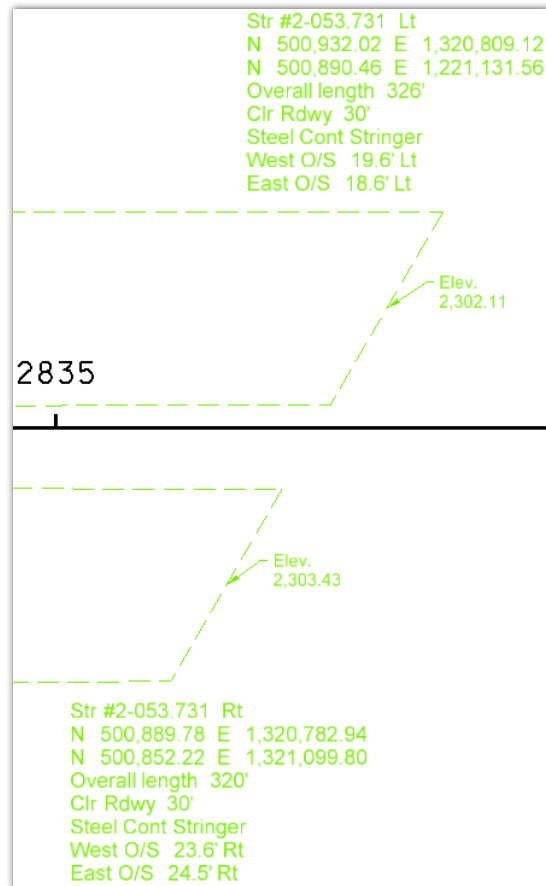When a box culvert has wing walls it needs to be labeled. The fifth line will read Winged Hdwls.

Bridge labels should include the length, width, and any offset. The length and width will be expressed as "Overall length and "Clr Rdwy". These can both be found in the Bridge Listing book. The offset will be the distance from the labeled coordinates to the survey centerline if it is greater than 0.10'.

All box culverts that lie within or begin inside the coverage area must be labeled. If a box is not in the Bridge Listing book, the structure number will be left off and the description will be derived from handwritten field notes or electronic field book data.

Elevations at the point of the shot used in the label for the coordinates will be placed on the plans with a leader. This shot should be on the top of the box/bridge in the center.

In the rare case where a pipe culvert appears in the bridge book then it should be labeled like a pipe culvert and include the structure number like a box culvert or bridge.

There are even rarer cases where a culvert consists of a box culvert and a pipe culvert. The label should be symbolized by the type of culvert that is exposed. E.g., Str #49-087.438 is a 35' RCB that was extended using RCP ends. This pipe is labeled and symbolized as a pipe culvert.

When dictated by the project parameters, the bridge clearance label will be added. At a minimum this will show the shortest clearance distance from the highway to the bridge. It will be shown on both bounds if it is a divided highway. Additional clearance label locations may be requested other than the minimum clearance. This would be done on a project-by-project basis. The label should include a note/dimension arrow and read "Clearance height ##.##'", shown to the hundredth of a foot.

21-4.6   Pipe Culverts

Barrel Length

The barrel length of a pipe culvert is that portion of the pipe without any end sections. Information on standard end section sizes consult Standard Design Drawings D-714-1 through D-714-11. All pipe data, including the label and the graphical element in the drawing, should reflect the barrel length.

The correct location for a field EFB shot on a culvert is on the flow line at the end of the barrel which includes the "C" distance. This point works out to be a shot on the flow line as close to inside the pipe as you can get.

Once you have this shot you can subtract the "C" distance as listed on the Standard Design Drawings to get the Barrel length. The "C" distances for the common sized reinforced concrete pipe flared and traversable end sections are shown below.
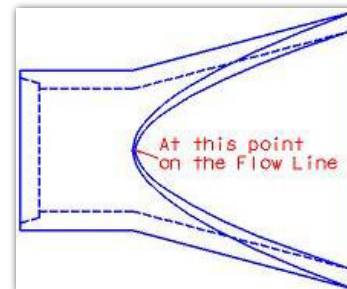
The culvert graphic in the DGN file should be shortened by the corresponding "C" distance. This may require shortening both ends, one end or maybe each end by a separate value. Even though you are modifying the culvert graphic, the original survey shot, and elevation should not be changed based on the "C" distance. The label for these shortened pipes should show the station and offset to the adjusted graphic, and not for the original visualized graphic.

