

Chapter Twenty-three
PLAN PREPARATION (Geometrics)

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Chapter Twenty-three

PLAN PREPARATION (Geometrics)

[Chapter Three](#) in Part I addresses issues applicable to all design units involved in the preparation of construction plans for traffic design projects, including information on sheet sizes, drafting guidelines, computerized design, etc. Chapter Twenty-three presents guidelines that are specific to the preparation of the geometric detail plan sheets. Where the Geometrics Unit is responsible for preparation of a complete set of construction plans (e.g., title sheet, typical sections, summary sheets, cross sections), the geometric designer should also review the plan preparation guidance provided in Chapter Four of the Montana Road Design Manual.

23.1 GENERAL GUIDELINES

23.1.1 Example Geometric Plans

When developing a set of construction plans, it is often useful to review an example set. [Part VII “Miscellaneous,”](#) provides a typical set of construction plans.

23.1.2 CADD Standards for Geometric Plans

See MDT CADD Standards Manual for guidance on file naming requirements, cell libraries, symbology and other CADD requirements.

23.1.3 MDT Detailed Drawings

The MDT Detailed Drawings provide information on design elements that are consistent from project to project. They typically are not included in the plan set. Rather, they are referenced as needed on individual plan sheets. [Section 4.2.4](#) provides additional information on the MDT Detailed Drawings.

23.1.4 Organization of Geometric Plans

23.1.4.1 Sheet Sequence

For consistency from project to project, the construction plan sheets for geometric projects should be assembled in the sequence presented in [Section 3.1.2.1](#).

23.1.4.2 Sheet Numbers

Consistently using the MDT sheet numbering convention is important. The Title Sheet will be considered as page one but will not be numbered. All other sheets within the plan set will be numbered according to the guidelines presented in [Section 3.1.2.2](#).

23.1.5 Drafting Guidelines

The drafting of individual plan sheets will be performed using the MicroStation CADD and GEOPAK software packages. The [MDT CADD Standards Manual](#) provides specific drafting guidelines (e.g., plan abbreviations, drafting levels, annotation guidelines, stationing, sheet breaks) that should be employed when preparing construction plans for geometric projects.

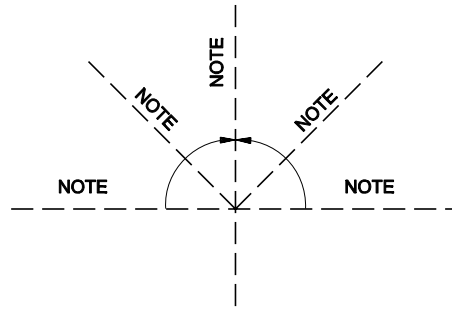
23.2 PLAN SHEET CONTENT

Prepare the construction plans as simply as practical. Avoid the use of duplicate data and unnecessary cross references. [Section 23.1, Chapter Three, MDT CADD Standards Manual](#) and Chapter Four of the [Montana Road Design Manual](#) provide general guidelines for preparing construction plans for geometric projects. The following sections provide additional guidance on what should be included on typical geometric detail sheets.

23.2.1 General Details

For each of the geometric details in the following sections, include the following:

1. Project Block. On all sheets except the Title Sheet, provide a standard project block in the upper right-hand corner. The project block will contain the State, project number and sheet number.
2. Title Block. Provide a standard title block in the lower right-hand corner of each detail sheet. The title block will typically contain the project number, sheet title, street or ramp name, and/or location information (e.g., road, intersection, interchange, city and county names).
3. Scales. For most geometric details, use a scale of 1"= 50' (1:500). This will typically allow each detail to fully fit on a plan sheet. For those design elements requiring additional delineation, a scale of 1"= 20' (1:200) may be used. Note the scale used on the sheet, typically identified in the sheet's title block. A bar scale should also be provided on the sheet for when the sheet is reduced.
4. North Arrow. Provide a North arrow on each detail sheet, preferably pointing towards the top of the plan sheet or towards the right. The North arrow should be uniform within each set of plans. The standard North arrow CADD cell should be used.
5. Note Orientation. In general, write all notes and dimensions horizontally from left to right, except for the following:
 - a. Plan Views. Stationing, at 100 ft (100 m) intervals, is placed vertically approximately 4 in (100 mm) above the centerline. Curve data is placed radially on the inside of the curve. Place curve controls, equations and angle points at right angles to the centerline in accordance with [Figure 23.2A](#).



