MINT FARM PHASE 2 RAIL STUDY BY TRANSPO GROUP

I. General

A. DESIGN CRITERIA

Design criteria are established to provide a foundation for the development of spur track design at the Mint Farm Industrial Park. The criteria establish the technical engineering parameters that will be used in the design of the track. The design process must address site-related challenges in accordance with the design criteria and to minimize environmental challenges.

B. TRACKWORK PRACTICES

All trackwork practices described shall govern the design of track structure for the Mint Farm Industrial Park. Construction plans and specifications shall comply with these criteria based on the current requirements of the following:

1. Burlington Northern Santa Fe Railway (BNSF)

- *Engineering Standards*
- *Standard Plans*
- *Design Guidelines for Industrial Track Projects*

2. Washington Utilities and Transportation Commission (WUTC)

- *WAC Chapter 480-60, "Laws and Rules Relating to Railroads"*

3. American Railway Engineering and Maintenance-of-Way Association (AREMA)

- *Manual for Railway Engineering*

II. Track Alignment

A. HORIZONTAL TRACK ALIGNMENT

The track alignment shall be designed to maximize freight ride quality at the highest permissible safe-operating speeds.

1. General

The horizontal alignment shall consist of tangent sections connected by circular curves with spiral transition curves, unless otherwise approved by the Railroad. The track shall be stationed along the centerline of the right side track in the direction of increasing stationing. The right side track shall be designated as "Track 1" and the adjacent track (if present) as "Track 2". Stationing along track shall be the basic control for locating all other facilities along the route. Separate stationing shall be used for track where tracks are neither parallel nor concentric, where widened track centers are required around curves, or where tracks are in separate structures. The stationing along the adjacent track shall be equated to Track 1 at the points where parallel alignment resumes.

2. Tangent Sections

a. The minimum length of tangent between curved sections (except those with compound curves) shall be as follows:

Condition	Tangent Length
Minimum	100 feet
Absolute Minimum	80 feet

All tangent lengths below the minimum require Railroad approval.

b. All special trackwork shall be located on horizontal tangents.

3. Curved Sections

a. Circular Curves

Circular curves shall be defined by the chord definition of curvature, and specified by their degree of curvature. Degree of curve shall be converted to radius using the following formula:

$$R = \frac{180 \times 100}{D_c \times \pi}$$

Where:

R = radius of curvature in feet
D_c = degree of curvature

For multi track layouts, where two or more tracks follow the same general alignment, the tracks should be placed on concentric curves.

b. Superelevation

Superelevation shall be used in the terminal with the permission of the Railroad only. Yard track shall not be superelevated.

Superelevation shall be constant through the circular curve. Superelevation shall be achieved by maintaining the top of the inside rail at the top of rail (TOR) profile and raising the outside rail by an amount equal to the track actual superelevation. For curves with spirals, the superelevation transition shall occur linearly over the length of the spiral curve. For curves without spirals, the superelevation transition shall occur at a uniform rate.

Superelevation shall be per BNSF standards. Maximum underbalance shall be 2 inches for freight trains.

c. Spiral Curves

Spiral curves shall be provided between circular curves and horizontal tangents, and between adjacent circular curves of varying radius. Spirals shall be Talbot (clothoid) curves as defined by the AREMA Manual for Railway Engineering.

d. Compound Curves

Two consecutive curves constitute a compound curve if they join at a point of tangency where both curves are on the same side of the common tangent and the radii of the two curves are different.

Compound circular curves may be used provided that they are connected by an adequate spiral transition curve.

The minimum allowable spiral length between compound spiral curves shall be 50 feet.

Spiral transition curves may be omitted between compound circular curves when the following formula is met:

$$\Delta R_c \leq 0.34(R_s/V)^2$$

Where:

ΔR_c = the difference between the radii of the two circular curves in feet.
R_s = the radius of the smaller radius curve in feet.
V = the design speed in mph.

B. VERTICAL TRACK ALIGNMENT

1. General

The profile grade line shall be defined by the top of rail (TOR) of the low rail. Changes in the profile gradient shall be joined by parabolic vertical curves having a constant change in gradient along the length of the vertical curve. In areas of curved horizontal alignment where the profile is given for only one track, the grade of the second track shall be adjusted uniformly to accommodate for the differences in length throughout the curve.

2. Grades

Grades shall not exceed the maximums specified below:

Condition	Desirable	Maximum

Main Tracks	1.0%	3.0%
Spur Tracks	1.0%	5.0%
Unloading Tracks	0.0%	0.25%
Yard Tracks	0.0%	0.5%
Special Trackwork	1.0%	3.0%

The absolute maximum instantaneous grade shall not exceed 5% and must have Railroad approval.

When a vertical grade is located within a horizontal curve, the maximum grades shown above shall be reduced using the following formula:

$$G_c = G_t - 230/R_c$$

Where:

G_c = maximum grade allowed in a horizontal curve in percent
G_t = maximum grade allowed in tangent track (from above) in percent
R_c = radius of the horizontal curve in feet

The absolute minimum length of constant profile grade shall be 90 feet.