The reinforced concrete pipe (RCP) that the NDDOT installs has always been manufactured in even foot increments (2', 4', 6', and 8' segments). This means that the actual barrel length of an RCP is always mathematically an even number. A seal ring is placed between each segment of the pipe and the pipes are assembled. The soil is then packed on top of this pipe. At this point several things can happen.

- It is possible that the segments were not butted up to each other as tight as possible during installation.
- The compaction of the dirt on the pipe can cause small separations to begin to form which pushes the pipes apart.
- As time goes on, any water that seeps into the joints goes through the freeze and thaw of winter and can push the segments apart.

This separation of the segments can be a couple of tenths between each pipe segment. A 96' culvert comprised of 8-foot segments will have 11 of these joints or seal rings. A couple tenths of separation per joint equals over 2' of separation. This example is in extreme cases, but small separations do happen on almost all RCPs. The designers only want to know what the actual barrel length is for their calculations and reclamation. This job of determining the "Actual" barrel length was put on the CADD editors of our department (and you). So, if an RCP was assembled perfectly and no separation has occurred you would end up with a perfect even number every time.

Our field crews do, however, have tolerances that they work within. Imperfect equipment, bad satellite coverage or even a slight lean in the pole while collecting the culvert point could push the XY tolerances of the culvert location to a tenth or so. This means that theoretically a perfectly placed 96' culvert collected with poor satellite coverage could end up being 96.42' long. This is why we use the "2' (round down)" rule when it comes to RCP lengths. Occasionally, when a culvert is a couple hundredths short of an even number, you may round up, but it is almost always down. Remember, **RCP** barrel lengths are **ALWAYS EVEN**, if you end up with an odd length pipe it may be useful to consult the original

plans for some guidance. The surveyed pipe length will always take precedence over the original suggested length. E.g., the surveyed length is 264.73', the plan was 262', then the labeled distance will be 264'.

Corrugated steel pipe (CSP) is delivered in various sizes, but they are always in 1-foot increments. In the field they will cut them to size if necessary. The designers always call for them to be installed by 1-foot increments (80' or 95', not 93.12'). We will always round the barrel length down to the nearest foot for these pipes.

The original plans should be used as an aid with editing culvert data. The plans are useful to determine the existence of culverts and sometimes assist with determining the size and type. They are not very useful in determining the length of culverts being that so many culverts have been altered or extended during the past.

It is difficult to measure the size of culverts in the field sometimes. If the original plans call for a pipe diameter that is very close but different than the information provided by the field crew, it may be a good idea to have the culvert size verified in the field.

The "C" distance described below is only a reference. These distances have changed throughout time. E.g., 30" flared end sections installed in the 1960's has a "C" distance of 3.65'. The "C" distance should be found for each project in the original plans.

RCPF Diameter (in.)	12	15	18	21	24	27	30	36	42	48	54	60	66	72-84
C Length (ft.)	4.08	3.83	3.83	3.13	2.50	2.00	1.65	2.90	2.92	2.17	2.69	3.25	2.25	1.75

RCPT Diameter (in.)	15	18	24	30	36
C Length (ft.)	0.75	0.75	1.00	1.00	1.25

See original plans or standard drawings section D-714 for more information.

The C value for corrugated steel pipe is 0.00' for all pipes less than 42" in diameter. For corrugated steel pipe from 42" to 84" the "C" distance is 1.00'.

Culvert Inverts

Culvert invert elevation labels will be placed on all culverts that were accurately located with standard survey procedures. This will be the elevation of the original survey shot and not based on the graphic that has been modified by the "C" distance trimming.

Survey Field Book Codes and Descriptions

The field book definitions of pipe culverts are used to create the Pipe Culvert Labels. The following explains what each part of the definition means and how to read them. **NOTE:** These definitions will appear different in the original ASCII files. This section reviews **only** the definitions as they appear in drawing **after** they have been processed in Open Roads Designer.

The ascii field code example of +24RCPF*FP PLUGGED will be used herein. The condition of each end of the culvert barrel, along with the condition of each end section if applicable, will be added to the field book description decoration e.g., FP PLUGGED.

The above example shows the beginning of a 24" Reinforced Concrete Pipe with a Flared end section. The barrel is in fair condition, the flare is in poor condition, and the additional description shows it to be plugged.