ORIENTATION OF NOTES

Figure 23.2A

- b. **Special Considerations.** Where limited space for notes and dimensions makes horizontal placement detrimental to the readability of the plans, they may be placed vertically.

Do not write notes or dimensions from right to left in an inverted position. See Figure 23.2A for the proper way to illustrate notes.

6. **Use of Notes.** Notes on plan sheets should be brief, clear and consistent. Indicate any installations and removals by station and provide a brief description. Do not include detailed descriptions on the detail sheet. Place these descriptions on the Note Sheet.
7. **Drafting Details.** The MDT CADD Standards Manual illustrates the topography symbols and the corresponding CADD cells that should be used in preparing the detail sheets. [Figure 3.2A](#) provides the recommended abbreviations that should be used. [Section 3.2](#) also provides additional drafting details that should be reviewed when preparing detail sheets.
8. **Horizontal Alignment Data.** [Chapter Twenty-five](#) presents the criteria for horizontal alignment. Show the horizontal alignment data on the detail sheets and plans as follows:
 - a. **Horizontal Curve Data.** Where practical, place design centerline horizontal curve data, including superelevation, inside the curves to which they apply. Where a curve extends onto multiple sheets, show the curve data on the sheet where the PI is located. [Figure 23.2B](#) presents the order and rounding accuracy that should be used to present the curve data.

SPIRAL CURVE DATA	SIMPLE CURVE DATA	ACCURACY	
		US Customary	Metric
Δ	Δ	01°01'01"	01°01'01"
R_C (existing)	R (existing)	0.01 ft	0.001 m
R_C (new)	R (new)	10 ft	5 m
L_S		0.01 ft	0.01 m
θ_s		01°01'01"	01°01'01"
Δ_S		01°01'01"	01°01'01"
T_S	T	0.01 ft	0.01 m
L_C	L	0.01 ft	0.01 m
E_S	E	0.01 ft	0.01 m
S	S	1%	1%

**HORIZONTAL CURVE DATA
(Plan Sheets)**

Figure 23.2B

- b. **Curve Points.** Show perpendicular lines from the design centerline for all curve points. Indicate the curve notation (e.g., PC, PT, SC, TS) and station to the nearest hundredth of a foot (meter) (i.e., 0 + 00.01) along the perpendicular line. Include the PI station with the curve data.
 - c. **Bearings.** Write bearing notations below the line to which they apply. Note the bearing in degrees, minutes, and seconds, rounded to the nearest second (i.e., N 01° 01' 01" E).
 - d. **Offsets.** Where a conventional survey is used, note the offsets between the construction and survey centerlines at the beginning and end points where they are parallel to each other.
 - e. **Equations.** Equations are used to correct any stationing differences that may occur along the centerline. Show them perpendicular to the design centerline.
9. **Special Details.** In most cases, topography and other similar elements are typically not shown on the detail. Only show those elements that may affect the design of the intersection, interchange, etc. (e.g., existing traffic signals, highway lighting supports, utilities, railroads).

23.2.2 Intersection Details

Intersection detail sheets are generally provided where the intersection has significant details so that the information cannot be adequately shown on the plan and profile sheets. Intersection detail sheets are typically developed for most complex urban and rural intersections (e.g., intersection with turning lanes, turning roadways, lane tapers, traffic signals) and for ramp/cross road intersections at interchanges. Intersection detail sheets are generally not developed for minor intersections.

When preparing an intersection detail sheet, consider the following information:

1. Number of Intersections per Sheet. Typically, only one complex intersection should be shown per sheet. However, if the intersection does not have significant details and there is room on the sheet, two intersection details may be shown on the same sheet. Ensure that each intersection detail is adequately titled.
2. Sequence of Intersections. Show the intersections on the detail sheets as they are located along the mainline in order of increasing stations. Project stationing typically increases from south to north and west to east. Show the mainline intersections first and then any additional intersection off the mainline after the mainline intersections details.
3. Notation. Clearly label each street or roadway approach in the detail (e.g., Main Street, Ramp B-2).
4. Station Call Outs. Because intersections generally will have separate stationing for each roadway, ensure the applicable design centerline station is called out for the approach. Offsets are measured to the back of curbs. Provide station call outs at the following locations:
 - a. beginning and ending points of the project, if they are within the intersection detail;
 - b. the intersection point between the design centerlines for the roadways;
 - c. 100 ft (100 m) station increments;
 - d. horizontal curve control points (e.g., PC, TS, PT, PCC);
 - e. beginning and ending points of pavement and shoulder tapers, including the distance and direction from the design centerline;

