Appendix D Basis of Design

Basis of Design

Symmes Rd Railroad Crossing Elimination

City of Fairfield, Butler County, Ohio

Introduction

The basis of design presents the technical criteria to be followed for conceptual and preliminary engineering on Symmes Rd and N Gilmore Rd Railroad Crossing Elimination Project. The basis of design is being developed in coordination with the major project stakeholders: the Federal Railroad Administration (FRA); Butler County Transportation Improvement District (BCTID); City of Fairfield; and CSX Transportation, Inc. (CSXT).

This project contemplates two railroad crossing elimination projects in the City of Fairfield, Butler County, Ohio. The improvement projects to be evaluated include, but are not limited to, the following:

- Eliminate of the at grade railroad crossing on Symmes Road by constructing a new bridge over the CSXT railroad tracks.
- Modifications to the intersections of Symmes Rd with Hicks Blvd, Industry Drive, Tedia Way, and N Gilmore Road as a result of the grade separation.
- Elimination of the at grade railroad crossing on N Gilmore Rd by closing N Gilmore Rd and constructing cul-de-sacs on both sides of the CSXT railroad tracks.

The basic requirement for roadway geometric design shall be to provide safe, economical, and efficient vehicular and rail transportation through the corridor. The primary purpose of this basis of design (BOD) is to establish the technical criteria to be used for infrastructure concept design and preliminary engineering in the project.

Traffic

Traffic design shall be provided in accordance with all Ohio Department of Transportation (ODOT) established and published standards for Traffic Engineering.

Certified Traffic

Certified Traffic shall be developed using the Ohio Traffic Forecasting Manual and in accordance with Table 4-2 Traffic Forecasting Method Selection Criteria for a “Locally Administered, Not on State System, with Federal Funding” project that is considered Low Risk. This location qualifies for condition E (Other Growth Rate) when projecting traffic volumes for Opening and Design Years.

Detailed turning movement counts will be performed at the five (5) project intersections. The study intersections include Symmes Road and Hicks Boulevard, SR 4 (Dixie Hwy), Industry Drive, Tedia Way, and N Gilmore Road. The counts will be reviewed to determine the AM and PM peak periods within the project area. The ADT volumes will be developed by factoring the raw turning movement counts at each intersection with daily and seasonal adjustment factors obtained from the Ohio Department of Transportation’s webpage. The daily factors are dependent upon the functional classification of the roadway as well as the specific hours that the traffic count was performed. The seasonal adjustment factors are determined by the functional classification of the roadway, the day of the week and the month that the traffic count will be performed.

Design hour volumes (DHVs) will be developed for the study area using the peak hour to design hour factors that are published by the Ohio Department of Transportation Office of Statewide Planning and Research. The design hour factors utilized to develop the DHVs are dependent upon the roadway’s functional classification as well as the day of the week and month the count was performed. These design hour factors were then applied to the raw movement counts. The ADT and design hour volumes will be rounded to the nearest ten. Additional traffic will be added to the roadway network during the design hours to ensure that all movements show a minimum of 10 vehicles.

Developing the future traffic volumes involves developing a proposed growth rate based on historical traffic volume data, future known development data, and other factors. The historical data will be extracted from ODOT’s TIMS website for the study area.

Capacity Analysis

Capacity Analysis shall be performed in accordance with the ODOT Analysis and Traffic Simulation (OATS) manual. Synchro traffic analyses software will be utilized for conducting signalized intersection capacity analyses and HCS will be utilized for conducting roundabout analyses. The operational goals for all intersection analysis are shown in the table below.

Operational Goals (As Per OATS Manual)

Result	Inside An MPO	Outside of an MPO
Intersection LOS	D or better[1]	C or better[1]
Approach LOS	E or better[1]	
Control LOS	E or better[1]	
v/c[2]	All movements < 1.0 with ≤ 0.93 preferred	
QSR[3]	All movements < 1.0	

1: LOS is acceptable if QSR < 1.0; 2: v/c = Volume-to-Capacity ratio; 3: QSR = Queue-Storage ratio

Level of Service (LOS) thresholds are shown in the table below.

LOS Thresholds

LOS	Control Delay per Vehicle (seconds)	
	Signalized/Roundabout Intersections	Unsignalized Intersections
A	≤10	≤10
B	>10 and ≤20	>10 and ≤15
C	>20 and ≤35	>15 and ≤25
D	>35 and ≤55	>25 and ≤35
E	>55 and ≤80	>35 and ≤50
F	>80	>50

Roadway

Roadway Standards

For the design of roadway elements for the project, the designers shall utilize the AASHTO Policy on Geometric Design of Highways and Streets, 6th Edition, 2011, commonly referred to as the “Green Book.”