The first part of the field book code is either a plus or minus symbol e.g., +24RCPF. This symbol is defined as a linking code in Open Roads Designer. It lets the program knows to start drawing a line at the + and stop drawing the line at the -.

The second part of the code is the diameter of the pipe in inches e.g., 24RCPF. In most cases this number should be in even increments. If you come across an unusual culvert like a 33", you will need to verify the information in the field book explaining the culvert.

The third part of the code is the culvert type e.g., 24RCPF. Culvert types include:

- CSP - corrugated steel pipe
- CPP - corrugated plastic pipe
- RCP - reinforced concrete pipe
- CIP - cast iron pipe
- PVC - poly-vinyl chloride
- CAS - concrete asphalt pipe
- SPP - structural plate pipe

If a pipe has a flared end section, an "F" is added to the end of the "culvert type" e.g., +24RCPF, a "T" is used for traversable end sections. The abbreviations for common end section types are:

- CSFES - corrugated steel pipe with flared end section
- CSTES - corrugated steel pipe with traversable end section
- CPFES - corrugated plastic pipe with flared end section
- RCFES - reinforced concrete pipe with flared end section
- RCTES - reinforced concrete pipe with traversable end section
- CIFES - cast iron pipe with flared end section
- PVCFES - poly-vinyl chloride pipe with flared end section

This ends the code part for the culvert. This is the name decoration in ORD.

The field book description will contain the condition/description. The first letter is the condition of the barrel of the culvert e.g., FP PLUGGED. "G" represents good, "F" represents fair, and "P" represents poor.

The second letter represents the condition of the end section, if applicable e.g., FP PLUGGED. "G" represents good, "F" represents fair, "P" represents poor, and "N" represents none.

When the condition of the pipe or end section is added to the label, the worst condition for the item is used. It is common for one end section to be in poor condition while the other end is in good condition. In this case you would just label the condition as poor. It is much less common but the same holds true for the condition of the pipe.

In some cases, there are culverts that only have an end section at one end. In this case, the condition letter on the end of the culvert that does not have the end section is "N". For example, an 18" CSP, one end has a traversable end section, and the other end does not. The barrel at one end is in fair condition, and the traversable end section is in good condition, the code would be +18CSPT and the description would be FG. At the other end of the culvert, the barrel is in good condition but there is no end section the code would be -18CSPT while the description would be GN.

Arch type culverts need to be addressed differently. When you look at the ASCII file you will notice that it has an (*) asterisk between the code and description that is shown in the DGN file. The size of the culvert will be added to the point after the asterisk (*) e.g., +RCPF*60x45GF. The culvert is an RCP with a flared end section, the barrel size has a 60" span with a 45" rise which is in good condition and the flare is in fair condition.

Additional notes may be added as needed such as "plugged", or "too small", etc. after the condition letters. There are times when additional descriptions for the culvert are needed but are too long to type into the data collector. These longer descriptions should be entered in the hardcopy field book in a chapter for "culvert details". Extra notes like "large beaver dam at inlet" or "6-foot-deep scour at outlet" may be seen. If additional notes were needed, the code and comment for the culvert should look like this: +24CSPF*GP SEEFB. The "SEEFB" represents (see hardcopy field book). This should alert the CADD editors that additional data available and can then look up the information. The following are examples of how the culverts are coded.

A 24" RCP with traversable end sections, the barrel is good, and the end sections are poor on both ends of the culvert.

Pt. #	Northing	Easting	Elevation	Code*Description
5001	501564.0258	2489254.6578	2500.5468	+24RCPT*GP

	5004	501568.1258	2489220.4578	2501.0254	-24RCPT*GP

A 36" CSP with flared end sections and is in good condition, but one end is plugged.

Pt. #	Northing	Easting	Elevation	Code*Description
489	506245.3658	2478658.2498	1645.2451	+36CSPF*G
490	506290.2456	2478651.1254	1647.2541	-36CSPF*G PLUGGED

A 6" PVC with one end in good condition, no end section, and unable to locate the other end.

Pt. #	Northing	Easting	Elevation	Code*Description
542	503904.6958	2483956.4538	2072.8960	+6PVC*G SEEFB

In the field book under "Culvert Details", the point number of the culvert can be found along with a description of the situation; #542 a 6" PVC was found as an outlet. Could not locate the inlet end, but it could possibly be a roof drain outlet from the nearby building at 1903 N State St.