3. Vertical Tangents

The desired minimum length of tangent grade between vertical curves is 300 feet. The absolute minimum distance may be reduced to 100 feet with Railroad approval.

4. Vertical Curves

Tangents along the track shall be connected with parabolic vertical curves having a constant rate of change of grade.

a. Vertical Curve Length

The length of vertical curves shall be determined from BNSF standards, rounded up to the nearest 50 feet.

b. Combined Horizontal and Vertical Curves

Where possible, combined horizontal and vertical curves shall be avoided. Where a vertical curve must coincide with a horizontal curve, the length of the vertical curve shall be increased to 1.5 times the minimum required length.

C. SPECIAL TRACKWORK LOCATION

Special trackwork is defined as any type of turnout, crossover or rail crossing. All special trackwork shall be located on horizontal and vertical tangent.

For special trackwork the horizontal and vertical tangent shall extend from the distance specified below preceding the point of switch to the end of the long ties.

The minimum length of tangent track preceding a point of switch shall be as follows:

Condition	Tangent Length
Desirable	100 ft
Absolute Minimum	50 ft

Tangent length less than the minimum shall require Railroad approval

D. CLEARANCES

Clearances shall meet or exceed the minimum clearances described by the WUTC and the BNSF.

III. Trackwork

A. TRACK GAUGE

Track gauge shall be the standard gauge of 4 feet 8½ inches, measured between the inner (gauge) sides of the heads of the rails at a distance of ⅝" below the top of rails.

B. TRACK CONSTRUCTION TOLERANCES

Track construction tolerances are determined by taking into consideration safety, speed of operation and the type of service to be provided. The track construction tolerances are indicated in Table 1.

Table 1
Track Construction and Maintenance Tolerances

Type of Track	Gage Variation (1)	Cross Level and Superelevation Variation (1)	**Vertical Track Alignment**		**Horizontal Track Alignment**	
			Total Deviation (2)	Middle Ordinate in 62' Chord	Total Deviation (2)	Middle Ordinate in 62' Chord

Yard Track	+ 1/4" - 1/8"	± 1/4"	± 1"	± 1/4"	± 1/2"	± 1/8"

Notes:

(1) Variations of track gauge, cross level and superelevation shall not exceed 1/8 inch per 31 feet of track.

(2) Total deviation is measured between the theoretical and actual alignment at any point in the track.

C. BALLASTED TRACK

1. General

Proper design of the roadbed and ballast elements of the track structure is very important to provide an adequate foundation and to minimize the maintenance requirements of the railroad. Roadbed and ballast sections shall be designed and analyzed to minimize the overall ROW width required while providing a uniform, well-drained foundation for the track structure. The trackbed includes the subgrade, subballast, ballast, ties and rail with associated other track materials.

2. Subgrade

The subgrade is the finished surface of the roadbed below the subballast, supporting the loads transmitted through the rails, ties and ballast. The subgrade shall be compacted to at least 95% compaction of maximum dry density as determined by the current revision of ASTM D 698T (Procter Test). If laboratory results indicate that existing material is unsuitable, the material must be removed and replaced with clean, sound and properly compacted material, per ASTM standards.

Once information regarding the water table level, the subsoil and its properties are available, specific soil mechanics recommendations shall be prepared.

3. Sub-Ballast

The sub-ballast for all tracks shall consist of a uniform layer placed and compacted over the entire width of the subgrade following the profile and cross section thereof. Minimum depth of subballast for yard tracks shall be 6 inches. Additional depth shall be used when necessary to decrease subgrade pressure.

4. Ballast

a. Ballast is a selected crushed and graded hard aggregate material placed upon the subballast for the purpose of providing support for the rail and ties and distribution of the track loadings to the subgrade. AREMA states that ballast (plus subballast) must be of sufficient depth to distribute pressure between tie and subgrade. The ballast must sustain and transmit static and dynamic loads in three directions (transverse, vertical and longitudinal) and distribute those loads uniformly over the subgrade. The prime functions of the ballast are to drain the track system, distribute the rail vehicle loads to the subgrade, and hold the track in proper alignment, cross level and grade. It can also cushion the ride and isolate from the ground any vibrations that originate at the rail/wheel interface. It also permits relatively easy adjustment of the track alignment.

b. The gradation must provide the means to develop the stability and density requirements for the ballast section and provide the void space necessary to allow proper run-off of precipitation. AREMA size No. 5 shall be used in yards, industry tracks and other non-main line tracks using timber ties. For simplicity and uniformity, the same material quality specification, except for gradation, shall be used for all ballast installations.

c. For yard tracks, a minimum depth of 6 inches of ballast shall be used between the bottom of timber tie and the top of subballast. For unit train tracks, 12 inches of ballast shall be installed.

d. Crushed blast furnace slag or crushed limestone ballast is not permitted.