In addition to the Green Book, the following local standards have been used to develop the design criteria.

- ODOT Location & Design Manual, Volume 1 (L&D)
- Butler County Thoroughfare Plan 2007 (Updated 2017)
- Fairfield Forward – City of Fairfield Comprehensive Plan
- Fairfield Connects – City of Fairfield Connectivity Plans
- City of Fairfield Standard Construction Drawings

Roadway Design Designations

The following design designations for each roadway have been established by the roadway standards mentioned.

Design Designations							
Design Designation	**Symmes Rd**	**S.R. 4 (Dixie Hwy)**	**Hicks Blvd**	**Industry Dr**	**Tedia Way**	**N Gilmore Rd**	**Reference**
Current ADT (2028)	14,450	25,960	3,250	1,910	580	6,850	Design Traffic
Design Year ADT (2048)	15,970	28,690	3,600	2,110	640	7,570	Design Traffic
Design Hourly Volume (2048)	1,690	2,530	390	200	120	240	Design Traffic
Directional Distribution	74%	62%	67%	65%	50%	50%	Design Traffic
Trucks (24 hour B&C)	4%	3%	2%	2%	2%	2%	Design Traffic
Design Speed	40	40	30	30	30	30	L&D Section 104.2
Legal Speed	35	35	25	25	25	35	Posted Speed Limit
Design Functional Classification	Urban Minor Arterial	Urban Principal Arterial	Local	Local	Local	Urban Minor Arterial	ODOT Functional Classification Maps
NHS Project	No	Yes	No	No	No	No	FHWA National Highway System - Ohio

Roadway Design Criteria

The following design criteria for each roadway have been established by the roadway standards mentioned.

Symmes Road & N Gilmore Road Railroad Crossing Elimination
(Roadway Design Criteria)