Labels

A pipe culvert label consists of four basic parts: location, pipe type, pipe condition and end section description. This information can be found in the EFB Description. The amount and type of information in the label will vary dependent on how the pipe lays on the ground compared to the alignment. There are five styles of labeling culverts: Centered, Non-centered, Parallel, Perpendicular, and Skewed. Except for the Skewed style of pipe, the last two pieces of information (pipe description, and end section description) are the same on all culvert labels.

There are many text levels available for culverts. The item used for the station, offset, and type is the "Exst Ties Culv". The item used for the culvert elevations is the "Culv Elev text Exst". The level "Exst Culv" is seldom used for labels outside of miscellaneous notes.

The station and offset of the pipe will begin each culvert tie label. The culvert label style will determine its contents as well as its proximity to multiple alignments. If a culvert is within 300' of more than one alignment then the station and offset line shall be appended with "(Align:xxxxx)", where xxxxx is the name of the alignment being used for the station and offset values. See the Centered Culvert example below.

The pipe description consists of the pipe's inside diameter, an "X", barrel length (please see the description below), and the type of pipe. Lengths are rounded down to the nearest foot for CSP and rounded down to the nearest even foot for RCP. E.g., 24" X 62' RCP.
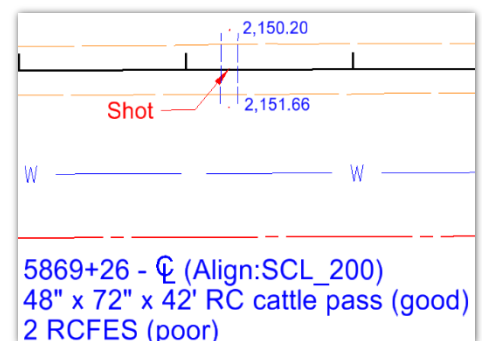
The end section description is simply the number and type of end sections. Using the example: a pipe with two flared end sections in good condition would read "2 RCFES (good)". If, however you only have one flared end section you need to say what end it is on, it may read "1 RCFES (good, S end)". You have the option of whether to include this end section on the same line as the pipe description. If this choice is made, then the two descriptions should be separated by a dash.

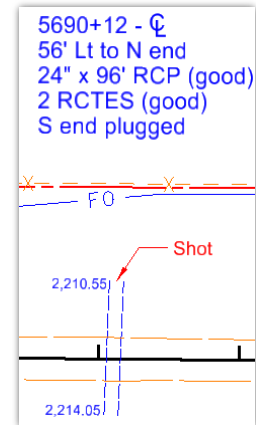E.g., 24" X 62' RCP - 2 RCFES (good)

Perpendicular as listed hereafter is defined as: Any culvert whose endpoints have a difference in station of less than five feet.

Parallel as listed hereafter is defined as: Any culvert having one endpoint no closer than five feet to the alignment than the other.

- A **Centered Culvert** is a pipe perpendicular to the alignment, with its midpoint no more than five feet from the alignment.
    - o The location label will have the station followed by a dash and the letters "₵". The station will be at the midpoint of the pipe.
    - o E.g., 5869+26 - ₵
    - o The Pipe and Flared end section descriptions will follow

5869+26 - ₵ (Align:SCL_200)
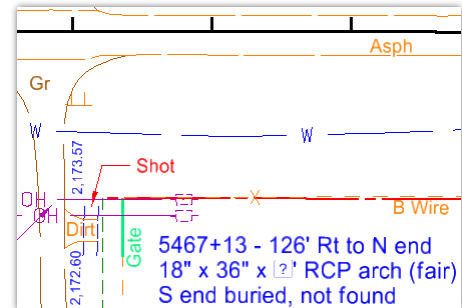48" x 72" x 42' RC cattle pass (good)
2 RCFES (poor)