- f. beginning and ending points of curb and gutter locations, including the distance and direction from the design centerline;
 - g. beginning or ending point for curb radii, including the distance and direction from the design centerline; also, for curb returns with compound curves, note the PCC station;
 - h. beginning and ending points of sidewalks, including the distance and direction from the design centerline;
 - i. curb openings, including the distance and direction from the design centerline;
 - j. curb ramp locations, including the distance and direction from the design centerline;
 - k. major utility or railroad crossings;
 - l. side street intersections or approaches;
 - m. construction permit locations and right-of-way breaks; and
 - n. other locations where deemed appropriate.
5. Tapers. For each pavement or shoulder edge taper, call out the station and the distance and direction from the design centerline. Also, note the taper rate adjacent to the taper.
6. Curb Returns. Radii are measured to the back of curbs. For each curb return, indicate the following:
- a. beginning and ending stations of the curb return;
 - b. the corner radii; for compound curves, note the radii for each curve;
 - c. the deflection angle, Δ ; and
 - d. for curb returns using the simple radius with taper designs, the taper rates for the beginning and exiting tapers.
7. Pavement Markings. Typically, pavement markings shown include centerlines, lane lines, edge lines, channelizing lines, transition tapers, stop lines, curb lines, crosswalks, lane-use control markings, etc. Do not note the type of pavement markings on the geometric detail. These callouts are provided in the signing and pavement marking plans.

8. Dimensions. Indicate the following dimensions on the intersection detail:
 - a. each travel lane width;
 - b. turn lane widths;
 - c. turning roadway widths;
 - d. shoulder widths;
 - e. median widths;
 - f. sidewalk widths;
 - g. offsets from the design centerline to lane lines, median edges, turning radii controls;
 - h. for turning roadways, island details (note that these may be shown in a blowup detail); and
 - i. special right-of-way widths.
9. Curb Ramps. Show the location of each curb ramp. Only show dimensions or design details for curb ramps if they vary from the MDT Detailed Drawings.

23.2.3 Interchange Details

Interchange layout detail sheets are provided for all new interchanges and whenever the alignments of existing ramps are revised. When developing interchange layout sheets, consider the following;

1. Station Call Outs. Provide station call outs at the following locations:
 - a. beginning and ending points of the project, if they fall within the interchange detail;
 - b. the intersection point between design centerlines of the mainline, crossroad and each ramp;
 - c. 100 ft (100 m) station increments;
 - d. horizontal curve control points (e.g., PI, PC, PT, TS, SC, PCC);

- e. beginning and ending points of exit and entrance freeway/ramp terminals, including the distance and direction from the mainline design centerline;
 - f. beginning and ending points of pavement and shoulder tapers, including the distance and direction from the design centerline; and
 - g. other locations where deemed appropriate.
2. Exit and Entrance Freeway/Ramp Junctions. Identify the beginning and ending points for each freeway/ramp junction by station, including the distance and direction from the freeway mainline. For taper ramps, also note the deflection angle. Add a note to the station calling out where the ramp begins and ends (e.g., Begin Ramp B-4, End Ramp B-1).
 3. Horizontal Curve Data. [Section 23.2.1](#) discusses the type of horizontal curve information that should be provided on the plan sheets. For clarity, the horizontal curve data for each ramp may be placed on an open area on the sheet. However, ensure that the data is clearly labeled for the user to identify which data applies to each curve.
 4. Dimensioning. Provide the following dimensions on interchange layout sheet:
 - a. lane widths;
 - b. ramp widths;
 - c. shoulder widths; and
 - d. any necessary offset dimensions from the design centerline of the mainline, crossroad or ramp to the applicable pavement edge or lane lines.
 5. Notation. Clearly label the mainline, crossroad, each ramp, frontage roads, etc. (e.g., Main Street, Interstate 15, Ramp B-2).
 6. Drainage Structures. Show all drainage structures on the layout sheet. However, do not call out these structures.
 7. Pavement Markings. For clarity, it may be necessary to show centerlines, lane lines, edge lines, stop lines, lane configurations, etc. However, do not call out these markings on the interchange layout sheet. These traffic control devices will be noted in the Signing Sheets.