5. Walkways

Walkways shall be provided at switch stands for all turnouts. In yards and where switching is performed, walkways shall be installed along the length of the turnout and the track. Minimum walkway width shall be 2 feet 6 inches.

6. Timber Cross Ties

Yard tracks shall use timber cross ties 8 feet in length spaced 22 inches center to center. All cross ties shall be 7" grade, creosoted treated tie, 7 inches by 9 inches, conforming to AREMA specifications for Timber Ties.

7. Other Track Material

a. The standard rail fastening for timber cross ties in yard track shall consist of steel tie plates fastened to the cross tie with cut track spikes. Tie plates shall provide for a 40:1 cant to the running rail. Each rail will be spiked with two spikes per tie plate on tangent track staggered with inside spikes to the east or north and outside spikes to the west or south. On curves a third spike is required on the gauge side of the rail.

b. Rail anchors shall be installed to prevent the rail from running. Anchors shall be installed at the rate of 16 anchors per 39-foot panel for bolted track. For CWR, box anchor every second tie, except: box anchor 184 ties on each side of permanent bolted joints, railroad crossings, open deck bridges, and turnouts (including the turnout side).

8. **Running Rail**

   New or industrial quality 115 RE tee rail shall be used for yard ballasted track. Tee rail shall conform to the current AREMA "Specification for Steel Rails". Rail shall be bolted together to form continuous lengths. Joint bars, track bolts, nuts and split ring washers shall be based on BNSF standards.

D. SPECIAL TRACKWORK

The term "special trackwork" designates the trackwork units necessary where tracks converge, diverge, or cross one another. Special trackwork includes turnouts, diamond crossings, and crossovers. All tee rail special trackwork design shall be based on BNSF standards except as modified to meet the special conditions of the Railroad.

E. INSULATED JOINTS

Insulated joints shall be of the epoxy-bonded type. Insulated joints shall be used in the running rail wherever it is necessary to electrically isolate contiguous rails from each other in order to comply with track signaling or traction power criteria. Insulated joints shall be based on BNSF standards.

F. DERAILS

1. Either sliding or switch point derails shall be used to prevent out-of-control railway equipment from fouling adjoining or adjacent tracks. Derails shall be installed on the downgrade end of yard and secondary track, normally used for the storage of equipment, if this track is directly connected to the main line track and if its prevailing grade is descending toward the main line track. Derails shall be used at other track locations where they would be likely to prevent or minimize injury to personnel, and/or damage to equipment.

2. Derails shall be located so as to derail equipment in the direction away from the main line.

G. GRADE CROSSINGS

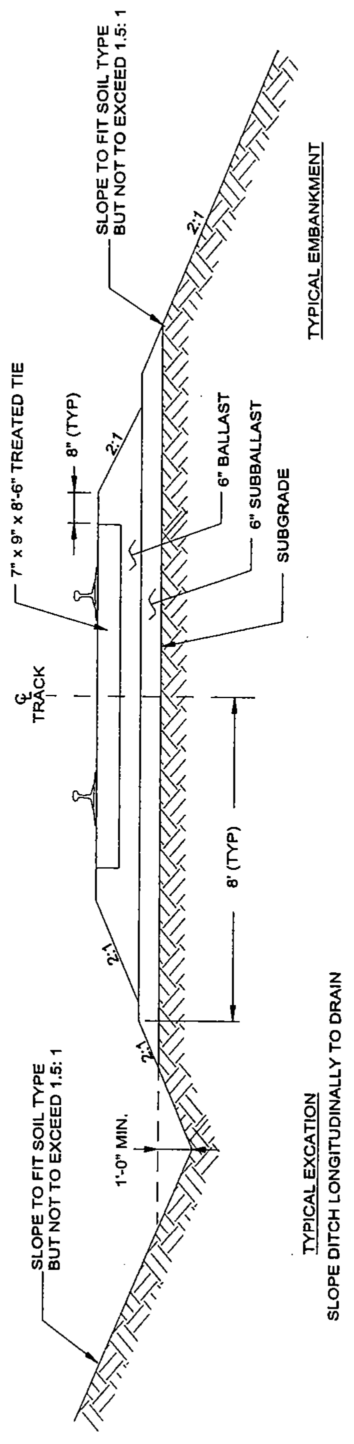
1. The design of at-grade crossings shall be based upon the use of conventional railroad grade crossing materials, including proprietary-design concrete panels with elastomeric rail isolation.

2. Private crossings shall be constructed using asphalt pavement with rubber headers. Timber panels are an acceptable alternative.

H. MISCELLANEOUS TRACK EQUIPMENT - BUMPING POSTS

Track bumping posts shall be designed to meet the coupler of the railroad vehicle. They shall be installed at the ends of all stub-end tracks. Sand pits beyond the end of track or energy absorbing "skate" bumping posts may also be considered at specific locations with prior approval of the Railroad.

END TRACK DESIGN CRITERIA



Design Critera
Ballasted Track Section