this as described previously.
- o This example includes a culvert existing near multiple alignments. The alignment feature name is appended to the first line to clarify.
- • A **Non-centered Culvert** is a pipe crossing the alignment and perpendicular to it, with its midpoint displaced more than five feet from the crossing point of the alignment.
  - o The location label will be to the furthest end of the pipe from the alignment. The first line of the label will have the station followed by a dash and the letters "$\mathbb{C}$". E.g., 5690+12 - $\mathbb{C}$
    The second line will have an offset distance, the direction of the end and which end it is. E.g., 56' Lt to N end
  - o The Pipe and Flared end section descriptions will follow this as previously described.
  - o If additional information is needed to describe the functionality of the pipe it can be placed at the end of the label.
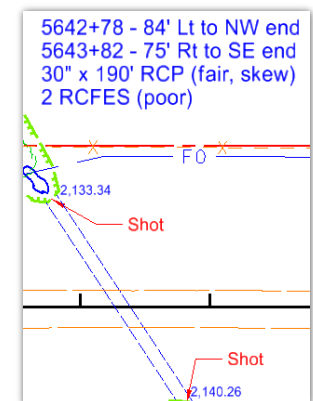
- • A **Parallel Culvert** is a pipe that lies parallel with the main alignment within a tolerance of plus or minus five feet.
  - o The location label will have the station, a dash, offset distance, and direction, all of which will describe the midpoint of the pipe.
  - o E.g., 5509+36 – 51' Rt
  - o The Pipe and Flared end section descriptions will follow this as described before.

- • A **Perpendicular Culvert** is one that does not cross the main alignment and is perpendicular to the alignment.
  - o The location label will be to the end closest to the alignment. The label will contain the station, a dash, offset distance, offset direction, and which end it is.
  - o E.g., 5467+13 - 126' Rt to N end
  - o The Pipe and Flared end section descriptions will follow this as previously described.
  - o This example labels a culvert where one end was not located. A note explaining the situation was added. The ? (\208) was added in the place of the length.

- • A **Skewed Culvert** is neither perpendicular nor parallel. Any culvert that is over five feet from either parallel or perpendicular to the alignment is skewed.
  - o The location label for skewed pipes has two lines. The first line of the label will be the end point of the pipe with the lesser station value. Both lines have the following guidelines. The label will consist of the station, dash, offset distance, direction of the offset from the alignment, and which end it is.
  - o E.g.   5642+78 - 84' Lt to NW end
            5643+82 - 75' Rt to SE end
  - o The description of the pipe will be followed by the word "skew" in parentheses.
  - o E.g., 30" X 190' RCP (good, skew)
  - o The end section description on skewed pipe is usually on a separate line from the pipe description.

The placement of the culvert labels should be close to the culvert itself. A general rule of thumb is to put the center of the label at approximately the same station as the center of the culvert. The label

should be just outside the right of way with enough space to add one additional line of text without overlapping other graphics. However, the labels should always remain inside the design corridor. It may be necessary to shift the label up or down-station to accommodate the overlapping features.

21-4.7   Underground Utilities

Approximate Utility Line Placement

It is always the best practice for underground utility lines such as electric, fuel, fiber optic, gas, telephone, television, and water to be field surveyed. In some circumstances, this is not an option. Utility lines may need to be placed in the Topog.dgn based on other sources such as maps or graphics received from the utility company.

When means other than direct field locate are used to place the graphics, additional annotation is required. The label "Approx Loc" needs to be added to the utility lines at the appropriate interval based on the scale of the project. The label should use the same symbology as the owner label. A disclaimer statement, using the same symbology, needs to be added within the design corridor at an interval so that it will display on every plan sheet of the project where the approximate location of the line exists. The disclaimer should state the origin of the information used to place the line. For instance, "The FO lines labeled Approx Loc in this vicinity were placed using GIS shape file received from Babble Communications Inc."

The supplementary maps or graphics should only be used if the owner of the line is responsible for the content of the data. Previous surveys should not be considered viable for placing utility line within the preliminary survey.

Sanitary Sewers

Sanitary sewer lines should be placed in the Topog.dgn at their correct flow line elevation. The flow line elevation is typically derived from information provided by the field crew. This data can be found in SFN 61145 provided by the survey field crew.

The horizontal location for the pipe end is usually the center of a manhole. This position may not be horizontally accurate, but it will still provide enough information to the designers when it is at the correct elevation.

The sanitary sewer line shall have a label denoting the size and type. E.g., 8" PVC

Storm Sewers

Storm sewers and culverts perform a similar purpose and for this reason sometimes a storm drain is shot as a culvert. If a drainage feature has one or less features between its inlet and outlet, then it is a culvert. If there are two or more features, then it is considered a storm drain. These features can be anything from slots cut in an RCP to allow drainage in the median to lift stations. Typically, they are curb inlets and manholes.