Reference	Design Criteria	*Symmes Rd* Normal Design Criteria (NDC)	*S.R. 4 (Dixie Highway)* Normal Design Criteria (NDC)	*Hicks Blvd* Normal Design Criteria (NDC)	*Industry Drive* Normal Design Criteria (NDC)	*Tedia Way* Normal Design Criteria (NDC)	*N Gilmore Rd* Normal Design Criteria (NDC)	Comments
	Sight Distance							
L&D V1 -Section 201.2 & 201.2.1 Fig. 201-1	Stopping	250'	250'	155'	155'	155'	250'	
L&D Fig. 201-5	Intersection (Left Turn)	NA	NA	280'	280'	280'	280'	
L&D Fig. 201-5	Intersection (Right Turn)	NA	NA	240'	240'	240'	240'	
	Horizontal Alignment							
L&D Fig. 202-1	Max. Deflection without Curve	2° 45'	2° 45'	5° 30'	5° 30'	5° 30'	2° 45'	
L&D Fig. 202-2	Minimum Curve Radius	15° 30' (370 ft)	15° 30' (370 ft)	37° 00' (155 ft)	37° 00' (155 ft)	37° 00' (155 ft)	15° 30' (370 ft)	
L&D Fig. 202-8, L&D Fig. 202-9/9a, L&D Fig. 202-10	Max. Superelevation Rate	3.5%	3.5%	4%	4%	4%	3.5%	
	Vertical Alignment							
L&D Fig. 203-1E	Maximum continuous grade	7%	7%	10%	10%	10%	7%	Prefered maximum grade is 5%-6%.
L&D Sec. 203-2.2	Minimum continuous grade	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	
L&D Fig. 203-2	Max grade breaks w/o curve	0.95%	0.95%	1.85%	1.85%	1.85%	0.95%	
L&D Fig. 203-3	Rate of vertical curvature (crest)	29	29	12	12	12	29	
L&D Fig. 203-6	Rate of vertical curvature (sag)	49	49	26	26	26	49	
L&D Fig. 302-1	Minimum vertical clearence (ft)	16.5	16.5	14.5	14.5	14.5	16.5	
L&D Sec. 203-3.4	Minimum Desirable Length of curve	105'	105'	75'	75'	75'	105'	Three times design speed.
	Cross Section							
L&D Fig. 301-4 & 303-1	Lane Width	11'	11' (1-12' lane required)	11'	11'	11'	11'	National Truck Route (1-12' lane required in each direction)
L&D Fig. 301-3	Graded shoulder width (Lt)	8'	8'	8'	8'	5'	8'	
L&D Fig. 301-4 & Butler County Thoroughfare Plan	Treated shoulder width (Lt)	4'	4'	2'	2'	2'	4'	
L&D Fig. 301-3 & Butler County Thoroughfare Plan	Graded shoulder width (Rt)	8'	8'	8'	8'	5'	8'	
L&D Fig. 301-4	Treated shoulder width (Rt)	4'	4'	2'	2'	2'	4'	
L&D Fig. 301-4 & Butler County Thoroughfare Plan & Fairfield Connects Plan	Curbed shoulder width (Lt)	2' Gutter	8'	1' (4' w/ guardrail)	1' (4' w/ guardrail)	1' (4' w/ guardrail)	2' Gutter	
L&D Fig. 301-4 & Butler County Thoroughfare Plan & Fairfield Connects Plan	Curbed shoulder width (Rt)	2' Gutter	10'	1' (4' w/ guardrail)	1' (4' w/ guardrail)	1' (4' w/ guardrail)	2' Gutter	
	Curb Type	ODOT Type 2	ODOT Type 2	ODOT Type 3	ODOT Type 3	ODOT Type 3	ODOT Type 2	
L&D Fig. 301-3	Minimum Guardrail Offset	10'	10'	8'	6'	6'	10'	
L&D Sec. 301.1.4	Converging taper	20.416:1	20.416:1	10.416:1	10.416:1	10.416:1	20.416:1	
L&D Sec. 301.1.4	Diverging taper	50' Min	50' Min	50' Min	50' Min	50' Min	50' Min	
L&D Sec. 301.1.5	Cross slope (normal crown)	1.60%	1.60%	1.60%	1.60%	1.60%	1.60%	
L&D Sec. 307.2.1	Roadside grading	Clear Zone Grading (4:1)	Clear Zone Grading (4:1)	Clear Zone Grading (4:1)	Clear Zone Grading (4:1)	Clear Zone Grading (4:1)	Clear Zone Grading (4:1)	
L&D Fig. 600-1	Clear Zone Width	17'	17'	15'	15'	8'	17'	An Urban Lateral Offset of 8' may be used.
	Intersection							
L&D Fig. 401-15a & L&D Fig. 401-15b	Intersection Design Vehicle	SU-30 [A1]	SU-30 [A1]	SU-30 [A1]	SU-30 [A1]	SU-30 [A1]	SU-30 [A1]	[Degree of Encroachment]
L&D Fig. 401-15a & L&D Fig. 401-15b	Intersection Check Vehicle	WB-40 [A2] WB-62 [A2, arterial] WB-62 [B2, local]	WB-40 [A2] WB-62 [A2, arterial] WB-62 [B2, local]	WB-40 [B2] WB-62 [C2]	WB-40 [B2] WB-62 [C2]	WB-40 [B2] WB-62 [C2]	WB-40 [A2] WB-62 [A2, arterial] WB-62 [B2, local]	[Degree of Encroachment]
	Pedestrian/Bicycle Facilities							
MDG Section 2.5.1.1 & Butler County Thoroughfare Plan	Sidewalk Treatment	Sidewalk Both Sides	Sidewalk Both Sides	Sidewalk Both Sides	Sidewalk Both Sides	Shared Streets	Sidewalk Both Sides	
MDG Section 4.3.2 & Butler County Thoroughfare Plan	Sidewalk Width	5'	5'	5'	5'	5'	5'	
MDG Section 4.3.2 & Butler County Thoroughfare Plan	Buffer Width	4'-8'	4'-8'	4'-8'	4'-8'	4'-8'	4'-8'	5' Desired
MDG Section 2.5.2.1 & Butler County Thoroughfare Plan	Bicycle Treatment	Shared Use Path	Shared Lanes	Shared Lanes	Shared Lanes	Shared Lanes	Shared Lanes	High Active Transporation Demand and Need Area
MDG Section 5.3.1 & Butler County Thoroughfare Plan	Shared Use Path Width	11'	N/A	N/A	N/A	N/A	N/A	A shared-use path should be provided on the south side of Symmes Rd.
MDG Section 4.3.2 & Butler County Thoroughfare Plan	Buffer Width	4'-8'	4'-8'	4'-8'	4'-8'	4'-8'	4'-8'	5' Desired

Hydraulics

Drainage design shall be performed in accordance with the City of Fairfield Design, Construction, and Materials Specification Handbook Section 200.