23.2.4 Rest Areas/Weigh Stations Details

For rest areas and weigh stations, the Geometrics Unit is responsible for the overall layout design of a rest area or weigh station. In general, there are two types of rest areas and weigh stations — those along freeways and those along non-freeways with at-grade access points. When preparing rest area/weigh station details, consider the following:

1. Design Criteria. Sections 18.4 and 18.5 in the Montana Road Design Manual provide the design criteria for rest areas and weigh stations, respectively.
2. Station Call Outs. For facilities along freeways, the stationing for an interchange layout ([Section 23.2.3](#)) will apply (e.g., exit and entrance ramp station call outs). For facilities along non-freeways, the stationing for an intersection detail ([Section 23.2.4](#)) will apply.
3. Horizontal Curve Data. [Section 23.2.1](#) discusses the type of horizontal curve information that should be provided on the plan sheets. For clarity, the horizontal curve data for each curve may be placed on an open area on the sheet. However, ensure that the data is clearly labeled for the user to identify which data applies to each curve.
4. Tapers. For each pavement or shoulder edge taper, call out the station and the distance and direction from the design centerline. Also, note the taper rate adjacent to the taper.
5. Curb Returns. Radii are measured to the back of curbs. For each curb return, indicate the following:
 - a. beginning and ending stations of the curb return;
 - b. the corner radii; for compound curves, note the radii for each curve;
 - c. the deflection angle, Δ ; and
 - d. for curb returns using the simple radius with taper designs, the taper rates for the beginning and exiting tapers.
6. Dimensioning. Provide the following dimensions on the layout sheet:
 - a. lane widths;
 - b. ramp widths;
 - c. shoulder widths;
 - d. any necessary offset dimensions from the design centerlines;

- e. parking stall widths, lengths and angles (see Item 8);
 - f. sidewalk widths;
 - g. for weigh stations, scale location and dimensions; and
 - h. any other applicable dimension to lay out the detail.
7. Curb Ramps. Show the location of each curb ramp. Only show dimensions or design details for curb ramps if they vary from the MDT Detailed Drawings.
 8. Parking Stalls. Include all the applicable dimensions to adequately allow the contractor to construct and paint the parking areas. For additional guidance, review the following:
 - a. Section 18.1 of the Montana Road Design Manual for accessibility for disabled individuals (ADA criteria),
 - b. Section 18.4 of the Montana Road Design Manual for rest area parking,
 - c. Section 18.5 of the Montana Road Design Manual for weigh stations, and
 - d. [Section 31.4](#) of the Traffic Engineering Manual for off-street parking.
 9. Drainage Structures. Show all drainage structures on the layout sheet. However, do not call out these structures.
 10. Pavement Markings. For clarity, it may be necessary to show centerlines, lane lines, edge lines, stop lines, lane configurations, lane control markings, parking stall dimensions, crosswalks, etc. However, do not call out these markings on the detail sheet. These traffic control devices will be noted in the signing sheets.

23.2.5 Chain-up and Truck Turnout Details

For chain-up and truck turnouts, show the following on the detail sheet:

1. Station Call Outs. Provide station call outs at the following locations:
 - a. beginning and ending points of the project, if they are within the detail;
 - b. 100 ft (100 m) station increments;
 - c. horizontal curve points;
 - d. beginning and ending points of tapers, including distance and direction from the design centerline;

- e. beginning and ending points of curb and gutter locations, including distance and direction from the design centerline; and
 - f. other locations where deemed appropriate.
2. Tapers. For each pavement or shoulder edge taper, call out the station and the distance and direction from the design centerline. Also, note the taper rate adjacent to the taper.
3. Pavement Markings. For clarity, it may be necessary to show centerlines, lane lines, edge lines, etc. However, do not call out these markings on the detail sheet. These traffic control devices will be noted in the signing sheets.
4. Dimensions. Indicate the following dimensions on the turnout detail:
- a. each travel lane width;
 - b. shoulder widths;
 - c. turnout width;
 - d. offsets from the design centerline to lane lines, median edges, turning radii controls, etc.; and
 - e. right-of-way widths.

23.2.6 Mailbox Turnouts

The MDT Detailed Drawings present typical designs for mailbox turnout designs. In general, these designs should be used for most projects. Under certain circumstances, it may be necessary to modify these designs to meet site-specific conditions and a turnout detail will be required.

23.2.7 Truck-Runaway Ramps

Truck-runaway ramps will be designed on a site-by-site basis. When preparing these truck-runaway ramp details, review the literature and use engineering judgment.