Storm sewers or storm drains should be placed in the Topog.dgn at their correct flow line elevation. The flow line elevation is typically derived from information provided by the field crew. This data can be found in SFN 61145 provided by the survey field crew.

By default, storm drain lines are visualized using the Exst SD symbology, level *SD Line Exst*, color 7. Once **both** ends of a line have been properly modified to the correct flowline elevation, then the symbology shall be altered to use the Exst SD Elev Adj symbology. This uses the same level but changes it color to 8. If only one end can be adjusted then the line should retain the original symbology, color 7.

The horizontal location for the pipe ends that are not inlets or outlets are generally placed at the origin of the feature cells like curb inlets and manholes. This position may not be horizontally accurate, but it will still provide enough information to the designers when it is at the correct elevation. The inlets and outlets should be accurately located horizontally and vertically by the field crew.

Storm system will only have elevation labels placed in the dgn at inlets and outlets. The lines for the storm line shall have a label denoting the size and type. E.g., 24" RCP
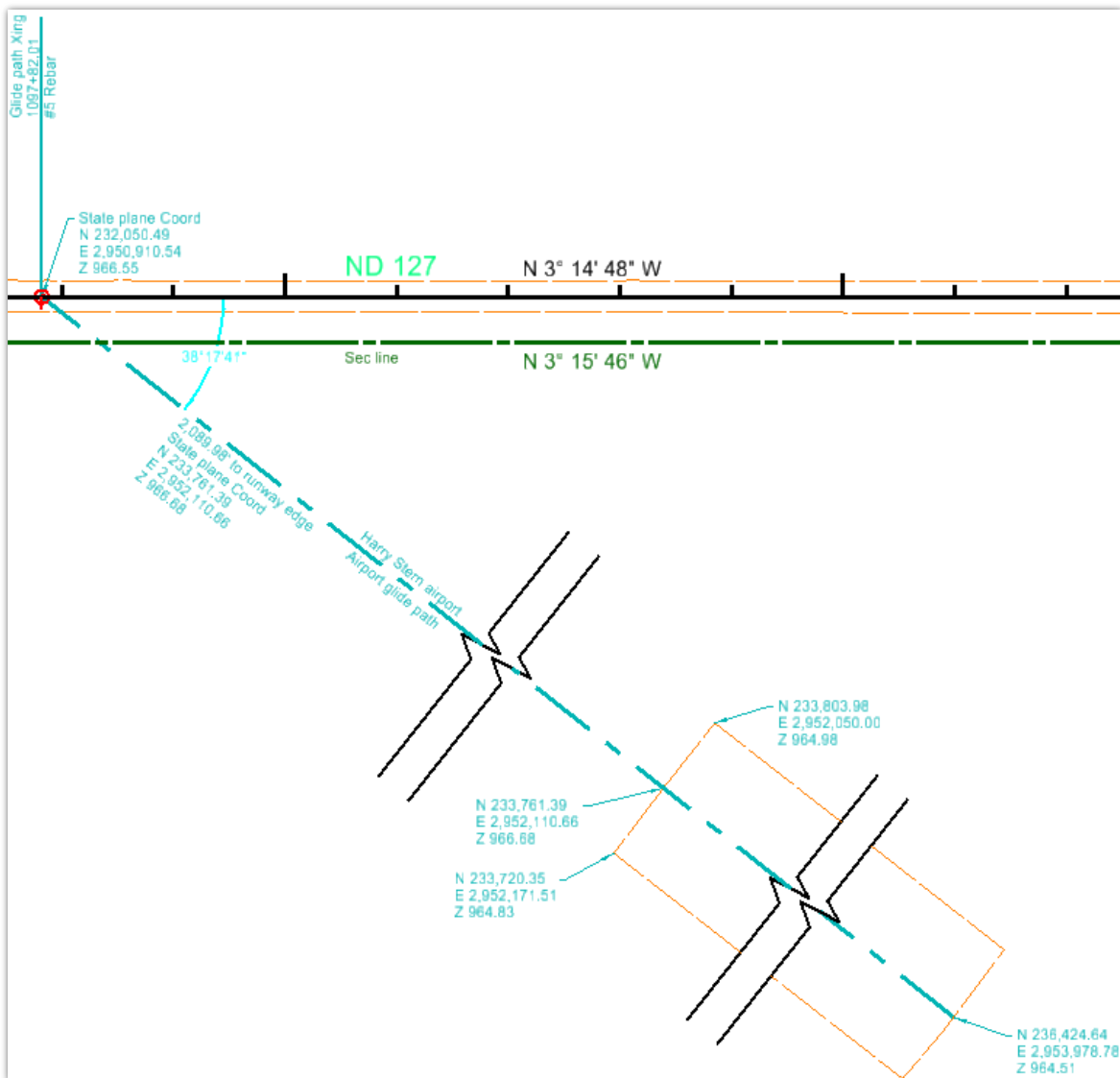
Overhead Utility lines