Additionally CSXT will require roadway drainage components connecting to CSXT property will be required to match existing flow rates for all storms.

The following drainage design criteria have been developed based on the standards above.

Symmes Road & N Gilmore Road Railroad Crossing Elimination (Drainage Design Criteria)			
City of Fairfield Design, Construction, and Materials Specification Handbook Reference	**Design Criteria**		**Comments**
Section 201 - Storm Design Standards			
201.01 Frequency	Storm sewers, open ditches, drive culverts	10 year (10% AEP)	
	Roadway Culverts	25 year (4% AEP)	
	Protection for buildings	50 year (2% AEP)	
201.02 Runoff	100 acres or less	Rational method, Q=CIA	
	more than 100 acres	S.C.S. TR-55 method	
201.03 Overland Flow Time	Use Chart 201-A		
	First pavement inlet	min. 10 minutes	
	First ditch catch basin	min. 15 minutes	
201.04 Rainfall Intensity	Use Chart 201-B		
Section 201.05 - Stormwater Management Requirements			
201.05 2 a	Quantitative Control.	Detention/retention of stormwater will be required for each subdivision or land development and redevelopment activity unless specifically exempted.	
201.05 2 b	Qualitative Control.	Stormwater quality control shall be implemented into sites within developing and redeveloping areas in accordance with general and specific requirements outlined in the latest edition of the Ohio EPA General (NPDES) permit for stormwater discharges associated with construction activity (see Part IIIG2e of the Ohio EPA's NPDES permit (Permit No. OHC0005 or latest edition).)	ODOT's L&Dv2 will be used for post construction BMP design
201.05 2 d	Stormwater Detention Must Meet Current Standards.	Stormwater detention is required if the impervious surface increases more than 50%	
201.05 2 e	Stormwater Detention Improvements Shall Be Made To Improve The Impact Of The Stormwater Runoff From The Site	Site developed after 1980 shall be considered C=0.3	
201.05 2 f	Stormwater Quality	Entire site shall be treated	
Section 202 - Storm Sewers			
202.02	Values for mannings "n"	Refer to section 1104.4.5, and Figure 1105-2 of the current ODOT, Location and Design Manual, Volume 2, Drainage Design	
202.03	Minimum pipe size	12 inches	
202.04	Minimum cover	2 feet to top of pipe or as recommended by the manufacturer	
202.05	Min. mean velocity	3 fps	
202.06	Max mean velociy	14.0 feet per second for Corrugated Metal Pipe 20.0 feet per second for Plastic and Concrete Pipe	
202.07	Max manhole spacing	400 feet for pipes 36" and under	
202.08	Manhole placement	Intersections, termini of sewers, changes in size and/or slope, changes in alignment (36 inches and under), places where inlet leads are to be connected	
202.08	Manhole placement	Drop manholes are required at stream entrances for storm sewer outfalls if the difference between stream and pipe inverts is greater than 12 inches. The manhole outlet pipe shall be directed with the flow of the stream	
202.09	Maximum Inlet Spacing	Flat (0.3% - 1.0%) 150' - 250' (normal conditions) Normal (1.0% - 5.0%) 250' (normal conditions) Steep (5% & greater) 150' - 250' (normal conditions)	Spacing shall be governed by a 2 inch allowable depth of gutter flow based upon a 10 minute time of concentration and a 10 year design storm if it would be less than the above spacing
202.09	Maximum Inlet Spacing	All low spots, where the street grade changes to a flatter slope, dead end of descending streets, at P.C. or P.T. of all intersection radius curves where the curb and gutter grade descends toward radius curve, (locate on property line extended or at mid-lot). Vane grates will be required for all street grades in excess of 2 percent	
202.09	Maximum Inlet Spacing	Modified Type 3 and Type 3A Catch Basins drawing on Page 1 of the Standard Construction Drawings	
202.1	Outlet protection	3 fps or less No protection required 3 fps to 5 fps Sodded ditch 5 fps to 18 fps Rock channel protection (If the mean velocity is between 5 fps and 18 fps, dumped rock channel protection will be as per Figure 1107-1 of the current ODOT Location and Design Manual, Volume 2.) greater than 18 fps Special outlet protection	
202.11	Steep slope protection	Sewers of a 15% slope or greater shall be anchored with concrete anchors spaced as follows: - Grades from 15% to 35% shall be anchored on 36 feet center to center. - Grades from 35% to 50% shall be anchored on 24 feet center to center. - Grades from 50% and over shall be anchored on 16 feet center to center.	
202.12	Headwalls	Headwalls or end sections will be per ODOT specifications. Full height headwalls will be required in rear and side yard areas	
Section 203 - Channel Design			
	Mannings "n" values	Rock lined channels = 0.08 Grass Channels = 0.03 Concrete/Asphalt Lining = 0.015	
	Side slopes	Desired 4:1 Maximum is 3:1	
	Minimum Freeboard	1 foot	
	Minimum Grade	Grass 1.0 % Concrete 0.35%	The minimum grade for all ditches shall be 1 percent except for streams, large channels with a paved bottom, and slopes paved to a height approved by the City Engineer
	Channel Protection	Seeding 0% - 2% Sodding 2% - 5% Lining > 5% and at all channel curves and at junctions with other channels.	Where possible, natural streams, including growth along the banks, shall not be disturbed. Roughness coefficients and increased peak flows and velocities shall be evaluated to determine stability
Section 204 - Materials			
204.06	Pipe Material Specification for Storm Sewer	Items 611, 706 and 707 of the current State of Ohio Department of Transportation Construction and Material Specifications shall apply	All pipes that cross under road pavement/curbs shall be reinforced concrete pipe.
		Corrugated/Smooth Metal Pipe	All corrugated/smooth metal pipes shall be aluminized type 2 coated, welded, seam pipe conforming to ODOT specifications unless approved by the Public Works Director
204.07	Manholes, Catch Basins, & Structures	See Item 611 of the current State of Ohio Department of Transportation Construction and Material Specifications	