All Overhead utility lines within the survey corridor shall be shown in the Topog.dgn. This includes lines crossing the centerline and those running parallel to it. Overhead lines that transition to underground lines shall be annotated, "Drop line" or "PP w/drop" at the pole.

The clearance height for overhead utility lines that cross the primary centerline shall be labeled. This will include any overhead utility line crossing for primary alignment and side roads. The label should include a note/dimension arrow and read "OH clearance height ##.#'", shown to the tenth of a foot. This height shall be for the shortest gap between the road surface and the lowest overhead line. A label will be needed on both bounds if it is a divided highway. Normally this is at the crown of the road, but it may vary depending on the sag of the line or if the roadway is superelevated where the crossing occurs.

21-4.8   Airports

Check with **surveyors** to see if requirements for airports have been fulfilled.

- All airport information resides in the Topog.dgn drawing.
- Airport requirements are listed in the survey manual in Chapter 19-6.4 & 19-14.
- The runway should be drawn using the surface line style corresponding to its surface type (asphalt, concrete, etc.).

- The glide path should be shown starting at the far end of the runway, extending through the near end of the runway, and intersecting the alignment. This line should be labeled "Airport glide path".
- This intersecting point will be labeled similarly to an alignment point. The labels should take on the "Exst Path Glide (05)" level. The following items will need to appear on the tie line.
  - "Glide path Xing"
  - Stationing
  - Monument
- Label the distance from the near end of the runway to the survey centerline within the design corridor.
- The near end of the runway should be labeled with the Northing, Easting **(IN STATE PLANE COORDINATES)** and Elevation at the centerline and both corners.
- The coordinate label for the centerline of the runway should be duplicated within the design corridor.
- The far end of the runway should be labeled with the Northing, Easting **(IN STATE PLANE COORDINATES)** and Elevation at the centerline.
- The Northing, Easting **(IN STATE PLANE COORDINATES)** and Elevation of the survey centerline crossing should be labeled.
- All labels in state plane coordinates within the design corridor shall be labeled as "State plane Coord".

21-4.9   Railroads

Railroad ownership must be labeled; current accepted abbreviations are:

BNSF Railway (BNSF)
Canadian Pacific Railway (CPR)
Dakota, Missouri Valley & Western (DVMW)
Dakota Northern Railroad (DNRR)
Northern Plains railroad (NPR)
Red River Valley & Western Railroad (RRVW)
Yellowstone Valley Railroad (YSVR)

The RR profile located by the field crew on the top of the rail shall be annotated in the Topog.dgn. An elevation will be shown for each rail at each of the shots near the right of way and the centerline for a total of 6 elevation labels.

21-5 DTM

21-5.1   General

Digital Terrain Model includes extractable features, including spot shots, break lines, voids, edges of roadways, concrete surfaces, and edges of water etc.

Coordinate System

The correct geographic coordinate system should be set based on the NDDOT Geographic Coordinate System (GCS) library. See CADD Standards manual section 3.21 for additional information.

Terrain DGNs

Terrain_Exst.dgn

Surface files containing accurate survey data representing the project which show a continuous roadway surface for the primary alignment.

Terrain_Exst_Alt.dgn

Surface files containing accurate survey data representing the project and alternate information that would disrupt a continuous surface for the primary alignment. This would typically be overpass, underpass and/or hydraulic data. This allows for profiles to be cut on side streets that cross our alignment over/under a bridge, stream profiles or maybe even railroad profiles at a railroad separation.