Bridges and Structures

CSXT has minimum requirements for outside parties constructing bridges over CSXT's railroad tracks. These requirements are intended to provide safe and continuous passage of all train traffic during and after construction of bridges over its tracks. The *CSXT Public Projects Information Manual*, including but not limited to the Overhead Bridge Criteria Appendix, provides information on the CSXT requirements for overhead bridges.

Overhead bridges for roadways will be developed in accordance with the *ODOT Bridge Design Manual* and requirements of the *AASHTO LRFD Bridge Design Specifications, 9th Edition*.

The following is a summary of more pertinent design items:

- Roadway bridge design loading:
  - Vehicular Live Load = HL-93
  - Future Wearing Surface = 0.060 kips per sq. foot

- CSXT requirements:
  - Vertical Clearance – A minimum vertical clearance of 23'-0" shall be provided, measured from top of high rail to lowest point of structure in the horizontal clearance area which extends 6'-0" either side of the centerline of track
  - Horizontal Clearance - Standard horizontal clearance from centerline of the track to the face of the pier or abutment shall typically be 25'-0" or greater.
  - Where the horizontal clearance from the centerline of the track to the face of a pier or abutment is greater than 25'-0", no crash wall will be required. Where this clearance is 25'-0" or less, a crash wall shall be required in accordance with AREMA Chapter 8, Section 2.1.5.
  - MSE walls are prohibited on or adjacent to CSX property.
  - All overhead roadway structures shall have a protective fence to extend at least 8'-0" from the top of the sidewalk or driving surface adjacent to the barrier wall. The fence may be placed on top of the barrier wall. Fencing should include anti-climbshields or be of a configuration to minimize the likelihood of climbing on the outside of the protective fencing.
    - ODOT's standard curved vandal protection fence (per Std Dwg VPF-1-24) will encroach over the roadway if there is no sidewalk underneath. May be able to increase the required height of the straight fence instead.
  - New overhead bridges shall clear span CSX's right-of-way.
    - This requirement is not feasible for this project due to the amount of property CSX owns in the area of the proposed bridge. Subsequent discussions with CSXT need to be had to determine the appropriate clear span distance for the project.

Conclusion

All proposed designs for construction shall be reviewed by the City of Fairfield and the BCTID. All proposed designs for construction on CSXT property shall be reviewed and approved by CSXT. Designers shall in all instances adhere to these criteria in the design of the Symmes Rd and N Gilmore Rd Railroad Crossing Elimination Project. In cases where these criteria cannot be met, or where a variance from the criteria would improve the performance or cost-effectiveness of project infrastructure, the designer shall submit in writing the details of the purpose and need for a variance from the design criteria. Variances from the criteria must be approved on a case-by-case basis for a specific location in advance of their incorporation into the design of the project by all affected major project stakeholders. Designers shall request all variances to the criteria in writing. The basis of design is applicable to areas where new construction or major remodeling might occur. Existing areas that remain unchanged are exempt from the design criteria as well as the approvals and design variance process.