No Voids Terrains

Surface files that contain areas with heavy vegetation, and heavy shadows etc. that have been identified during the compilation/extraction process as having compromised accuracy. These terrains should produce a continuous area of coverage for the entire project corridor. These files are created using best guess stereo plotter data and or compromised point cloud extracted data inside the obscured boundary. This best guess data shall **Not** be included in the Terrain_Exst or Terrain_Exst_Alt datasets.

See the [CADD Standards](#) manual section 5.4 for more information.

21-5.2   Editing

- All data used for Terrain extraction shall exist in the 3-D DTM.dgn file.
- The extractable data will be a combination of DTM spots, DTM break lines, DTM voids, and surface features such as: concrete edges, field lines, asphalt, dirt, and curbs.
- Any crossing break lines **Need** to be addressed and edited.
- Extraneous triangle sides that fall outside of the surface features must be eliminated. **Do Not** edit the terrain file, only the graphic data should be modified to address this issue.
- All obscured areas identified must be addressed for completeness within the limits required for the design of the project.
- When necessary two versions of the terrains shall be produced from the DTM.dgn. A version showing a continuous roadway surface for the primary alignment (Terrain_Exst.dgn) and one showing alternate overpass, underpass and/or hydraulic surface data (Terrain_Exst_Alt.dgn).
- All terrain data needs thorough checking for errors and omissions. Approved methods include:
  - Generating temporary cross sections throughout the project corridor at least every 25 feet.
  - Rendering the surface model and applying light from various angles to observe surface deviations and holes.
  - Generating centerline profiles along highways and side roads to check for road surface continuity.
  - Creating contours throughout entire surface model to visualize surface ambiguities and "spikes".
  - Creating thematic maps to visualize elevation ramps and anomalies.

Enclosing Break Lines

The outer edge of all break lines and DTM spots should be enclosed such that a perimeter with no gaps surrounds the area that will be used to create the terrain. Extract this feature as a Break line. This will allow for an extraction of the surface model using the edge method of Max Triangle Length set to a value of one foot to eliminate extraneous exterior triangles. Do not use the "Boundary" extraction type.

Flow Lines

Flow line data encompassed in the enclosing break lines mentioned above will be included in the DTM and used in the creation of the terrains. The Topog file will contain flow line data **only** if it is

outside of the surface extent. The Bridge Section should be consulted as to whether it will be necessary to create a StreamProfile.dgn file containing all flow line data.

Obscured Areas

Any area that does not have a clearly recordable surface such as deeply shadowed areas, tall grass, and marshland should be designated as an obscured area. If questionable features have been found to be accurate, then they should be modified to show this fact. E.g., after field verification if an Obscured Break line meets necessary survey accuracies, then it should be changed to a regular DTM Break Line. Any data that remains questionable should be contained within a closed shape that exists on one of the Obscured Bndry levels, whichever version is appropriate.

The DTM Obscured* levels will only be extracted into their own No Voids terrain file if the project manager requests it.

In the primary terrains (Terrain_Exst.dgn and Terrain_Exst_Alt.dgn) these Obscured Bndry levels should be extracted as Break Voids. This is an important process. The primary terrains must be relied on to have survey quality surface data. The No Voids terrains are there if an approximation of the surface is required to complete certain aspects of Corridor Modeling.

Structures

All extractable structures such as box culverts and bridges should be copied into the DTM.dgn from the Topog file.

Surfaces

All extractable surfaces such as roadway, curb and gutter, and riprap surfaces should be copied into the DTM.dgn from the Topog file. When the terrains are created only those parts of the features above the surface should be included.

Voids

Any area that is not to be included in the terrain file such as water and obscured areas should be voided when the terrain is created. All voided areas must be closed shapes. When the terrain is created the void perimeters will act as extractable features.

Once the terrain is complete the void lines will need to be visualized in the Topog DGN. See section 21-4.4 for addition information.

Graphical Filter Extraction

Graphical filters have been set up for the standard extraction of preliminary survey DTM graphics. There are 4 Graphical Filter Groups, "Exst & Alt 1", "Exst & Alt 2", "NO VOIDS Exst & Alt 1", "NO VOIDS Exst & Alt 2". They are tied in very tightly with the use of the CADD Standards. See the DTM.dgn section of the CADD Standards Manual, Appendix Q for more information.

21-5.3   Survey Field Book codes

A list of currently accepted field book codes can be found in the CADD Manual's Appendix I.